Lucent Technologies
Bell Labs Innovations

5ESS® Switch National ISDN Basic Rate Interface Specification

5E11 and Later Software Releases

235-900-341
Issue 6.00
October 1999

Notice

Every effort was made to ensure that the information in this IP was complete and accurate at the time of publication. However, information is subject to change.

This IP describes certain hardware, software, features, and capabilities of Lucent Technologies products. This IP is for information purposes; therefore, caution is advised that this IP may differ from any configuration currently installed.

Lucent Technologies is the successor to the business and assets of AT&T Network Systems business unit.

Mandatory Customer Information

Interference Information: Part 15 of FCC Rules – Refer to the *5ESS*® Switch Product Specification IP.

Trademarks

Warranty

Warranty information applicable to the *5ESS*® switch may be obtained from the Lucent Technologies Account Management organization. Customer-modified hardware and/or software is not covered by this warranty.

Ordering Information

This IP is distributed by the Lucent Technologies Customer Information Center in Indianapolis, Indiana.

The order number for this IP is 235-900-341. To order, call:

1–888–LUCENT8 (1–888–582–3688) or fax to 1–800–566–9568 (From inside the continental United States)

1–317–322–6847 or fax to 1–317–322–6699 (From outside the continental United States).

Support Telephone Numbers

Information Product Support Telephone Number: To report errors or ask nontechnical questions about this or other IPs produced by Lucent Technologies, call 1–800–645–6759.

Technical Support Telephone Numbers: For initial technical assistance, call the North American Regional Technical Assistance Center (NARTAC) at 1–800–225–RTAC (1–800–225–7822). For further assistance, call the Customer Technical Assistance Management (CTAM) Center:

1–800–225–4672 (From inside the continental United States)

1–630–224–4672 (From outside the continental United States).

The CTAM center is staffed 24 hours a day, 7 days a week.

Acknowledgment

Developed by Lucent Technologies Customer Training and Information Products.

How Are We Doing?

Title: ***5ESS*® Switch National ISDN Basic Rate Interface Specification 5E11 and Later Software Releases**

Identification No.: **235-900-341** Issue No.: **6.00** Date: **October 1999**

Lucent Technologies welcomes your feedback on this Customer Information Product (CIP). Your comments can be of great value in helping us improve our CIPs.

1. Please rate the effectiveness of this CIP in the following areas:

	Excellent	Good	Fair	Poor	Not Applicable
Ease of Use					/////////////////
Clarity					/////////////////
Completeness					/////////////////
Accuracy					/////////////////
Organization					/////////////////
Appearance					/////////////////
Examples					
Illustrations					
Overall Satisifaction					/////////////////

2. Please check the ways you feel we could improve this CIP.

❒ Improve the overview/introduction
❒ Improve the table of contents
❒ Improve the organization
❒ Include more figures
❒ Add more examples
❒ Add more detail
❒ Make it more concise/brief
❒ Add more step-by-step procedures/tutorials
❒ Add more troubleshooting information
❒ Make it less technical
❒ Add more/better quick reference aids
❒ Improve the index

Please provide details for the suggested improvement. ______________________

____

3. What did you like most about this CIP?

____

____

4. Feel free to write any comments below or on an attached sheet.

____

____

____

____

If we may contact you concerning your comments, please complete the following:

Name: ______________________ Telephone Number: ____________

Company/Organization: ______________________ Date: ____________

Address: ______________________________________

When you have completed this form, please fold, tape and return to address on back or Fax to: 336 727-3043.

--- Do Not Cut — Fold Here And Tape ---

Lucent Technologies
Bell Labs Innovations

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 1999 GREENSBORO, NC

POSTAGE WILL BE PAID BY ADDRESSEE

DOCUMENTATION SERVICES
2400 Reynolda Road
Winston-Salem, NC 27199-2029

How Are We Doing?

Title: ***5ESS*® Switch National ISDN Basic Rate Interface Specification 5E11 and Later Software Releases**

Identification No.: **235-900-341** Issue No.: **6.00** Date: **October 1999**

Lucent Technologies welcomes your feedback on this Customer Information Product (CIP). Your comments can be of great value in helping us improve our CIPs.

1. Please rate the effectiveness of this CIP in the following areas:

	Excellent	Good	Fair	Poor	Not Applicable
Ease of Use					/////////////////
Clarity					/////////////////
Completeness					/////////////////
Accuracy					/////////////////
Organization					/////////////////
Appearance					/////////////////
Examples					
Illustrations					
Overall Satisifaction					/////////////////

2. Please check the ways you feel we could improve this CIP.

❒ Improve the overview/introduction
❒ Improve the table of contents
❒ Improve the organization
❒ Include more figures
❒ Add more examples
❒ Add more detail
❒ Make it more concise/brief
❒ Add more step-by-step procedures/tutorials
❒ Add more troubleshooting information
❒ Make it less technical
❒ Add more/better quick reference aids
❒ Improve the index

Please provide details for the suggested improvement. ______________________________

____

3. What did you like most about this CIP?

____

____

4. Feel free to write any comments below or on an attached sheet.

____

____

____

____

If we may contact you concerning your comments, please complete the following:

Name: ______________________________ Telephone Number: ______________

Company/Organization: ______________________________ Date: ______________

Address: ____

When you have completed this form, please fold, tape and return to address on back or Fax to: 336 727-3043.

--- Do Not Cut — Fold Here And Tape --

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

Lucent Technologies
Bell Labs Innovations

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 1999 GREENSBORO, NC

POSTAGE WILL BE PAID BY ADDRESSEE

DOCUMENTATION SERVICES
2400 Reynolda Road
Winston-Salem, NC 27199-2029

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF TABLES

1. INTRODUCTION

1.1 PURPOSE

This document contains the specification for the National Integrated Services Digital Network (ISDN) basic rate user-network interface between the *5ESS*® switch and the standard terminals. This interface includes the physical layer, the data link layer, and the network layer for the basic rate interface (BRI).

Terminal manufacturers who design customer premises equipment (CPE) to support the complete set of services, or a subset of services, offered by the *5ESS* switch National ISDN BRI must use this document as their source for the interface requirements. These services may be offered for basic voice, supplementary voice, circuit-switched data, or packet-switched data (both permanent and on-demand).

When processing a service order, the *5ESS* switch marks a National ISDN BRI as "standard." The switch supports one to eight terminals, including any mix of standard fully initializing terminals (FITs) for circuit-switched voice (CSV), circuit-switched data (CSD) and packet services, and standard noninitializing terminals (NITs) for on-demand B-channel (ODB) packet and permanent packet D-channel (PPD) services. FITs and NITs are described in Section 6, "Terminal Initialization."

1.1.1 USING THIS INTERFACE SPECIFICATION

This specification should be used as the source of complete details on this standard interface to clarify the implementation of the switch and the interpretation of technical reference (TR) requirements. These details describe the *5ESS* switch offerings in terms of the support of NI-1, NI-2, and NI-3.

National ISDN is an evolving platform in which new features will be introduced continuously for new revenue opportunities, for improved operational efficiencies, and for support of specific applications. NI-1, NI-2, and NI-3 represent specific features, as documented in Bellcore SRs 1937, 2120, and 2457. To denote more specifically the availability of National ISDN features, such as NI-95 and NI-96, the industry is migrating to an additional terminology. A feature (NI-96, for example) is included in a specific version if the switch vendors can offer it by the first quarter of the year.

Beginning with the 5E12 software release, *5ESS* switch supports the protocols and services defined by Bellcore for the NI-3 standard interface. This specification covers, over and above the NI-3 services, additional supported services that require the use of NI-3 protocols.

NI-3 is a set of features offered on the standard user-network interface by *all* switches that vendors have designed for support of NI-3. NI-1 provided a standard protocol with little attention to the many vendors' various feature operations. NI-2 provided standardized operations for a number of features, based on their respective Bellcore TRs. These features are Additional Call Offering, Call Forwarding, Electronic Key Telephone Service (EKTS), and Flexible Calling. NI-3 includes support for additional features including Inspect, Call Appearance Reservation, Priority Calling for EKTS, and Parameter Downloading Type 2 to support the new EKTS capabilities.

This interface specification is expected to change as requirements and standards evolve. Therefore, Lucent Technologies reserves the right to change or delete any portions of the document, or to add information in future issues.

NOTE: LUCENT TECHNOLOGIES EXPRESSLY DISCLAIMS ANY WARRANTY AS TO THE ACCURACY OR COMPLETENESS OF INFORMATION

CONTAINED IN THIS DOCUMENT, AND ASSUMES NO RESPONSIBILITY FOR THE USE OF THE INFORMATION BY OTHERS.

1.1.2 THE ALTERNATIVE INTERFACE—CUSTOM ISDN BRI

The *5ESS* switch supports, in addition to this National ISDN BRI, distinct ISDN protocols and services defined for its Custom ISDN BRI. That user-network interface supports both point-to-point service and multipoint service. Complete information on the Custom ISDN BRI is provided in document 235-900-343, **5ESS** *Switch Custom ISDN Basic Rate Interface Specification*.

1.2 UPDATE INFORMATION

1.2.1 NEW IN THIS ISSUE

The following changes have been made for this issue:

- To reflect that the *5ESS* switch will accept an invoke ID of *one or two* octets in an Invoke component, the following elements of this document have been changed:
  - Section 4.1.3.5.5.2, “Invoke Identifier”
  - Section 7.1.1.10.1, “Invoke IDs in Components Received by the Switch”
  - Section 7.1.1.10.2, “Invoke IDs Used in Components Sent by the Switch”
  - Section 7.1.3.5, “Protocol Error Treatment.”
- To reflect that ISDN Feature Button Intercom Calling is not supported on the National ISDN BRI, Section 5.2.1.21.1, “Overview of EKTS Features,” and Section 5.2.1.21.3.2, “EKTS Group,” have been revised, and two process flow diagrams under the figure name “ISDN Feature Button Intercom Calling” have been removed.
- To reflect support of the 4-digit carrier identification code (CIC) used in a 7-digit carrier access code, the following elements of this document have been changed:
  - Section 4.2.1.2.4, “Keypad Equivalent of Functional Addressing without Dialing/Routing”
  - Table 4.2.1-1, “Keypad Equivalent of Functional Addressing without Dialing/Routing”
  - Table 5.1.1-1, “Keypad Equivalent of Functional Addressing with Private Dialing”
  - Section 5.2.1.10, “BRI Access to Interexchange Carrier Services.”
- Section 4.3.2.8, “Always On/Dynamic ISDN (AO/DI),” has been added to describe support of the AO/DI feature.
- Section 5.2.1.43, “Private Facility Access,” has been revised to reflect that toll-free numbering plan areas (NPAs) are not limited to the 800 prefix.

Where technical content has been changed, vertical bars in the outer margin mark the affected pages.

1.2.2 LUCENT TECHNOLOGIES

As a result of the AT&T divestiture, the AT&T Network Systems division became Lucent Technologies, a separate and independent corporation. The *5ESS* switch and many other network and transmission products became products of Lucent

Technologies. The marketing, sales, engineering, delivery, installation, support, and future development of these products are now provided by Lucent Technologies.

Therefore, the corporate name and logo on this document's cover, spine, and title page are changed from the AT&T brand to the Lucent Technologies brand. The AT&T name is being removed from the content (where appropriate), as well as from the 9-digit document order number.

Not all pages of this document are being reissued to make these changes; instead, the pages will be reissued over time, as technical and other changes are required. Customers on standing order for this document may see references to the AT&T name on previous-issue pages. Customers receiving new orders for this document will see the references changed to the Lucent Technologies name throughout the document as appropriate. Exceptions may exist in software-influenced elements such as input/output messages, master control center screens, and recent change/verify screens. These elements will not be changed in this document until such time as they are changed in the software code.

Document updates will not be made specifically to remove historical references to AT&T, especially in cases where the Network Systems division of AT&T, now Lucent Technologies, provided the product or service in question.

1.2.3 SUPPORTED SOFTWARE RELEASES

In accordance with the *5ESS* Switch Software Support Plan, the 5E10 software release was rated Discontinued Availability (DA) as of November 13, 1998, and the 5E11 software release will be rated DA as of November 13, 1999. The information supporting 5E10 and earlier is being removed over time, instead of concurrently, from all documentation.

If you are supporting offices that use a software release prior to 5E11 and have a need for the information that is being removed, retain the associated pages as they are removed from the paper documents, or retain the earlier copy of the CDROM.

1.2.4 TERMINOLOGY

This *5ESS* switch document may contain references to the *5ESS* switch, the 5ESS-2000 switch, and the 5ESS AnyMedia Switch. The official name of the product has been changed back to the *5ESS* switch. The documentation will not be totally reissued to change these references. Instead, the changes will be made over time, as technical changes to the document are required. In the interim, assume that any reference to the 5ESS-2000 switch or the 5ESS AnyMedia Switch is also applicable to the *5ESS* switch. It should be noted that this name change may not have been carried forward into software-influenced items such as input and output messages, master control center screens, and recent change/verify screens.

As a result of the World Telecommunications Standardization Conference held March 1-12, 1993, the International Telegraph and Telephone Consultative Committee (CCITT), no longer exists as an organization under the International Telecommunication Union (ITU). According to the ITU, the CCITT is now referred to as the International Telecommunication Union - Telecommunication Standardization Sector (ITU-TS).

For new and revised Recommendations issued by the ITU-TS, the term "CCITT Recommendation X.xxx" will be replaced by the "ITU-T Recommendation X.xxx" designation. For a transition period from 1993 to 1997, if the Recommendation had a previous CCITT designation, the new name will include "(formerly CCITT Recommendation X.xxx)." Names of existing CCITT Recommendations will not change unless revised.

As of March 18, 1999, Bellcore officially changed its name to Telcordia Technologies. Not all pages of this document are being reissued to reflect this change; instead, the pages will be reissued over time, as technical and other changes are required. Customers on standing order for this document may see that, on previous-issue pages, the Bellcore name is still exclusively used.

Customers receiving new orders for this document will see the Telcordia Technologies name used as appropriate throughout the document, and the Bellcore name used only to identify items that were produced under the Bellcore name. Exceptions may exist in software-influenced elements such as input/output messages, master control center screens, and recent change/verify screens. These elements will not be changed in this document until such time as they are changed in the software code. Document updates will not be made specifically to remove historical references to Bellcore.

1.3 ORGANIZATION

The content of this interface specification is organized as follows.

1.3.1 ABOUT SECTION 2, PHYSICAL LAYER

Section 2 section consists of the following subsections.

1.3.1.1 About Section 2.1, S/T Interface

Section 2.1 describes the S/T interface, which is used typically for intrabuilding applications when the distance between the switch and the terminals cause less than 6 dB of loss. The S/T interface is consistent with ITU-TS Recommendation I.430 and with *ANSI*[1] standard T1.605-1991. The S/T interface supports point-to-point and multipoint interconnections. If the user is served by a U interface from the switch, then an S/T interface terminal requires a network termination equipment, NT1, to connect it to the U interface. The S/T interface has an aggregate rate of 192 kbps.

1.3.1.2 About Section 2.2, *ANSI* U Interface

Section 2.2 describes the 2-wire U interface, which is used typically for longer distances and for applications where connection between the switch and the terminals include an outside plant cable. The U interface is consistent with *ANSI* standard T1.601-1991 for domestic use, and is under study by the ITU-TS for international use. If the user is served by a U interface from the switch, then an S/T interface terminal requires a network termination equipment, NT1, to connect it to the U interface. The U interface has an aggregate rate of 160 kbps.

1.3.2 ABOUT SECTION 3, DATA LINK LAYER

This section describes the proper operation of the link access procedure on the D-channel, based on ITU-TS Recommendations Q.920 (I.440) and Q.921 (I.441). The specification includes all essential data link layer functions such as frame delimiting, error detection/recovery, and flow control. More specifically, it supports point-to-point and broadcast data links, modulo 128 operation, automatic and manual assignment of terminal endpoint identifier (TEI), exchange identification (XID) audit, and parameter notification. The last two items are extensions that are not covered in the 1988 ITU-TS Recommendations. Multiple D-channel signaling and packet links are

---

1. Registered trademark of American National Standards Institute.

supported for custom multipoint operation and standard BRI operation and are identical for standard and custom operation.

1.3.3 ABOUT SECTION 4, NETWORK LAYER—BASIC CALL

Section 4 consists of the following subsections.

1.3.3.1 About Section 4.1, Message Definitions

This section defines all network layer messages used on the standard interface in this specification. The information elements used with each message are identified, and the coding rules and call control states are defined.

1.3.3.2 About Section 4.2, Basic Call Control for Circuit Mode Voice and Data Services

This section describes the procedures for establishing, maintaining, and clearing basic voice connections on a standard BRI. These procedures are defined in terms of messages exchanged over the D-channel. The messages are based on Bellcore NI-1, NI-2, and NI-3 documents and TRs.

Specification description language (SDL) diagrams are included for a description of the call control procedures, as viewed from the user side, for both call origination and termination.

1.3.3.3 About Section 4.3, Packet Services

This section specifies the call control procedures for packet transport mode data calls. Both the B- and D-channels support on-demand packet transport mode and permanent packet transport mode.

Packet transport mode connections for permanent B- and D-channels are established through the service order process (that is, provisioned). B-channels for on-demand packet transport mode are established using Q.931 procedures, consistent with Recommendation X.31. D-channels for on-demand may also use Q.931 procedures to terminate packet calls for noninitializing terminals. Virtual calls are signaled through X.25 procedures at the network layer on the permanent or on-demand connection. Permanent virtual circuits are established through the service order process and are supported on permanent B- and permanent D-channel connections. At the data link layer for packetized data, link access procedure-balanced (LAPB) is used on the B-channel and LAPD is used on the D-channel.

On packet transport mode connections, the network provides all essential X.25 facilities. Also available are additional X.25 and non-X.25 facilities.

The SDLs are included for a description of the call control procedures, as viewed from the user side, for both call origination and termination.

1.3.4 ABOUT SECTION 5, NETWORK LAYER—SUPPLEMENTARY SERVICES

Section 5 consists of the following subsections.

1.3.4.1 About Section 5.1, Common Protocols and Procedures for Voice and Data Services

This section describes the generic call control procedures for invoking supplementary services (for example, dial access procedures and feature button usage to invoke call forwarding or centrex-like business group features). It describes the terminologies (such as network determined busy) that apply to many of the supplementary services. It also describes the stimulus signaling protocols (that use feature buttons and access codes).

1.3.4.2 About Section 5.2, Supplementary Voice Services

This section describes the procedures used for the voice services. The procedures are defined in terms of messages exchanged over the D-channel. The messages and procedures are built on those specified in "Message Definitions," Section 4.1, and "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

The SDL diagrams are included for a description of the call control procedures, as viewed from the user side for conference, drop, transfer, hold, and key systems.

For 5E11, the Inspect feature was added.

1.3.4.3 About Section 5.3, Supplementary Data Services

This section defines procedures for supplementary data services for circuit transport mode calls. The data services constitute a subset of the supplementary voice services. The procedures, defined in terms of messages exchanged over the D-channel, are mostly identical to the procedures defined for voice services; exceptions are noted in the text. The procedures and messages contained in this section use those of "Message Definitions," Section 4.1, and "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, as a basis.

1.3.5 ABOUT SECTION 6, TERMINAL INITIALIZATION

This section defines the protocol and procedures for initialization. The endpoint initialization procedures are needed for some service configurations on a standard BRI.

1.3.6 ABOUT SECTION 7, COMMON ELEMENT PROCEDURES FOR SERVICE CONTROL

This section describes a functional mechanism for the user and network to exchange supplementary service information for service control. There are four components defined for this control. The components are a structured sequence of octets used to carry service-specific information in both the terminal-to-network and the network-to-terminal directions.

1.4 USER FEEDBACK

The producers of this manual are constantly striving to improve quality and usability. Please use the enclosed user comment form (available in paper documents only) to give us your comments and to advise us of any errors. Alternatively, you can write to us at the following address:

Lucent Technologies
Documentation Services
2400 Reynolda Road
Winston-Salem, NC 27106

Please include the issue number and/or date of the manual, your complete mailing address, and telephone number. We will answer all correspondence within 30 days informing you of the disposition of your comments.

You may also call our Documentation HOT LINE if you need an immediate answer to a documentation question. This HOT LINE is intended to enhance the comment process. The HOT LINE number is **1-800-645-6759** and it is available from 7:30 a.m. to 6:00 p.m. eastern standard time. Outside of those hours, the line is served by an answering machine. You can leave a message on the answering machine and someone will return your call the following business day.

Document users who have access to electronic mail facilities may send comments via electronic mail to **hotline5@wrddo.lucent.com**. When sending comments via electronic mail, please make sure that the document title, document number, document issue number, and/or document date are included in the mail along with your name, phone number, and address.

1.5 DISTRIBUTION

This manual is distributed by the Lucent Technologies Customer Information Center in Indianapolis, Indiana. Most service providers should place orders through their documentation coordinator. Some companies may allow customers to order directly from the Customer Information Center; however, the majority do not. Companies that use documentation coordinators to manage their orders receive a significant discount. If you do not know the name/number of the documentation coordinator for your company, you may call **1-888-582-3688** to obtain their name and telephone number.

Customers not represented by a documentation coordinator and employees of Lucent Technologies can order the documentation for the *5ESS* switch directly from the Customer Information Center. Proper billing information must be provided. These orders may be mailed to:

Lucent Technologies Customer Information Center
Order Entry
2855 N. Franklin Road
Indianapolis, IN 46219

Orders may also be called in on **1-888-LUCENT-8 (1-888-582-3688)** from within the continental United States and on **+1-317-322-6847** from outside the continental United States. Orders may be faxed in on **1-317-322-6699**.

1.6 TECHNICAL ASSISTANCE

Technical assistance for the *5ESS* switch can be obtained by calling the North American Regional Technical Assistance Center (NARTAC) at **1-800-225-RTAC**. This telephone number is monitored 24 hours a day, 7 days a week. During regular business hours, your call will be answered by your local NARTAC. Outside of normal business hours, all calls will be answered at a centralized technical assistance center where service-affecting problems will be dispatched immediately to your local NARTAC. All other problems will be referred to your local NARTAC on the next regular business day.

1.7 ACCESS ARRANGEMENTS AND INTERWORKING

This section describes channel configuration and directory number (DN) assignments for basic access arrangements and the interworking supported by this interface specification.

1.7.1 CHANNEL CONFIGURATIONS

The standard BRI supports voice, circuit switched data (CSD), and packet-switched data (PSD) services. The PSD services can be either permanent or on-demand. The PSD assigned to a B-channel means that the B-channel is permanently connected to a packet handler.

Table 1-1 provides an overview of the voice, data, and packet services that may be assigned to a terminal on a standard interface. This table presents some, but not all, of the allowed combinations. Once a configuration is chosen, the assignment of channels for given services is fixed. If alternate services are allowed, for example, voice/CSD on one channel (see Configurations 10 through 14), selection of service is done on a call-by-call basis.

For Configurations 1 through 7 wherever voice/CSD are given, the B-channels assigned are fixed at service order. However, for Configurations 10 through 14 wherever voice/CSD are described, the B-channel is assigned on a per-call basis.

For example, if a customer has subscribed to Configuration 7, that customer will have B-channels assigned and fixed at service order, that is, B_x will be assigned to voice and B_y will be assigned to CSD at service order. To change the B-channel assignments, a switch recent change is required before B-channel "y" can accept voice calls and before B-channel "x" can accept CSD calls. This recent change is similar to a recent change for adding a line feature for a customer or changing a customer speed call list.

As another example, if a customer has subscribed to Configuration 13, that customer has subscribed to voice and CSD on B_x channel. The B_x channel is an allocatable resource, and since consecutive calls can have different bearer capabilities that are specified only at call setup, the customer may set up voice or data on the B_x channel.

Table 1-1 — Channel Configuration Alternatives for a Terminal on a Standard Interface

CONFIGURATION	B_x[b c]	B_y[bc]	D[b d]
1	[a]	[a]	PPSD
2	CSV	[a]	(PPSD)
3	CSD	[a]	(PPSD)
4	PPSD	[a]	[a]
5	CSV	CSV	(PPSD)
6	CSD	CSD	(PPSD)
7	CSV	CSD	(PPSD)
8	CSV	PPSD	[a]
9	CSD	PPSD	[a]
10	CSV/CSD	[a]	(PPSD)
11	CSV/CSD	CSV/CSD	(PPSD)
12	CSV/CSD	CSV	(PPSD)
13	CSV/CSD	CSD	(PPSD)
14	CSV/CSD	PPSD	[a]
15	CSV/CSD	OPSD/CSD	(PPSD)
16	CSD/OPSD	OPSD/CSV	(PPSD)
17	CSD/OPSD	OPSD/CSV/CSD	(PPSD)
18	OPSD	OPSD	(OPSD)

Note(s):

a. No service assigned; however, D-channel must always be active.

b. PPSD = Permanent packet-switched data
OPSD = On-demand packet-switched data

c. The values of x and y are an ordered pair chosen from the two element set: (x,y) = [(1,2),(2,1)].

d. The parentheses around PPSD and OPSD mean that permanent/on-demand packet-switched data service on the D-channel is optional.

Table 1-2 describes the possible channel configurations for a single terminal operating in a passive bus arrangement with multiple terminals on the same digital subscriber line (DSL). Each terminal may have this configuration.

Table 1-2 — Channel Configuration for a Terminal with Other Terminals on the Same Standard Interface

BEARER SERVICE	USER SUBSCRIPTION OPTIONS [a]		
	NUMBER OF B-CHANNELS ALLOWED	SUPPORTED ON D-CHANNEL	SUPPORTED ON B-CHANNEL
Voice	0-2	NO	YES
Circuit-Switched Data	0-2	NO	YES
Permanent Packet-Switched Data	0-2	YES	YES
On-demand Packet-Switched Data	0-2	YES	YES

Note(s):

a. When a particular bearer service can be supported on only a single B-channel (cannot have two simultaneous B-channel connections on the same BRI for that bearer service), that bearer service must be capable of operation on either B-channel (that is, B1 or B2). The PPSD presents an exception to this rule since it is always assigned to a particular B-channel, and no other bearer service can be assigned to the same B-channel as PPSD.

1.7.2 DIRECTORY NUMBERS

Terminals can have one or more DNs depending on the services subscribed to. Terminals designed to operate on a standard interface are required to know either their calling DN for terminal identification within call control procedures (NITs) or their service profile identifier (SPID) for terminal identification through initialization procedures (of FITs). If the user also subscribes to packet-switched data service, a separate packet-switching DN may be used. If the user subscribes to data facility pooling service, one DN is needed for each type of modem pool to which the user subscribes.

If the terminal belongs to a multiline hunt group for packet-switched service, a group DN (or a range of contiguous DNs) is needed for the entire group. In addition, an individual member may opt to have its own DN. If the hunt group is for circuit-switched service, there is one DN for the entire group to share. An individual member may also opt to have its own DN.

1.7.3 INTERWORKING

The *5ESS* switch equipped for ISDN supports intra- and inter-ISDN switch connections, as well as connections to non-ISDN networks. The switch can interwork with existing analog lines and analog trunks. It can connect with the direct distance dialing (DDD) network, 56-kbps circuit-switched data networks, and X.25 packet-switched networks. If transit networks are involved, the switch will support interexchange carrier selection and preselection for both data and voice calls.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

2. PHYSICAL LAYER

This section defines the Layer 1 characteristics of the user-network interfaces for Integrated Services Digital Network (ISDN) basic access. This section consists of two major sections. "S/T Interface," Section 2.1, defines the interface at the S and T reference points: between the ISDN terminal equipment (TE) and the Network Termination Type 1 (NT1), between the TE and the NT2 (for example, PBX), and between the NT2 and the NT1. "*ANSI*[1] U Interface," Section 2.2, defines the *ANSI*-Standard interface at the network side of the NT1.

1. Registered trademark of American National Standard Institute.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

2.1 S/T INTERFACE

This section defines the Layer 1 characteristics of the user-network interface to be applied at the S- or T-reference points for the basic interface structure defined in ITU-TS Recommendation I.412. The reference configurations for the interface are defined in ITU-TS Recommendation I.411 and are reproduced in Figure 2.1-1. The definitions and characteristics of the functional groups are also provided in ITU-TS Recommendation I.411. A notation of the "U" reference point has been added.

This section is intended to provide for general compliance with all provisions of *ANSI*[1] Standard T1.605-1991 and ITU-TS Recommendation I.430 that are essential to the satisfactory interfacing in point-to-point and point-to-multipoint interconnections of TEs and NTs that do not provide for activation/deactivation. However, compatibility with TEs and NTs that conform to all provisions of *ANSI* Standard T1.605-1991 and ITU-TS Recommendation I.430 is assured.

The individual departures and limitations of options of this section from the provisions of *ANSI* Standard T1.605-1991 are described in "Summary of Limited Options and Departures from *ANSI* Standard T1.605-1991," Section 2.1.6.12.

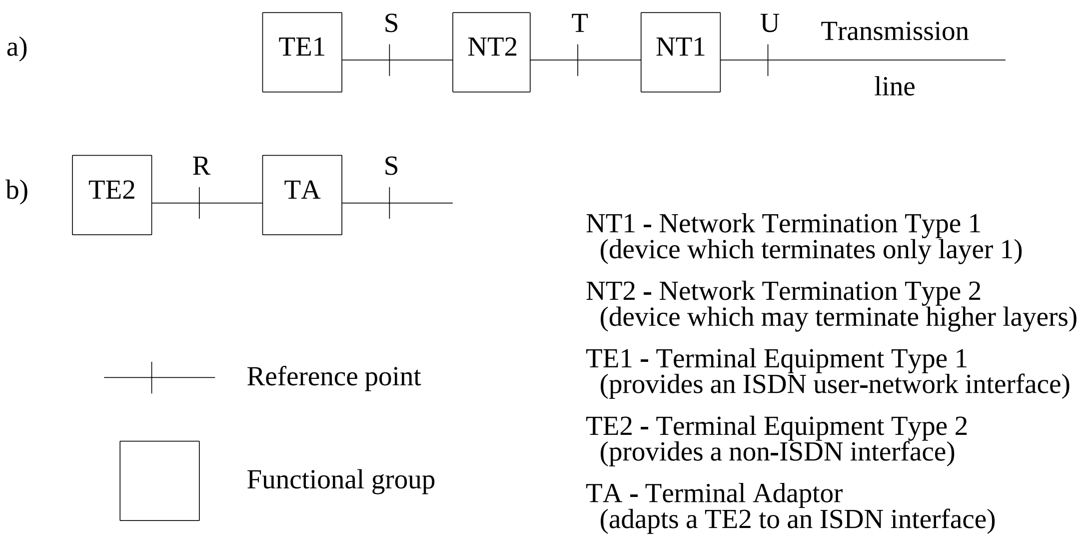


Figure 2.1-1 — Reference Configurations for the ISDN User-Network Interfaces

In this section, the term "NT" is used to indicate network terminating Layer 1 aspects of NT1 and NT2 functional groups, and the term "TE" is used to indicate terminal terminating Layer 1 aspects of TE1, TA, and NT2 functional groups, unless otherwise indicated.

1. Registered trademark of American National Standard Institute.

2.1.1 OVERVIEW OF S/T CONFIGURATION AND OPERATION

2.1.1.1 Service Characteristics

2.1.1.1.1 Services Required from the Physical Medium

Layer 1 of this interface requires a balanced metallic transmission medium, for each direction of transmission, capable of supporting 192 kbps.

2.1.1.1.2 Service Provided to Layer 2

Layer 1 provides the following services to Layer 2 and the management entity.

2.1.1.1.2.1 Transmission Capability

Layer 1 provides the transmission capability, by means of appropriately encoded bit streams, for the B- and D-channels and the related timing and synchronization functions.

2.1.1.1.2.2 Activation/Deactivation

Layer 1 provides the signaling capability and the procedures necessary to enable customer TEs and/or NTs to be deactivated when required and reactivated when required. However, TEs and NTs are not required to provide the activation/deactivation capability. TEs that cannot initiate activation and active only NTs are permitted. That is, deactivation is an optional capability of NTs, and the capability of initiating activation is an optional feature of TEs.

The network is always active. Therefore, it is assumed in this section that it is appropriate for TEs and NTs to remain active at all times. "Activation/Deactivation," Section 2.1.2.2, defines general procedures that shall be followed by all TEs and NTs. Those procedures assure compatibility between TEs/NTs that do not provide the activation/deactivation capability and those that do provide the capability.

The procedures to be followed by TEs/NTs in which the activation/deactivation capability is provided are not included in this section. See *ANSI*[1] Standard T1.605-1991 for the full set of activation/deactivation procedures.

2.1.1.1.2.3 D-Channel Access

Layer 1 provides the signaling capability and the necessary procedures to allow TEs to gain access to the common resource of the D-channel in an orderly fashion while meeting the performance requirements of the D-channel signaling system. These D-channel access control procedures are defined in "D-Channel Access Procedure," Section 2.1.2.1.

2.1.1.1.2.4 Maintenance

Layer 1 provides the signaling capability, procedures, and necessary functions at Layer 1 to enable the maintenance functions to be performed.

2.1.1.1.2.5 Status Indication

Layer 1 provides an indication to the higher layers of the status of Layer 1.

2.1.1.1.3 Primitives Between Layer 1 and Other Entities

Primitives represent, in an abstract way, the logical exchange of information and control between Layer 1 and other entities. They neither specify nor constrain the implementation of entities or interfaces.

---

1. Registered trademark of American National Standard Institute.

The primitives to be passed across the Layer 1/2 boundary or to the management entity and parameter values associated with these primitives are defined and summarized in Table 2.1.1-1. For a description of the syntax and use of the primitives, refer to ITU-TS Recommendation X.211. Additional primitives may apply where activation/deactivation is accommodated.

Table 2.1.1-1 — Primitives Associated with Layer 1

GENERIC NAME	SPECIFIC NAME		PARAMETER		MESSAGE UNIT CONTENTS
	REQUEST	INDICATION	PRIORITY INDICATOR	MESSAGE UNIT	
L1 <—> L2					
PH-Data	X[a]	X[b]	X	X	For example, setting priority for D-channel contention resolution. (See Section 2.1.2.1.4)
M <—> L1					
MPH-Error	-	X	-	X	Type of error or recovery from a previously reported. error.
MPH-Information	-	X	-	X	Connected/ disconnected

Note(s):

a. PH-Data Request implies underlying negotiation between Layer 1 and Layer 2 for the acceptance of the data.

b. Priority indication applies to only the request type.

2.1.1.2 Modes of Operation

Both point-to-point and point-to-multipoint modes of operation, as described in the following section, are intended to be accommodated by the Layer 1 characteristics of the user-network interface. In this section, the modes of operation apply only to the Layer 1 procedural characteristics of the interface and do not imply any constraints on modes of operation at higher layers.

2.1.1.2.1 Point-to-Point Operation

Point-to-point operation at Layer 1 implies that only one source (transmitter) and one sink (receiver) are active at any one time in each direction of transmission at an S or T reference point. (Such operation is independent of the number of interfaces that may be provided on a particular wiring configuration - see "Types of Wiring Configuration," Section 2.1.1.3.)

2.1.1.2.2 Point-To-Multipoint Operation

Point-to-multipoint operation at Layer 1 allows more than one TE (source and sink pair) to be simultaneously active at an S or T reference point. (The multipoint mode of operation may be accommodated, as discussed in "Types of Wiring Configuration," Section 2.1.1.3, with point-to-point or point-to-multipoint wiring configurations. Also, NTs may provide a multiple number of T-interfaces. See "Example of NT that Supports Multiple T Interfaces to Accommodate Multipoint Operation with More Than Eight TEs," Section 2.1.6.4, for an example of an NT that uses multiple point-to-point (and point-to-multipoint) wiring configurations to accommodate the multipoint mode of operation.)

For the T-interface that is directly connected to the network without the use of a physically separate NT1, both the short passive bus and the extended passive bus point-to-multipoint configurations are fully supported as described in *ANSI* Standard T1.605-1991 and in "Wiring Configurations and Round-trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3. Additionally, a variety of branched (see "Branched Passive Bus Wiring Configuration," Section 2.1.6.5) point-to-multipoint configurations are supported. For a complete description of configurations that are supported, refer to *ISDN Customer Premises Equipment Planning Guide* (document 533-700-100).

2.1.1.3 Types of Wiring Configuration

2.1.1.3.1 Overview of Wiring Configurations

Figure 2.1.1-1 shows a general reference configuration for wiring in the user premises. The required electrical characteristics of the user-network interfaces (I_A and I_B) are stated in "Electrical Characteristics," Section 2.1.4. Those characteristics must be met for the various interface wiring configurations.

Those required electrical characteristics were determined on the basis of certain assumptions about the various wiring configurations that may exist in the user premises. Those assumptions are identified in two major wiring configurations, described in "Point-to-Point Configuration," Section 2.1.1.3.2, and "Point-to-Multipoint Configuration," Section 2.1.1.3.3.

Additional material concerning those assumptions is contained in "Wiring Configurations and Round-trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3. (The examples given there are now to be used for illustrative purposes only. They describe the general categories of interface wiring configurations for which electrical characteristics must be met. They do not in any way specify how the interface wiring must be configured. The specific interface wiring configuration within a category is unimportant as long as the required electrical characteristics are met.)

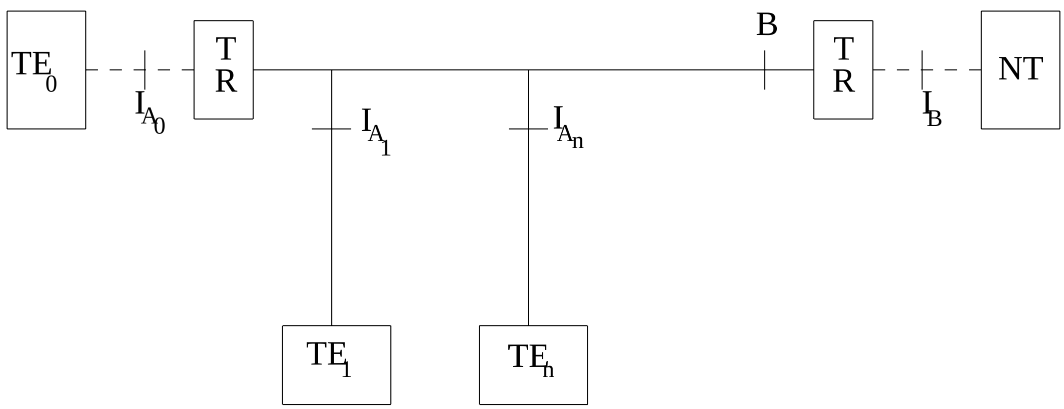
2.1.1.3.2 Point-to-Point Configuration

A point-to-point wiring configuration implies that only one source (transmitter) and one sink (receiver) are interconnected on an interchange circuit.

2.1.1.3.3 Point-to-Multipoint Configuration

A point-to-multipoint wiring configuration allows more than one source to be connected to the same sink or more than one sink to be connected to the same source on an interchange circuit. Such distribution systems are characterized by the fact that they contain no active logic elements performing functions (other than possibly amplification or regeneration of the signal).

For the T-interface that is directly connected to the network without the use of a physically separate NT1, both the short passive bus and the extended passive bus point-to-multipoint configurations are fully supported as described in *ANSI* Standard T1.605-1991 and in "Wiring Configurations and Round-trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3. Additionally, a variety of branched (see "Branched Passive Bus Wiring Configuration," Section 2.1.6.5) point-to-multipoint configurations are supported. For a complete description of configurations that are supported, refer to *ISDN Customer Premises Equipment Planning Guide* (document 533-700-100).



TR = terminating resistor
I = electrical interface
B = location of I_B when the terminating resistor (TR) is included in the NT

Figure 2.1.1-1 — Reference Configuration for Wiring in the User Premises Location

2.1.1.3.4 Wiring Polarity Integrity

For a point-to-point wiring configuration, the two wires of the interchange circuit pair may be reversed. However, for a point-to-multipoint wiring configuration, the wiring polarity integrity of the interchange circuit (TE-to-NT direction) must be maintained between TEs (see "Reference Configuration," Section 2.1.5.2).

In addition, the wires of the optional pairs, which may be provided for powering, shall not be reversed in either configuration.

2.1.1.3.5 Location of the Interfaces

The wiring in the user premises is considered to be one continuous cable run with jacks for the TEs and NT attached directly to the cable or using stubs less than 1 meter long. The jacks are located at interface points I_A and I_B (see Figure 2.1.1-1). One interface point, I_A, is adjacent to each TE. The other interface point, I_B, is adjacent to the NT. However, in some applications, the NT may be connected to the wiring without the use of a jack or with a jack that accommodates multiple interfaces (for example, when the NT is a port on a PBX). In this case, the only interface of significance may be at I_A. If the interface cabling is provided as part of (or uniquely specified for) the NT, the interface requirements directly applicable to NTs do not apply and the only requirements of significance are those specified for TEs (that is, at I_A). The required electrical characteristics (described in "Electrical Characteristics," Section 2.1.4) for I_A and I_B are different in some aspects.

2.1.1.3.6 NT and TE Associated Wiring

The wiring from the TE or the NT to its appropriate jack affects the interface electrical characteristics. A TE, or an NT that is not permanently connected to the interface wiring, may be equipped with either of the following for connection to the interface point (I_A and I_B, respectively):

- a hard-wired connecting cord (of not more than 10 meters in the case of a TE, and not more than 3 meters in the case of an NT) and a suitable plug
- a jack with a connecting cord (of not more than 10 meters in the case of a TE, and not more than 3 meters in the case of an NT) that has a suitable plug at each end

Normally, the requirements of this section apply to the interface point (I_A and I_B, respectively), and the cord forms part of the associated TE or NT. However, where the terminating resistors are connected internally to the NT, the connecting cord may be considered as an integral part of the interface wiring. In this case, the requirements of this section may be applied to the NT at the connection of the connecting cord to the NT. Note that the NT may attach directly to the interface wiring without a detachable cord. Also note that the connector (plug and jack) used for the connection of the detachable cord to the NT is not subject to standardization.

Although a TE may be provided with a cord less than 5 meters long, it shall meet the requirements of this section when tested with a cord having a minimum length of 5 meters. As specified previously, the TE cord may be detachable. Such a cord may be provided as a part of the TE, or the TE may be designed to conform to the electrical characteristics specified in "Electrical Characteristics," Section 2.1.4, with a "standard ISDN basic access TE cord" conforming to the requirements specified in "Standard ISDN Basic Access TE Cord," Section 2.1.4.11, and having the maximum permitted capacitance.

The use of a TE with an extension cord up to 25 meters long is permitted, but only on point-to-point wiring configurations. (The total attenuation of the wiring and of the extension cord should not exceed 6 dB.)

2.1.1.4 Functional Characteristics

The following paragraphs describe the functional characteristics of the interface.

2.1.1.4.1 Interface Functions

The functions for this interface are defined in "B-Channel," Section 2.1.1.4.1.1, "Bit Timing," Section 2.1.1.4.1.2, "Octet Timing," Section 2.1.1.4.1.3, "Frame Alignment," Section 2.1.1.4.1.4, "D-Channel," Section 2.1.1.4.1.5, "D-Channel Access Procedure," Section 2.1.1.4.1.6, "Power Feeding," Section 2.1.1.4.1.7, "Deactivation," Section 2.1.1.4.1.8, “Activation," Section 2.1.1.4.1.9, "Maintenance," Section 2.1.1.4.1.10. (B- and D-channels, referenced in this section, are intended to be consistent with the descriptions in ITU-TS Recommendation I.412.)

2.1.1.4.1.1 B-Channel

This function provides, for each direction of transmission, two independent 64 kbps channels for use as B-channels.

2.1.1.4.1.2 Bit Timing

This function provides bit (signal element) timing at 192 kbps to enable the TE and NT to recover information from the aggregate bit stream.

2.1.1.4.1.3 Octet Timing

This function provides 8-koctet/s timing for the NT and TE.

2.1.1.4.1.4 Frame Alignment

This function provides information to enable NT and TE to recover the time division multiplexed channels.

2.1.1.4.1.5 D-Channel

This function provides, for each direction of transmission, one D-channel at a bit rate of 16 kbps.

2.1.1.4.1.6 D-Channel Access Procedure

This function is specified to enable TEs to gain access to the common resource of the D-channel in an orderly controlled fashion. The functions necessary for these procedures include an echoed D-channel at a bit rate of 16 kbps in the direction NT to TE. For the definition of the procedures relating to D-channel access, see "D-Channel Access Procedure," Section 2.1.2.1.

2.1.1.4.1.7 Power Feeding

This function provides for the capability to transfer power across the interface. The direction of power transfer depends on the application. In a typical application, it may be desirable to provide for power transfer from the NT toward the TEs in order to, for example, maintain a basic telephony service in the event of failure of the locally provided power. (In some applications unidirectional power feeding or no power feeding at all, across the interface, may apply). The detailed specification of power feeding capability is contained in "Power Feeding," Section 2.1.5.

2.1.1.4.1.8 Deactivation

This function is specified in order to permit the TE and NT to be placed in a low power consumption mode when no calls are in progress. However, it is assumed in this section that it is appropriate for TEs and NTs to remain in the active state all the time.

2.1.1.4.1.9 Activation

This function restores all the functions of a TE or an NT, which may have been placed into a low power consumption mode during deactivation, to an operating power mode (see "Power Feeding," Section 2.1.5) whether under normal or restricted power conditions. However, it is assumed in this section that it is appropriate for TEs and NTs to remain in the active state at all times.

2.1.1.4.1.10 Maintenance

This function provides the signaling capability, procedures, and functions necessary for Layer 1 maintenance of the interface.

2.1.1.4.2 Interchange Circuits

Two interchange circuits, one for each direction of transmission, shall be used to transfer digital signals across the interface. All of the functions described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1, except for power feeding, shall be carried by means of a digitally multiplexed signal structured as defined in "Frame Structure," Section 2.1.1.4.4.

2.1.1.4.3 Connected/Disconnected Indication

The appearance/disappearance of power is the criterion used by a TE to determine whether it is connected/disconnected at the interface. This is important for terminal endpoint identifier (TEI) assignments according to the procedures described in "Data Link Layer Specifications," Section 4.3.2.7.2.

A TE that considers itself connected, when unplugged, can cause duplication of TEI values after reconnection. When duplication occurs, procedures described in "Data Link Layer," Section 3, will permit recovery.

2.1.1.4.3.1 TEs Powered Across the Interface

A TE that is powered from Power Source 1 or 2 across the interface shall use the detection of Power Source 1 or 2, respectively, to establish the connection status. (See "Power Feeding," Section 2.1.5, for a description of the power sources.)

2.1.1.4.3.2 TEs Not Powered Across the Interface

A TE that is not powered across the interface may use either:

- the detection of Power Source 1 or Power Source 2, whichever may be provided, to establish the connection status
- the presence/absence of local power to establish the connection status

The TEs that are not powered across the interface and are unable to detect the presence of Power Source 1 or 2 shall consider themselves connected/disconnected when local power is applied/removed.

Note: It is desirable to use the detection of either Power Source 1 or Power Source 2 to establish the connection status when automatic TEI selection procedures are used within the management entity.

2.1.1.4.3.3 Indication of Connection Status

The TEs that use the detection of Power Source 1 or 2, whichever is used to determine connection/disconnection, to establish the connection status shall inform the management entity (for TEI purposes) using:

- ***MPH-Information Indication (Connected):*** when operational power and the presence of Power Source 1 or 2, whichever is used to determine connection/disconnection, is detected
- ***MPH-Information Indication (Disconnected):*** when the disappearance of Power Source 1 or 2, whichever is used to determine connection/disconnection, is detected, or power in the TE is lost

The TEs that are unable to detect Power Source 1 or 2, whichever may be provided, and, therefore, use the presence/absence of local power to establish the connection status (see "TEs Not Powered Across the Interface," Section 2.1.1.4.3.2) shall inform the management entity using:

- ***MPH-Information Indication (Disconnected):*** when power (Note) in the TE is lost
- ***MPH-Information Indication (Connected):*** when power (Note) in the TE is applied

Note: The term "power" could be the full operational power or backup power. Backup power is defined such that it is enough to hold the TEI values in memory and maintain the capability of receiving and transmitting Layer 2 frames associated with the TEI procedures.

2.1.1.4.4 Frame Structure

In both directions of transmission, the bits shall be grouped into frames of 48 bits each. The frame structure shall be identical for all configurations (point-to-point and point-to-multipoint).

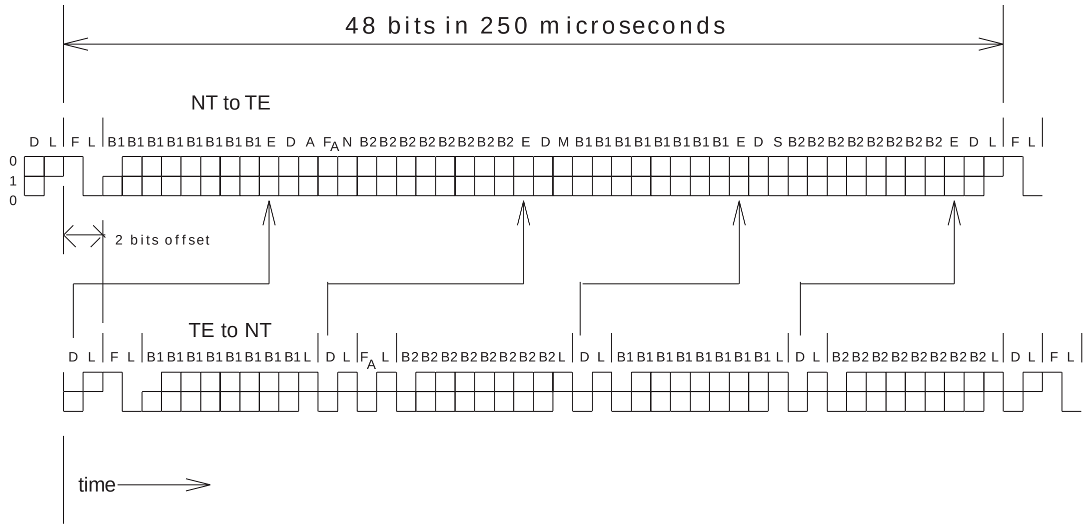
2.1.1.4.4.1 Bit Rate

The nominal transmitted bit rate at the interfaces shall be 192 kbps in both directions of transmission.

2.1.1.4.4.2 Binary Organization of the Frame

2.1.1.4.4.2.1 Direction-dependent Frame Structures

The frame structures are different for each direction of transmission. Both structures are illustrated diagrammatically in Figure 2.1.1-2, and they are explained in "TE to NT," Section 2.1.1.4.4.2.2, and "NT to TE," Section 2.1.1.4.4.2.3. The first bit to be transmitted is Bit 1, the leftmost bits in Figure 2.1.1-2. For the meaning of the polarities of the framing bits in Figure 2.1.1-2, see Figure 2.1.2-2.



F	= framing bit	N	= bit set to a binary value N = F_A (NT to TE) [see "Frame Alignment (Synchronization) Procedures," Section 2.1.2.3]
L	= DC balancing bit		
D	= D-channel bit		
E	= D-echo-channel bit	B1	= bit within B-channel 1
F_A	= Auxiliary framing bit [see "Frame Alignment (Synchronization) Procedures," Section 2.1.2.3]	B2	= bit within B-channel 2
		A	= bit used for activation
		S	= S-channel bit
		M	= Multiframing bit

Note 1: Vertical bars demarcate the ends of those parts of the frame that are independently DC-balanced.

Note 2: The F_A bit in the direction TE to NT is used as a Q bit in every fifth frame if the Q channel capability is applied (see "Frame Alignment in the Direction TE to NT," Section 2.1.2.3.3).

Note 3: The nominal 2-bit offset is as seen from the TE (I_A in Figure 2.1.1-1). The corresponding offset at the NT may be greater due to delay in the interface cable and varies by configuration.

Note 4: For the meaning of the polarities of the framing bits, see "Power Feeding," Section 2.1.5.

Figure 2.1.1-2 — Frame Structure at Reference Points S and T

2.1.1.4.4.2.2 TE to NT

Each frame consists of the following groups of bits; each individual group is DC-balanced by its last bit (L bit):

bit position	group
1 and 2	framing bit with balance bit
3 - 11	B1 channel (first octet) with balance bit
12 and 13	D-channel bit with balance bit
14 and 15	F_A auxiliary framing bit or Q bit with balance bit
16 - 24	B2 channel (first octet) with balance bit
25 and 26	D-channel bit with balance bit
27 - 35	B1 channel (second octet) with balance bit
36 and 37	D-channel bit with balance bit
38 - 46	B2 channel (second octet) with balance bit
47 and 48	D-channel bit with balance bit

2.1.1.4.4.2.3 NT to TE

Frames transmitted by the NT contain an echo channel (E-bits) used to retransmit the D-bits received from the TEs. The D-echo channel is used for D-channel access control. The last bit of the frame (L-bit) is used for balancing each complete frame.

The bits are grouped as follows:

bit position	group
1 and 2	framing bit with balance bit
3 - 10	B1 channel (first octet)
11	E, D-echo-channel bit
12	D-channel bit
13	bit A used for activation
14	F_AA auxiliary framing bit
15	N bit (coded as defined in "Initialization—Switch Initiated," Section 6.4)
16 - 23	B2 channel (first octet)
24	E, D-echo-channel bit
25	D-channel bit
26	M, multiframing bit
27 - 34	B1 channel (second octet)
35	E, D-echo-channel bit
36	D-channel bit
37	S-channel bit
38 - 45	B2 channel (second octet)
46	E, D-echo-channel bit
47	D-channel bit
48	frame balance bit

2.1.1.4.4.2.4 Relative Bit Positions

At the TEs, timing in the direction TE to NT shall be derived from the frames received from the NT.

The first bit of each frame transmitted from a TE toward the NT shall be delayed, nominally, by two bit periods with respect to the first bit of the frame received from the NT. Figure 2.1.1-2 illustrates the relative bit positions for both transmitted and received frames.

2.1.1.4.4.2.5 B-Channel Bit Order − Voice

When a B-channel is used for the transmission of PCM voice, the voice signal shall be coded in accordance with ITU-TS Recommendation G.711. Further, the Most Significant Bit (MSB, sign bit) should be transmitted first and is received first.

2.1.1.4.5 Line Code

For both directions of transmission, pseudo-ternary coding is used with 100-percent pulse width as shown in Figure 2.1.1-3. Coding is performed in such a way that a binary ONE is represented by no line signal; whereas, a binary ZERO is represented by a positive or negative pulse. The first binary ZERO following the framing bit balance bit is of the same polarity as the framing bit balance bit. Subsequent binary ZEROs must alternate in polarity. A balance bit is a binary ZERO if the number of binary ZEROs following the previous balance bit is odd. A balance bit is a binary ONE if the number of binary ZEROs following the previous balance bit is even.

During an interim period, transport capabilities available in some networks may not support use of B-channels without a restriction on the sequences that may be transmitted. The necessary restrictions and means of conforming to the restrictions while using the full 64-kbps rate are described in "Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities," Section 2.1.6.2.

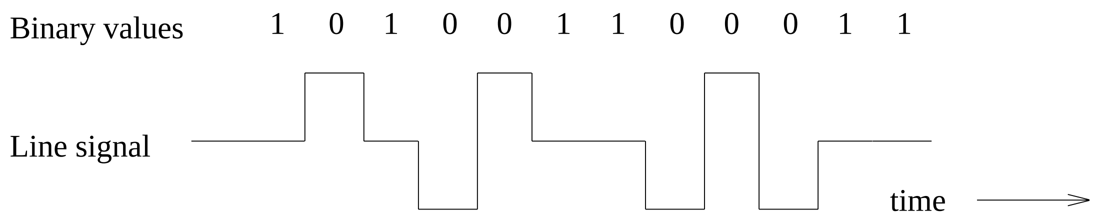


Figure 2.1.1-3 — Pseudo-Ternary Code - Example of Application

2.1.1.4.6 Timing Considerations

The NT shall derive its timing from the network clock. A TE shall derive its timing (bit, octet, frame) from the signal received from the NT and use this derived timing to synchronize its transmitted signal.

2.1.2 INTERFACE PROCEDURES

2.1.2.1 D-Channel Access Procedure

The following procedure allows for a number of TEs connected in a multipoint configuration to gain access to the D-channel in an orderly fashion. The procedure always ensures that, even in cases in which two or more TEs attempt to access the D-channel simultaneously, one, but only one, of the TEs will be successful in completing transmission of its information. This procedure relies upon the use of Layer 2 frames delimited by flags consisting of the binary pattern "01111110" and the use of zero-bit insertion to prevent flag imitation (see "Data Link Layer," Section 3).

The procedure also permits TEs to operate in a point-to-point manner.

2.1.2.1.1 Interframe (Layer 2) Time Fill

When a TE has no Layer 2 frames to transmit, it shall send binary ONEs on the D-channel, that is, the interframe time fill on the D-channel in the TE-to-NT direction shall be all binary ONEs.

When an NT has no Layer 2 frames to transmit, it shall send binary ONEs on the D-channel, that is, the interframe time fill on the D-channel in the NT-to-TE direction shall be all binary ONEs. The HDLC flag that defines the end of a Layer 2 frame may also define the start of the next Layer 2 frame.

2.1.2.1.2 D-Echo Channel

The NT, on receipt of a D-channel bit from the TEs, shall reflect the binary value in the next available D-echo-channel bit position toward the TEs. (The need to force the D-echo-channel bits to all binary ZEROs during certain loopbacks is for further study. See "Test Loopback Characteristics," Section 2.1.6.8.3)

2.1.2.1.3 D-Echo Channel Monitoring

A TE shall monitor the D-echo channel, counting the number of consecutive binary ONEs. If a ZERO bit is detected, the TE shall restart counting the number of consecutive ONE bits. The current value of the count is called C.

Note: C need not be incremented after the value 11 has been reached.

2.1.2.1.4 Priority Mechanism

Layer 2 frames are transmitted in such a way that signaling information is given priority (priority class 1) over all other types of information (priority class 2). Furthermore, to ensure that within each priority class all competing TEs are given a fair access to the D-channel, once a TE has successfully completed the transmission of a Layer 2 frame, it is given a lower level of priority within that class. The TE is given back its normal level within a priority class when all TEs have had an opportunity to transmit information at the normal level within that priority class.

The priority class of a particular Layer 2 frame may be a characteristic of the TE which is preset at manufacture or at installation, or it may be passed down from Layer 2 as a parameter of the PH-Data Request primitive.

The priority mechanism is based on the requirement that a TE may start Layer 2 frame transmission only when C (see "D-Echo Channel Monitoring," Section 2.1.2.1.3) is equal to, or exceeds, the value X_1 for priority class 1 or is equal to, or exceeds, the value X_2 for priority class 2. The value of X_1 shall be eight for the normal level and nine for the lower level of priority. The value of X_2 shall be ten for the normal level and eleven for the lower level of priority.

In a priority class the value of X_1 or X_2 is changed from the normal level of priority to the value of the lower level of priority (that is, higher value) when a TE has successfully transmitted a Layer 2 frame of that priority class.

The value of X_1 or X_2 is changed from the lower level of priority back to the value of the normal level of priority when C (see "D-Echo Channel Monitoring," Section 2.1.2.1.3) equals the value of the lower level of priority (that is, higher value).

2.1.2.1.5 Collision Detection

While transmitting information in the D-channel, the TE shall monitor the received D-echo channel and compare the last transmitted bit with the next available D-echo bit. If the transmitted bit is the same as the received echo, the TE shall continue its transmission. If, however, the received echo is different from the transmitted bit, the TE shall cease transmission immediately and return to the D-channel monitoring state.

2.1.2.1.6 Priority System

"SDL Representation of a Possible Implementation of the D-Channel Access," Section 2.1.6.6, describes an example of how the priority system may be implemented.

2.1.2.2 Activation/Deactivation

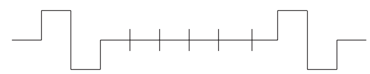
2.1.2.2.1 About this Section

Activation/deactivation is a function specified in *ANSI*[1] Standard T1.605-1991. Provision of this function and compliance with the associated procedures is not required of TEs or NTs conforming to this section. However, procedures are included to assure compatibility of conforming TEs and NTs with NTs and TEs, respectively, that provide for activation/deactivation. See "General TE Procedures," Section 2.1.2.2.3, and "General NT Procedures," Section 2.1.2.2.4. In addition, timing requirements for activation/deactivation are provided because they may be critical to the design process.

2.1.2.2.2 Signals

The identifications of specific signals across the S/T reference point are given in Figure 2.1.2-1. Also included is the coding for these signals. (These signals are of primary importance in the specification *ANSI* Standard T1.605-1991] of the procedures for activation/deactivation, and they are used in the following procedures for nonactivation/nondeactivation TEs and NTs.)

1. Registered trademark of American National Standard Institute.

Signals from NT to TE (Note 2)		Signals from TE to NT	
INFO 0	No signal. (Note 3)	INFO 0	No signal.
INFO 2 (Note 4)	Frame with all bits of B, D, and D-echo channels set to binary ZERO. Bit A set to binary ZERO. N and L bits set according to the normal coding rules.	INFO 1 (Note 3)	A continuous signal with the following pattern: Positive ZERO, negative ZERO, six ONEs.  Nominal bit rate = 192 kbit/s.
INFO 4 (Note 4)	Frames with operational data on B, D, and D-echo channels. Bit A set to binary ONE.	INFO 3	Synchronized frames with operational data on B and D channels.

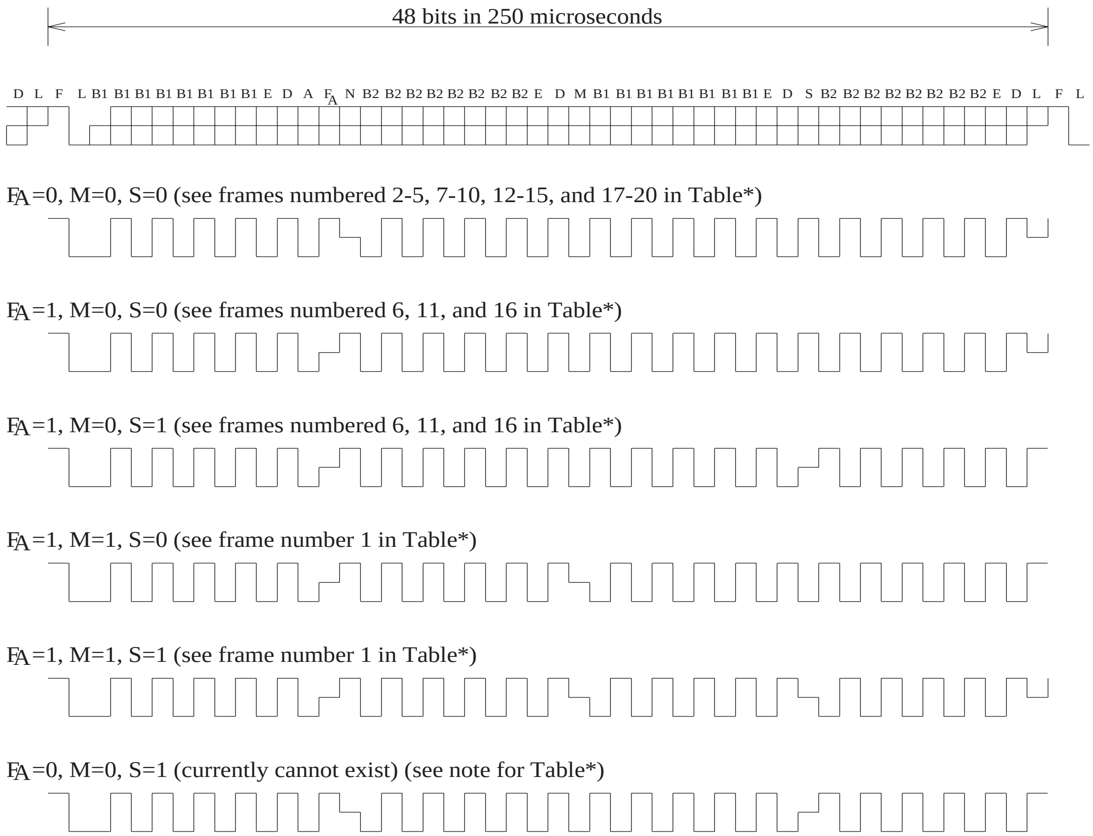
Note 1: The duration of the transmission of INFO 0 may be indefinitely short, depending on events causing transition to another transmitted signal. The reception of INFO 0 shall not be detected until at lease 48 contiguous binary ONEs have been received.

Note 2: For configurations in which the wiring polarity may be reversed (see "Point-to-Multipoint Configuration," Section 2.1.1.3.3), signals may be received with the polarity of the binary ZEROs inverted. All NT and TE receivers should be designed to tolerate wiring polarity reversals.

Note 3: TEs that do not need the capability to initiate activation of a deactivated T1.605 interface (for example TEs required to handle only incoming calls) need not have the capability to send INFO 1. In all other respects, these TEs shall be in accordance with "Activation/Deactivation," Section 2.1.2.2. Note that in the point-to-multipoint configuration more than one TE transmitting simultaneously will produce a bit pattern, as received by the NT, different from that described, for example two or more overlapping (asynchronous) instances of INFO 1.

Note 4: During the transmission of INFO 2 or INFO 4, the F_A bits and the M bits from the NT may provide the Q-bit pattern designation as described in "Frame Alignment in the Direction TE to NT," Section 2.1.2.3.3. Figure 2.1.2-2 shows bit patterns that are representative of an INFO 2 frame.

Figure 2.1.2-1 — Signals Across S/T Reference Point



* Refers to Table 2.1.2-2, "S-Channel Structure."

Figure 2.1.2-2 — Representative Bit Patterns of an INFO-2 Frame

2.1.2.2.3 General TE Procedures

All TEs shall conform to the following procedures:

a. The TEs, when first connected, when power is applied, or upon the loss of frame alignment (see "Loss of Frame Alignment," Section 2.1.2.3.2.1) shall transmit INFO 0 continuously until the received signal has been clearly identified as being INFO 0, INFO 2, or INFO 4. However, a TE that is disconnected but powered is a special situation and could be transmitting INFO 1 when connected.

b. To initiate communication with (or activate) an NT, a TE that is both sending and receiving INFO 0 shall send INFO 1. [The TEs that do not need the capability to initiate activation of a deactivated interface (for example, TEs required to handle only incoming calls) need not have the capability to send INFO 1. In all other respects, these TEs shall be in accordance with the general TE procedures listed in this section.]

c. Upon reception of any signal (that is, INFO 2 or INFO 4 prior to full identification of signal), a TE that is sending INFO 1 shall send INFO 0 (or INFO 3 if frame alignment can be established and INFO 3 can be transmitted within 5 ms of the appearance of INFO 2 or INFO 4).

d. The TEs shall transmit INFO 3 when frame alignment is established (see "Frame Alignment," Section 2.1.1.4.1.4). However, the satisfactory transmission of operational data cannot be assured prior to the receipt of INFO 4.

e. The TEs that are locally powered shall, when power is removed, initiate the transmission of INFO 0 before frame alignment is lost.

2.1.2.2.4 General NT Procedures

All NTs shall conform to the following procedures:

a. To initiate communication with (or activate) a TE, an NT that is sending INFO 0 shall send INFO 2.

b. Upon receipt of INFO 1, an NT that is sending INFO 0 shall send INFO 2 to activate.

c. Upon receipt of INFO 3, an NT that is sending INFO 2 may send INFO 4.

d. To terminate communication with (or deactivate) a TE, an NT that is sending INFO 2 or INFO 4 shall send INFO 0.

e. Upon receipt of INFO 0 or upon loss of frame synchronization, an NT that is sending INFO 4 shall send INFO 2.

2.1.2.2.5 Activation Times

2.1.2.2.5.1 TE Activation Times

A TE that is sending INFO 0 shall, upon the receipt of INFO 2 or INFO 4, establish frame synchronization and initiate the transmission of INFO 3 within 100 ms. A TE that is receiving INFO 2 and sending INFO 3 shall recognize the receipt of INFO 4 within two frames (in the absence of errors).

A TE that is sending INFO 1 shall, upon the receipt of INFO 2 or INFO 4, cease the transmission of INFO 1 and initiate the transmission of INFO 0 (or INFO 3, see "General TE Procedures," Section 2.1.2.2.3) within 5 ms and then respond to INFO 2 or INFO 4, within 100 ms.

To assure that a TE will transmit INFO 0 within 5 ms after the appearance of a signal to which it cannot synchronize, operation of TEs should be verified where the received signal is any bit pattern (containing at least three binary ZEROs in each frame interval) to which TEs conforming to "Frame Alignment," Section 2.1.2.3.2.2, are not able to synchronize.

2.1.2.2.5.2 NT Activation Times

An NT that is sending INFO 0 shall, upon the receipt of INFO 1, initiate the transmission of INFO 2 (synchronized to the network) within 1 second under normal conditions. Delays, "Da," as long as 30 seconds are acceptable under abnormal (non-fault) conditions, for example, as result of a need for retrain for an associated loop transmission system.

An NT that is sending INFO 2 shall, upon the receipt of INFO 3, initiate the transmission of INFO 4 within 500 ms under normal conditions. Delays, "Db," as long as 15 seconds are acceptable under abnormal (non-fault) conditions provided that the sum of the delays "Da" and "Db" is not greater than 30 seconds.

2.1.2.2.6 Deactivation Times

A TE shall respond to the receipt of INFO 0 by initiating the transmission of INFO 0 within 25 ms.

An NT shall respond to the receipt of INFO 0 or the loss of frame synchronization by initiating the transmission of INFO 2 within 25 ms; however, the Layer 1 entity does not deactivate in response to INFO 0 from a TE.

For conformance test purposes, while a TE (NT) is transmitting INFO 3 (INFO 4) with a sinusoidal signal having a voltage of 100 mV peak-to-peak superimposed on the received signal, the TE (NT) shall react to the reception of INFO 0 by transmitting INFO 0 (INFO 2) within a period of time 250 µs to 25 ms. A provision for the immediate reaction to INFO 0 following the receipt of 48 contiguous binary ONEs may cause the release of ongoing communications in response to spurious interface signal interruptions. A persistence check timer should be considered to minimize such a possibility, but the total reaction time shall not exceed 25 ms.

2.1.2.2.7 Activation without Network Intervention

"Activation of the S/T Interface without Intervention of the Network Interface to the NT," Section 2.1.6.7, describes how the S/T interface can be activated (for example, for maintenance purposes) when the network interface to the NT cannot also be activated.

2.1.2.3 Frame Alignment (Synchronization) Procedures

2.1.2.3.1 Overview of Frame Alignment

The first bit of each frame is the framing bit, F; it is a binary ZERO.

The frame alignment procedure makes use of the fact that the framing bit is represented by a pulse having the same polarity as the preceding pulse (line-code violation). This allows rapid reframing.

According to the coding rule, both the framing bit and the first binary-ZERO bit following the framing bit balance bit (Bit Position 2 in the same frame) produce a line-code violation. To guarantee secure framing, the auxiliary framing bit pair F_A and N in the direction NT to TE or the auxiliary framing bit F_A with the associated balancing bit L in the direction TE to NT are introduced. This ensures that there is a line-code violation at 14 bits or fewer (14-bit criterion) from the framing bit F, due to F_A or N being a binary-ZERO bit, for the NT-to-TE direction, and that, for the TE-to-NT direction, there is a line-code violation at 13 bits or fewer (13-bit criterion) from the framing bit F, due to F_A being a binary-ZERO bit if the F_A -bit position is not used as a Q-bit. The framing procedures do not depend on the polarity of the framing bit F, and thus are not sensitive to wiring polarity.

The coding rule for the auxiliary framing bit pair F_A and N, in the direction NT to TE, is such that N is binary opposite of F_A ($N = F_A$). The F_A and L bits in the direction TE to NT are always coded such that the binary values of F_A and L are equal.

Note that a nonmultiframing NT (see "Multiframing," Section 2.1.2.3.4) must issue a binary ZERO in all F_A-bit positions to ensure the "wrapping" action of a TE (see "Q-Bit Position Identification Algorithm," Section 2.1.2.3.4.3) guarantees a binary ZERO F_A bit is returned to the NT receiver.

2.1.2.3.2 Frame Alignment in the Direction NT TO TE

Frame alignment, on initial activation of the TE, shall comply with the procedures defined in "Activation/Deactivation," Section 2.1.2.2.

2.1.2.3.2.1 Loss of Frame Alignment

Loss of frame alignment may be assumed when a time period equivalent to two 48-bit frames has elapsed without having detected valid pairs of line-code violations obeying the 14-bit criterion as described previously. The TE shall cease transmission immediately.

2.1.2.3.2.2 Frame Alignment

Frame alignment may be assumed to occur when three consecutive pairs of line-code violations obeying the 14-bit criterion have been detected.

2.1.2.3.3 Frame Alignment in the Direction TE to NT

2.1.2.3.3.1 Application of 13-bit Criterion

The criterion of a line-code violation at 13 bits or fewer from the framing bit (F) shall apply except if the Q-channel (see "Multiframing," Section 2.1.2.3.4) is provided, in which case the 13-bit criterion applies in four out of five frames.

2.1.2.3.3.2 Loss of Frame Alignment

The NT may assume loss of frame alignment if a time period equivalent to at least two 48-bit frames has elapsed since detecting consecutive violations according to the 13-bit criterion, if all F_A bits transmitted by the NT are set to binary ZERO, that is, multiframing is not identified. Otherwise, a time period equivalent to at least three 48-bit frames shall be allowed before assuming loss of frame alignment. On detection of loss of frame alignment, the NT shall transmit INFO-2 frames toward the TE.

2.1.2.3.3.3 Frame Alignment

The NT may assume that frame alignment has been regained when three consecutive pairs of line-code violations obeying the 13-bit criterion have been detected.

2.1.2.3.4 Multiframing

2.1.2.3.4.1 Supported Multiframing

Multiframing provides a Layer 1 signaling capability between the TEs and the NT in both directions through the use of extra channels referred to as the S-channel for the NT-to-TE direction and the Q-channel for the TE-to-NT direction. Multiframing over a T-interface that is directly connected to the network without the use of a physically separate NT1 is not supported.

This Layer 1 signaling capability exists only between the TE and NT, that is, there is no requirement in the NT for the direct transfer of signals between these S- and Q-channels and the Layer 1 signaling channel between the NT and the network.

Use of the Q- and S-channels shall be the same in point-to-point as in point-to-multipoint configurations. There is neither an inherent collision detection mechanism provided for the Q-channel nor any addressing mechanism for the S-channel. Procedures necessary to prevent or deal with collision and to indicate the desired TEs that are required for any application are not a part of this section.

Use of the Q-channel and S-channel is optional. NTs that do not support these channels are not required to encode the F_A and M bits as required for the defined multiframing. TEs that do not use those channels must provide for identification of the Q-bit positions and, if identified, must set each Q-bit to a binary ONE. Detection and use of the M-bit by such TEs is optional.

Uses of the Q-channel in addition to those specified in "Layer 1 Maintenance," Section 2.1.3, are for further study.

2.1.2.3.4.2 General Mechanism

a. ***Q-Bit Identification:*** The Q bits (TE-to-NT) are defined to be the bits in the F_A-bit position of every fifth frame. The Q-bit positions in the TE-to-NT direction are identified by binary inversions of the F_A-bit pair (F_A = binary ONE, N = binary ZERO) in the NT-to-TE direction. The provision of this capability in NTs is optional. The provision for identification of the Q-bit positions in the NT-to-TE direction permits all TEs to synchronize transmission in Q-bit positions; thereby avoiding interference of F_A bits from one TE with the Q bits of a second TE in passive bus configurations.

b. ***Multiframe Identification:*** A multiframe, which provides for structuring the Q-bits into 4-bit characters (Q1 - Q4), is established by setting the M-bit, in bit position 26 (see "NT to TE," Section 2.1.1.4.4.2.3) of the NT-to-TE frame, to binary ONE in every twentieth frame. This structure provides for 4-bit characters in a single channel, TE-to-NT. The provision of this capability in NTs is optional. Detection and use of the M bit by the TE is optional if the Q-channel is not intended to be used.

2.1.2.3.4.3 Q-Bit Position Identification Algorithm

The Q-bit position identification algorithm is illustrated in Table 2.1.2-1. Until synchronization to the F_A bit is declared, a TE should "wrap" the received Q-bit identifier (F_A bit) into the TE-to-NT Q-bit position. The TE synchronizes to the received F_A inversions and shall set each Q bit to binary ONE in every fifth frame, that is, in frames in which F_A bits (NT-to-TE direction) should be equal to binary ONE. Q-channel messages are transmitted only after multiframe synchronization to the binary ONEs in the M bit of the NT-to-TE frame is achieved. The algorithm used by a TE to determine multiframe synchronization or loss of multiframe synchronization is not described in this section.

No special Q-bit identification derived from the received signal is required in the NT because the maximum round-trip delay of NT-to-TE-to-NT is a small fraction of a frame, and, therefore, Q-bit identification is inherent in the NT.

Table 2.1.2-1 — Q-Bit Position Identification and Multiframe Structure

FRAME NUMBER	NT-TO-TE F(A) bit POSITION	NT-TO-TE M BIT	TE-TO-NT F(A) BIT POSITION [a b]
1	ONE	ONE	Q1
2	ZERO	ZERO	ZERO
3	ZERO	ZERO	ZERO
4	ZERO	ZERO	ZERO
5	ZERO	ZERO	ZERO
6	ONE	ZERO	Q2
7	ZERO	ZERO	ZERO
8	ZERO	ZERO	ZERO
9	ZERO	ZERO	ZERO
10	ZERO	ZERO	ZERO
11	ONE	ZERO	Q3
12	ZERO	ZERO	ZERO
13	ZERO	ZERO	ZERO
14	ZERO	ZERO	ZERO
15	ZERO	ZERO	ZERO
16	ONE	ZERO	Q4
17	ZERO	ZERO	ZERO
18	ZERO	ZERO	ZERO
19	ZERO	ZERO	ZERO
20	ZERO	ZERO	ZERO
1	ONE	ONE	Q1
2	ZERO	ZERO	ZERO
etc.			

Note(s):

a. If the Q-bits are not used by a TE, the Q-bits shall be set to binary ONE.

b. Where multiframe identification is not provided with a binary ONE in an appropriate M-bit, but where Q-bit positions are identified, Q-Bits 1 through 4 are not distinguished.

2.1.2.3.4.4 TE Multiframe Identification

The first frame of the multiframe is identified by the M-bit equal to a binary ONE. TEs that are intended to neither use, nor provide for the use of, the Q-channel are not required to identify the multiframe. TEs that are intended to use, or to provide for the use of, the Q-channel shall use the M-bit equal to a binary ONE to identify the start of the multiframe.

The algorithm used by a TE to determine when synchronization or loss of synchronization of the multiframe is achieved is not described in this section. However, note that the transmission of multiframing from an NT is not mandatory.

2.1.2.3.5 S-Channel Structuring Algorithm

The algorithm for structuring the S-bits [NT-to-TE frame bit position 37 (see "NT to TE," Section 2.1.1.4.4.2.3)] into an S-channel uses the same combination of the F_A-bit inversions and the M-bit that are used to structure the Q-channel as described in "Multiframing," Section 2.1.2.3.4. The S-channel structure, shown in Table 2.1.2-2, provides for five subchannels, SC1 through SC5. Each subchannel SCn is comprised of the bits SCn1 through SCn4, which provide for the transfer of one 4-bit character per multiframe (5 ms). This section covers the use of subchannels SC1 and SC2 only. Subchannels SC3 through SC5 are reserved for future use and shall be coded with all binary ZEROs. The coding and use of the 4-bit character of SC1 are defined in "Codes, Message Durations, and Detection Algorithms for Q-Channel and SC1 Subchannel," Section 2.1.3.3, and "NT-to-TE Direction Messages (SC1 Bits)," Section 2.1.3.6. The coding and use of the 4-bit character of SC2 are defined in "NT-to-TE Direction Messages (SC2 Bits)," Section 2.1.3.7.

Table 2.1.2-2 — S-Channel Structure

[a] FRAME NUMBER	NT-TO-TE F(A)-bit POSITION	NT-TO-TE M BIT	NT-TO-TE S BIT
1	ONE	ONE	SC11
2	ZERO	ZERO	SC21
3	ZERO	ZERO	SC31
4	ZERO	ZERO	SC41
5	ZERO	ZERO	SC51
6	ONE	ZERO	SC12
7	ZERO	ZERO	SC22
8	ZERO	ZERO	SC32
9	ZERO	ZERO	SC42
10	ZERO	ZERO	SC52
11	ONE	ZERO	SC13
12	ZERO	ZERO	SC23
13	ZERO	ZERO	SC33
14	ZERO	ZERO	SC43
15	ZERO	ZERO	SC53
16	ONE	ZERO	SC14
17	ZERO	ZERO	SC24
18	ZERO	ZERO	SC34
19	ZERO	ZERO	SC44
20	ZERO	ZERO	SC54
1	ONE	ONE	SC11
2	ZERO	ZERO	SC21
etc.			

Note(s):

a. S-subchannels SC3 through SC5 are reserved for future specification and are set to all binary ZEROs. Optional subchannels SC1 and SC2, when not provided, are set to all binary ZEROs.

2.1.2.4 Idle Channel Code on the B-Channels

A TE shall send binary ONEs in any B-channel that is not assigned to it.

The idle code from the network to the terminal is not defined.

2.1.3 LAYER 1 MAINTENANCE

2.1.3.1 Overview of Layer 1 Maintenance

The transmitted D-channel bits and the resultant D-echo bits may be used by TEs in point-to-point configurations to assure satisfactory operation of the interface and the NT unit. Layer 1 maintenance over a T-interface that is directly connected to the network without the use of a physically separate NT1 is not supported.

As indicated in "Interface Procedures," Section 2.1.2, maintenance function signaling channels are provided in both the NT-to-TE and TE-to-NT directions. The functions to be signaled on these channels and the associated protocol are specified in the following sections. The provision of the functions in TEs and NTs is optional, but, where a function is provided, the signals shall conform to those specified.

Two independent S-subchannels are defined. They are both optional. TEs and NTs are permitted to implement only the SC1 subchannel, only the SC2 subchannel, both subchannels, or neither subchannel.

For the Q-channel if implemented, or any S-subchannel if implemented, the transmission by a TE or NT, respectively, of any individual maintenance message other than Idle (Normal) is optional. Additionally, the reception of any individual Q-channel message or any individual S-subchannel message requesting a maintenance function which has not been implemented shall be ignored by the respective NT or TE.

An overall maintenance plan for the general user equipment configuration (reference configuration shown in Figure 2.1-1) together with the network access and plans for the specific cases of TEs connected to an NT1 and of TEs connected to a PBX are described in "Interface Procedures," Section 2.1.2.

In the following discussion, the generic term "TE" refers to either a TE connected to an NT1, a TE connected to an NT2, or an NT2 connected to an NT1. Also, the generic term "NT" can be either an NT1 or an NT2 to which a TE (generic meaning) is connected.

2.1.3.2 Test Loopbacks

Loopbacks for which Layer 1 control is specified are indicated in Figure 2.1.3-1. The characteristics of the two loopbacks of concern are specified in Table 2.1.3-1. The loopback designations are based on the loopback notation used in *ANSI*[1] Standard T1.605-1991. The notation is presented in "Loopback Notation," Section 2.1.6.8.

1. Registered trademark of American National Standard Institute.

Table 2.1.3-1 — Test Loopback Characteristics

LOOPBACK (FIG. 2.1.3-1)	LOCATION	CHANNELS LOOPED	CONTROL POINT	ALTERNATE CONTROL
C[a]	Inside NT1	B1, B2	TE or NT2	None
B[b]	Inside NT2	B1, B2	TE	None

Note(s):

a. An exchange of Layer 3 messages may take place between the TE (or NT2) and the exchange prior to the use of the initiation of the Layer 1 control signal. However, there are situations in which the TE (NT2) will not receive a reply:
   - The message may not be transmitted when the interface/access is in a failure condition.
   - A network may not support the Layer 3 message.

b. The same consideration as expressed in the first footnote except that the NT2 may not support the Layer 3 message.

The locations of the loopbacks within the functional unit blocks in Figure 2.1.3-1 should not be construed as having any significance. The specific locations of the loopbacks within functional units (for example, NT1) are not part of this section. The location of a loopback within an equipment will depend upon several factors including implementation and application considerations.

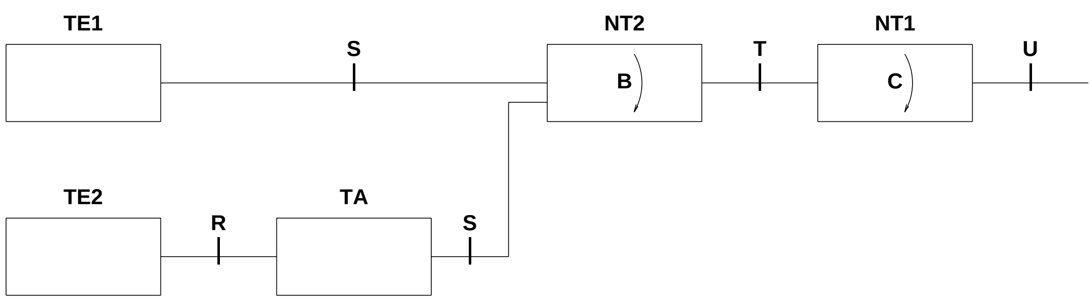


Figure 2.1.3-1 — Location of Test Loopbacks

2.1.3.3 Codes, Message Durations, and Detection Algorithms for Q-Channel and SC1-Subchannel

The codes for all the Q-channel and SC1-subchannel messages are defined in Table 2.1.3-2. Each code is a 4-bit character transmitted in a single multiframe.

One of the several Q-channel codes that are reserved for future specification could be defined in the future as an escape code to extend the number of messages if that ever becomes necessary. "NT-to-TE Direction Messages (SC1 Bits)," Section 2.1.3.6, defines the extension code for the SC1 subchannel.

Except where stated otherwise, the code for a message shall be repeated in at least six consecutive Q or SC1 characters or as many times as necessary to obtain the desired response (for example, loopback).

Except where stated otherwise, a message shall be considered received only when the proper code (and its extension if needed) is received in three consecutive Q or SC1 characters.

Table 2.1.3-2 — Codes for Q-Channel and SC1-Subchannel Messages

MESSAGE [a]	CODE USED IN DIRECTION							
	NT-TO-TE				TE-TO-NT			
	SC11	SC12	SC13	SC14	Q1	Q2	Q3	Q4
Idle (NORMAL)	0	0	0	0	1	1	1	1
Loss-of-Power Indication	1	1	1	1	0	0	0	0
STP Pass	0	0	1	0	-	-	-	-
STF Fail	0	0	0	1	-	-	-	-
ST Request[b]	-	-	-	-	0	0	0	1
STI Indication	0	1	1	1	-	-	-	-
Far-End Code Violation	1	1	1	0	-	-	-	-
DTSE-IN&OUT	1	1	0	0	-	-	-	-
DTSE-IN	1	0	0	0	-	-	-	-
DTSE-OUT	0	1	0	0	-	-	-	-
LB1 Request	-	-	-	-	0	1	1	1
LB1I Indication	1	1	0	1	-	-	-	-
LB2 Request	-	-	-	-	1	0	1	1
LB2I Indication	1	0	1	1	-	-	-	-
LB1/2 Request[c]	-	-	-	-	0	0	1	1
LB1/2I Indication	1	0	0	1	-	-	-	-
Loss-of-Received-Signal Indication	1	0	1	0	-	-	-	-
Disruptive Operation Indication	0	0	1	1	-	-	-	-

Note(s):

a. Codes not specified in the table are for future specification. Except for the Idle code, these codes are listed in order of priority. Provision of the Q- and SC1-subchannels is optional. The extension code to identify a message from an extended set of messages for the SC1 subchannel is "0 1 0 1." The following message codes have been reserved for ITU-TS Recommendation V.230: SC1 - "0 1 1 0"; Q - "1 1 0 1" and "1 1 0 0."

b. The code "0001" will be received by an NT1 when ST Request and any other code (except LP) is sent simultaneously by two or more TEs on a passive bus.

c. The code "0011" will be received by an NT1 when the LB1 and LB2 requests are transmitted by two different TEs (NT2s) on a passive bus.

2.1.3.4 Code Priorities for Q-Channel and SC1-Subchannel

The following rules apply for interruption of the sending of one code by another:

1. Loss of power (LP) always takes precedence.
2. Self-Test (ST) request, indication, pass, and fail take precedence over all other codes except LP.

3. Far-end code violation (FECV) is instantly sent (once) and replaces one occurrence of whatever else was being sent (except LP and ST). The FECV messages shall not be sent when signal has been lost from the TEs.
4. Report of error (DTSE) is instantly sent (once) and replaces one occurrence of whatever else was being sent (except LP, ST, and FECV). The DTSE messages must not be sent when signal has been lost at the network side of the NT1.
5. Loopback requests (LB) and confirmations can interrupt only three codes (Idle, Disruptive operation indication, and Loss of received signal).
6. Loss of received signal (LRS) replaces Idle or Disruptive operation indication whenever the loss is detected by the NT.
7. Disruptive NT Operation Indication (DOI) cannot interrupt any other code except Idle.
8. NORMAL is the idle code when no other codes are present.

2.1.3.5 TE-to-NT Direction Messages (Q-Bits)

2.1.3.5.1 Message Codes

The codes for the optional Q-channel messages are defined in Table 2.1.3-2.

2.1.3.5.2 Idle Channel (Normal)

The NORMAL message shall be transmitted during normal conditions, that is, at all times when no other message is being transmitted. The continuous transmission of the NORMAL message assures that spurious unintended loopbacks or conditions are cleared quickly.

This will be the usual message to request the release of a loopback.

2.1.3.5.3 Loss-of-Power Indication (LP)

This message is an indication to the NT that the TE in a point-to-point configuration or one of the TEs in a point-to-multipoint configuration has lost power and will soon discontinue transmission. This LP message should be transmitted in at least one but no more than three multiframes just prior to the initiation of the transmission of INFO 0 before frame alignment is lost (see "General TE Procedures," Section 2.1.2.2.3). The transmission of this indication requires the TE to have sufficient energy storage to maintain proper transmission for at least two full multiframes (10 ms).

2.1.3.5.4 Request Self-Test (ST)

The TE can request that the NT perform a self-test. The scope of the self-test is not defined. The self-test report returning from the NT1 shall be pass (STP) or fail (STF). The use of the ST message by a TE connected to an NT2 is for further study. (It is assumed that transmission on the D-channel as well as on the B-channels may be interrupted during the self-test.)

2.1.3.5.5 Request a Loopback (LB1, LB2, LB1/2)

The ability to request a Layer 1 B-channel loopback is independent of any current assignment of a B-channel. Any TE can request any Layer 1 B-channel loopback at any time regardless of whether the network has assigned the B-channel to any particular TE on a bus.

The two loopback request messages are designated LB1 (request loopback of channel B1) and LB2 (request loopback of channel B2). For example, a TE that is currently assigned to transmit over the B1 channel may send LB1 across the interface (at reference points S or T) to request a loopback in the NT of channel B1. These LB1 and LB2 messages are coded in such a way that the two different loopbacks can be requested at the same time by two different TEs on a bus. The resulting message that is received by the NT is defined as LB1/2. One TE will use the B1 channel looped back while the other TE uses the B2 channel looped back. The LB1/2 may also originate from a single TE.

Each loopback shall remain established as long as the NT continues to receive the appropriate message (LB1, LB2, or LB1/2) from the TEs. Any other message that is properly received from the TEs will cause the release of the loopback(s). The NORMAL message is the usual way of requesting the release of a loopback.

2.1.3.5.6 Additional TE-to-NT Direction Messages

Unassigned message codes are reserved for future specification.

2.1.3.6 NT-to-TE Direction Messages (SC1 Bits)

2.1.3.6.1 Message Codes

The codes for the optional SC1-subchannel (see "S-Channel Structuring Algorithm," Section 2.1.2.3.5) messages are defined in Table 2.1.3-2. One of the 16 codes (0 1 0 1) for the SC1 subchannel is defined as an escape code to extend the number of available messages. The mechanism for using this extension code is for further study. Use of the SC1 subchannel remains optional even when the SC2 subchannel is provided.

2.1.3.6.2 Idle Channel (Normal)

The NORMAL message shall be transmitted during normal conditions, that is, at all times when no other message is being transmitted. The continuous transmission of the NORMAL message assures that spurious unintended conditions are cleared quickly.

2.1.3.6.3 Loss-of-Power Indication (LP)

This is an indication to the TEs that the NT has lost power. This LP message should be transmitted in at least one multiframe. The transmission of this indication requires the NT to have sufficient energy storage to maintain proper transmission for at least two multiframes (about 10 ms).

2.1.3.6.4 Self-Test Report (STP, STF)

This message is a report to the TEs of an NT self-test that was requested by a TE. The report shall indicate pass (STP) or fail (STF).

2.1.3.6.5 Self-Test Indication (STI)

This message indicates to the TEs that the NT is in a self-test mode. The message shall continue to be transmitted until the NT completes the self test. (It is assumed that transmission on the D-channel as well as on the B-channels may be interrupted during the self-test.)

2.1.3.6.6 Far-End Code Violation (FECV)

This message indicates to the TEs that a previous multiframe incoming to the NT from the TEs contains one or more illegal S/T line-code violations. The FECV message shall be transmitted once for each incoming multiframe that contains any illegal line-code violations. FECV messages shall not be sent when signal has been lost from the TEs.

2.1.3.6.7 Detected Access Transmission System Error (DTSE-OUT, DTSE-IN)

This message is an indication to the TEs from the NT1 that a basic access system performance monitoring capability has indicated an error in a block of bits. DTSE messages must not be sent when signal has been lost at the network side of the NT1. It is assumed that the performance monitoring capability will independently indicate errors for each of the two directions of transmission. Therefore, two indications are provided: error-out and error-in for errors that are detected in the transmitted (from the NT1) direction and errors in the received (to the NT1) direction, respectively.

The DTSE messages shall be transmitted once for each time that a performance monitored block is detected to contain an error. Therefore, it is recognized that, when the S/T interface error rate is high, this information can be corrupted.

In cases where performance monitoring capability is intentionally corrupted (for example, for testing the error detection mechanism), the transmission of any corresponding DTSEs toward the TEs shall be suppressed. Specifically, when the NT is connected to the network through the two-wire interface described in "Service Provided to Layer 2," Section 2.1.1.1.2, the following defines the conditions in which the transmission of each DTSE message is suppressed. It also identifies the incoming network-side indicator expected to report a performance monitoring error. These indicators are crc for cyclic redundancy check and febe for far-end block error.

SC1 Message	When Suppressed	PM Indicator
DTSE-IN	Notified of corruption	crc
DTSE-OUT	Corruption requested	febe
DTSE-IN/OUT	Both notified and requested	crc and febe

2.1.3.6.8 B-Channel Loopback Indications (LB1I, LB2I, LB1/2I)

This message indicates to the TEs that the NT is looping back B-channel 1 (LB1I) or 2 (LB2I) or both (LB1/2I) toward the TEs. This message continues to be transmitted as long as the loopback remains active.

2.1.3.6.9 Loss-of-Received-Signal Indication (LRS)

This message is an indication to the TE that the NT cannot properly identify the signal that is being received across the U-interface. A loss of frame synchronization shall be considered one condition when the LRS message should be transmitted toward the TE. (Note that in some applications the loss of received signal may also result in the A-bit being set to ZERO.)

This message should be sent continuously in all multiframes until the condition is cleared. This message shall obey the criteria for reception and transmission as stated in "Codes, Message Durations, and Detection Algorithms for Q-Channel and SC1 Subchannel," Section 2.1.3.3.

2.1.3.6.10 Disruptive NT Operation Indication (DOI)

This message is an indication to the TEs that the NT is operating under a condition that may disrupt the normal flow of D-channel messages. Several examples of D-channel disruption are as follows:

- Looping back the full 2B+D user data stream toward the network.
- An indication from the network that it has lost transparency (disruption of Layer 2 communication) and cannot operate on D-channel messages.

- An operator-initiated NT test that causes the NT to disrupt the D-channel message flows in either direction.
- Any network generated alarm that indicates disruption of D-channel messages [for example, network alarm indication, see "Network Alarm Indication (NAI)," Section 2.1.3.7.8].
- Any future S/T or network-side action that would disrupt the D-channel operation or would remove the D-channel from service.

This message continues to be transmitted as long as the potentially disruptive operation remains active.

2.1.3.6.11 Additional NT-to-TE Direction Messages in the SC1 Subchannel

Unassigned message codes are reserved for future specification.

2.1.3.7 NT-to-TE Direction Messages (SC2 Bits)

2.1.3.7.1 Message Codes

The message codes for the optional SC2-subchannel (see "S-Channel Structuring Algorithm," Section 2.1.2.3.5) messages are defined in Table 2.1.3-3. Use of the SC2 subchannel remains optional even when the SC1 subchannel is provided. The SC2-subchannel messages are used to report to the TEs (in this section, TE refers to ISDN terminals and test equipment) a variety of possible testing, powering, and activation/ deactivation states of the NT. One of the 16 message codes (0 0 1 0) is defined as an escape message code to extend the number of available messages.

Table 2.1.3-3 — Codes for SC2-Subchannel Messages

MESSAGE [a]	DESCRIPTION [b]	CODE USED			
Rdea	Receiving valid dea = 0.	1	1	1	1
Ract	Receiving valid act = 0.	1	1	1	0
NAI	Network has notified NT of a network failure.	1	1	0	1
PPb	Primary Power Bad, Secondary Good.	1	1	0	0
PSb	Primary Power Good, Secondary Bad.	1	0	1	1
LUTI	2B+D looped back to Network, or NT1 placed into Quiet Mode or Insertion Loss Mode.	1	0	1	0
LB1N	B1 looped back to Network.	1	0	0	1
LB2N	B2 looped back to Network.	1	0	0	0
CcrcR	Corrupt crc Requested.	0	1	1	1
CcrcN	Corrupt crc Notified.	0	1	1	0
Rset	NT receiver is in either FULL RESET state or RECEIVE RESET state.	0	1	0	1
RUeoc	Receiving valid but unrecognized eoc message.	0	0	1	1
Extend	Introduce extended set of messages.	0	0	1	0
IBNAM	SC2 Subchannel is Implemented But there are No Active Messages.	0	0	0	1
SNI	SC2 Subchannel is Not Implemented.	0	0	0	0

Note(s):

a. Remaining message codes are reserved for future specification. Provision of the SC2-subchannel is optional.

b. Messages are reported in descending numerical order when two or more conditions are to be reported.

2.1.3.7.2 Assumed Configuration

The messages described in "Receiving Valid dea=0 Bit (Rdea) at Network Side of NT," Section 2.1.3.7.6, "Receiving Valid act=0 Bit (Ract) at Network Side of NT," Section 2.1.3.7.7, "Network Alarm Indication (NAI)," Section 2.1.3.7.8, "Primary or Secondary Power Bad (PPb or PSb)," Section 2.1.3.7.9, "Loop-Under-Test Indication (LUTI)," Section 2.1.3.7.10, "B-Channel Loopbacks Toward the Network (LB1N, LB2N)," Section 2.1.3.7.11, "Corrupt crc Requested (CcrcR) and Notified (CcrcN)," Section 2.1.3.7.12, "Reset (Rset) State to Network Side of NT," Section 2.1.3.7.13, "Reception of a Valid, but Unrecognized, eoc Message (RUeoc)," Section 2.1.3.7.14, "Subchannel Implemented but no Active Messages (IBNAM)," Section 2.1.3.7.15, "Subchannel not Implemented (SNI)," Section 2.1.3.7.16, "Additional NT-to-TE Direction," Section 2.1.3.7.17, apply to the basic access configuration in which the TEs, a test set, or both are connected to an NT1 or NT2 that is connected to the network through a 2-wire metallic loop described in "Service Provided to Layer 2," Section 2.1.1.1.2.

Other configurations that do not include the 2-wire metallic loop may use the same message codes for different purposes. Any messages and message codes for such configurations are for further study. Any message code to identify a specific configuration or application is also for further study.

2.1.3.7.3 Message Durations and Detection Algorithms

The message code for each message consists of four bits and shall be repeated in at least six but no more than eight consecutive SC2 message codes. An incoming message code shall be recognized upon the third consecutive identical reception of an SC2-subchannel message code.

Since each SC2-subchannel character requires one multiframe (5 ms), the six to eight repetitions required for the proper transmission of an SC2-subchannel message code have a 30- to 40-ms duration.

2.1.3.7.4 Cycling through SC2-Subchannel Messages

Several of the SC2-subchannel messages may exist at the same time. For example, a B1-channel loopback (LB1N) toward the network may be operational while an intentionally corrupted crc (CcrcR) is requested. In order to report all of the existing SC2 conditions to the TEs, the SC2-subchannel messages cycle through all the existing conditions.

The specific order in the cycle is specified in Table 2.1.3-3, top to bottom (in descending numerical order). Conceptually, the NT could cycle through a set of flags (ordered as in Table 2.1.3-3), a single flag representing each reportable condition. Where a flag is found to be set, that associated message is reported in the SC2 subchannel. In this manner, only those reportable conditions that are flagged will have messages sent on the SC2 subchannel, and those messages would be in the proper order.

In the previous example, the SC2-subchannel message cycle consists of six to eight LB1N message codes followed by six to eight CcrcR message codes followed by six to eight LB1N message codes, and so forth, until either a third condition exists or one of the existing conditions ceases to exist.

If only one reportable condition is active, the SC2 subchannel would consist of a continuous stream (at least six occurrences) of the corresponding message code that reports the condition. After those first six to eight message codes are sent, the NT is required to report any newly recognized condition in the next SC2-subchannel message code.

If no reportable condition is active, the idle message code (IBNAM) would be transmitted continuously in the SC2 subchannel. It is not required that the idle message code be sent in six or more consecutive message codes. It is sent only as long as no reportable condition exists. As soon as a reportable condition is recognized, the NT must interrupt (at the end of the current message code) the idle message code and begin the transmission of the message code reporting the new reportable condition.

It is expected that in most instances, only one reportable condition would be active at one time. However, there will be rare times in which two, three, or four reportable conditions will need to be reported. In the example where four conditions are being reported, the reporting cycle time would be 120 ms (4x30 ms) to 160 ms (4x40 ms).

In an extreme case where all conditions that can possibly exist at the same time do co-exist, the maximum cycle time would be 360 ms: Rdea, Ract, NAI, PPb or PSb, LB1N and LB2N, CcrcR and CcrcN, and RUeoc. The absolute maximum cycle time would occur when the reportable conditions change rapidly during a single cycle of

SC2-subchannel message reporting. The future possible use of the extension code could increase the maximum cycle time.

2.1.3.7.5 Initiating and Terminating Reporting of a Condition

When a new reportable condition appears at the NT, the NT must latch the corresponding message so that it is reported at the next opportunity, when its turn comes up next in the reporting cycle. The message code for that message shall be transmitted in at least one set of six to eight SC2-subchannel message codes, even if that new condition disappears before the message can be transmitted for the first time.

Upon the disappearance of an existing reportable condition that has already been reported at least once, the NT unlatches the corresponding message so that it will not be reported again when its turn comes up next in the reporting cycle.

Cases in which the NT conditions are turned on and off too rapidly and frequently during a single reporting cycle to report in the single cycle are for further study.

2.1.3.7.6 Receiving Valid dea=0 Bit (Rdea) at Network Side of NT

When the network intends to deactivate the interface at the network side of the NT, the NT receives a dea (deactivate) bit equal to binary ZERO from the network. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements in the use of the dea bit. Three consecutive receptions of dea=0 (or dea=1) are generally recognized as a valid change of state for the dea bit.

The NT may report this occurrence to the TEs by sending the Rdea message in the SC2 subchannel. The Rdea message remains in the reporting cycle until the valid reception of dea=1. Rdea continues to be reported if the interface at the network side of the NT is deactivated after a valid reception of dea=0.

2.1.3.7.7 Receiving Valid act=0 Bit (Ract) at Network Side of NT

When the network temporarily loses transparency and during start-up, the NT receives an act (activation) bit equal to binary ZERO from the network. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements regarding the act bit. When the received act=0, the network is not ready for Layer 2 communication over the D-channel. Three consecutive receptions of act=0 (or act=1) are recognized as a valid change of state for the act bit.

The NT may report this occurrence to the TEs by sending the Ract message in the SC2 subchannel. The Ract message remains in the reporting cycle until the valid reception of act=1 or until the interface at the network side of the NT becomes deactivated.

2.1.3.7.8 Network Alarm Indication (NAI)

An alarm indication signal from the network provides a clear indication to the NT that a trouble condition exists within a carrier system in the basic access configuration. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements concerning the alarm indication signal.

The NT can report this condition to the TEs by sending the NAI message on the SC2 subchannel. In this way a TE could better understand the condition that is causing a DOI [disruptive operation indication - see "Disruptive NT Operation Indication (DOI)," Section 2.1.3.6.10] to be sent over the SC1 subchannel. This message remains in the reporting cycle as long as the NT continues to receive the alarm indication signal from the network.

2.1.3.7.9 Primary or Secondary Power Bad (PPb or PSb)

When the NT recognizes that the primary and secondary power supplies are both normal, no power message is reported over the SC2 subchannel to the TEs. See "Interface Connector and Contact Assignments," Section 2.1.6.1, for specific requirements for powering across the interface.

When primary power is recognized to be normal and secondary power is marginal, unavailable, or not provided, the NT may send the PSb (power secondary bad) message over the SC2 subchannel. When secondary power is normal and primary power is marginal or unavailable, the NT may send the PPb (power primary bad) message over the SC2 subchannel. The PSb message shall not be sent by an NT1 that is designed not to accept or operate under secondary power.

The PSb or PPb message code remains in the reporting cycle until either the subnormal power returns to normal or both sources of power become marginal, unavailable, or not provided. When both are subnormal, the NT may report LP in the SC1 subchannel to report loss of power (see "Test Load Impedance," Section 2.1.4.6.2), and a corresponding SC2 channel message is unnecessary.

2.1.3.7.10 Loop-Under-Test Indication (LUTI)

The network may place the customer loop into various test conditions to diagnose suspected problems. A 2B+D loopback at the NT1 toward the network is one kind of test used while the basic access carries transmission in both directions. Other examples of network-imposed test conditions are NT1 quiet mode and NT1 insertion-loss test signal, both useful for metallic access testing when the access cannot be activated for one reason or another. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements for 2B+D loopbacks, quiet mode, and insertion loss.

The NT may inform the TEs whenever the network side of the NT is under some network-imposed test that prohibits call origination. The LUTI message on the SC2 subchannel notifies the TEs of any such test conditions.

This SC2-subchannel message may be used in conjunction with SC1-subchannel messages. For example, for 2B+D loopbacks the disruptive NT operation indication (DOI) may be sent over the SC1 Subchannel (see "Disruptive NT Operation Indication (DOI)," Section 2.1.3.6.10). For quiet mode or insertion loss, the NT may place the loss of received signal message (LRS) on the SC1 subchannel (see "Loss-of-Received-Signal Indication (LRS)," Section 2.1.3.6.9).

2.1.3.7.11 B-Channel Loopbacks Toward the Network (LB1N, LB2N)

When the NT is providing a B-channel loopback toward the network, this loopback condition can be reported to the TEs through the use of one of two loopback messages on the SC2 subchannel.

The LB1N message reports the loopback of the B1 channel toward the network, and LB2N reports the loopback of the B2 channel toward the network. When the full 2B+D stream of user data is looped back toward the network, the LUTI message is used [see "Loop-Under-Test Indication (LUTI)," Section 2.1.3.7.10].

The appropriate loopback message remains in the reporting cycle as long as the corresponding channel remains looped back toward the network.

2.1.3.7.12 Corrupt crc Requested (CcrcR) and Notified (CcrcN)

The cyclic redundancy check (crc) calculation is performed by both the network and the NT to indicate the integrity of the transmitted and received bit streams across the interface at the network side of the NT. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements relating to crc calculations.

The network may check its crc-error detection mechanism by requesting the NT to transmit an intentionally corrupt crc calculation for its transmitted bit stream toward the network. When the network recognizes its received corrupted crc calculation, it sends back a febe (far-end block error) bit equal to binary ZERO. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements relating to crc calculations and febe bits.

The network can also check the crc-error detection mechanism of the NT by sending an intentionally corrupt crc calculation for its transmitted bit stream toward the NT. Through the embedded operations channel (eoc) at the network side of the NT, the network informs the NT that the NT incoming crc calculations are intentionally corrupted. See "Service Provided to Layer 2," Section 2.1.1.1.2, for specific requirements relating to crc calculations and febe bits.

The NT can inform the TEs and a test set that intentionally corrupted crc calculations are being transmitted, received, or both across the interface at the network side of the NT. This intentionally corrupted crc condition can be reported by sending one of the two messages in the SC2 subchannel.

The CcrcR message indicates that the network requested the NT to transmit intentionally corrupted crc calculations. The CcrcN message indicates that the network has notified the NT that the NT incoming bit stream includes intentionally corrupted crc calculations. The appropriate Ccrc message remains in the reporting cycle as long as the intentional crc-error condition continues to exist.

2.1.3.7.13 Reset (Rset) State at Network Side of NT

The Rset message indicates that the NT is in one of the RESET states, either the RECEIVE RESET state or the FULL RESET state (see "Service Provided to Layer 2," Section 2.1.1.1.2).

In the transient RECEIVE RESET state the NT is not transmitting toward the network; it may respond to the start-up signal from the network; but it is not permitted to initiate transmission even to request service. See "Service Provided to Layer 2," Section 2.1.1.1.2, for the specific requirements for NT transceivers in this RESET state.

In the FULL RESET state the NT transceiver is not transmitting toward the network; it may respond to the start-up signal from the network; and it may initiate transmission only to request service. See "Service Provided to Layer 2," Section 2.1.1.1.2, for the specific requirements for transceivers in this RESET state.

The NT may be in one of the RESET states during power-up, during the start-up sequence, and during loss of signal from the network.

Whenever the NT transceiver enters one of these RESET states, it may report the condition to the TEs by using the Rset message on the SC2 subchannel. This message shall remain in the reporting cycle as long as the NT remains in either the RECEIVE RESET state or the FULL RESET state.

2.1.3.7.14 Reception of a Valid, but Unrecognized, eoc Message (RUeoc)

The NT may be receiving a valid (three identical consecutive messages), but unrecognized, message over the embedded operations channel from the network. This is possible when a newer vintage network is working with an older vintage NT. The NT can report such a reception by transmitting the RUeoc message over the SC2 subchannel.

2.1.3.7.15 Subchannel Implemented but no Active Messages (IBNAM)

The IBNAM code shall be transmitted at all times when no other message is being transmitted on the SC2 subchannel. It indicates to the TEs that the SC2 subchannel is implemented and all conditions are normal: dea=1, act=1, no network alarms, primary and secondary power are normal, no channels are being looped back toward the network, no NT1 test modes are in effect, no corrupt crc calculations are requested or notified, the network-side transceiver is not in a RESET state, and no unrecognized eoc messages are being received.

2.1.3.7.16 Subchannel not Implemented (SNI)

When the SC2 subchannel is not implemented by the NT1, this message, all zeros (0 0 0 0), is transmitted continuously on the SC2 subchannel toward the TEs.

2.1.3.7.17 Additional NT-to-TE Direction Messages in the SC2 Subchannel

Unassigned message codes are reserved for future specification.

2.1.4 ELECTRICAL CHARACTERISTICS

2.1.4.1 Grounding

Refer to "Reference Configuration," Section 2.1.5.2, for grounding information.

2.1.4.2 Bit Rate

2.1.4.2.1 Nominal Rate

The nominal bit rate is 192 kbps.

2.1.4.2.2 Tolerance

The tolerance (free-running mode) is ±100 ppm.

2.1.4.3 Jitter and Bit-Phase Relationship Between TE Input and Output

2.1.4.3.1 Test Configurations

The jitter and phase deviation measurements are carried out with four different waveforms at the TE input, in accordance with the following configurations:

a. Point-to-point configuration with 6-dB attenuation measured between the two terminating resistors at 96 kHz (high capacitance cable)

b. Short passive bus with eight TEs (including the TE under test) clustered at the far end from the signal source (high capacitance cable)

c. a) and b) Short passive bus with the TE under test adjacent to the signal source and the other seven TEs clustered at the far end from the signal source (high and low capacitance cable)

d. Ideal test signal condition, with one source connected directly to the receiver of the TE under test (that is, without artificial line).

Examples of waveforms that correspond to the configurations a, b, c, and d are given in Figures 2.1.4-1, 2.1.4-2, 2.1.4-3, and 2.1.4-4. Test configurations that can generate these signals are given in "Test Configurations," Section 2.1.6.9.

2.1.4.3.2 Timing Extraction Jitter

Timing extraction jitter, as observed at the TE output, shall be within −7 percent to +7 percent of a bit period, when the jitter is measured using a high-pass filter with a cut-off frequency (3-dB point) of 30 Hz under the test conditions described in "Test Configurations," Section 2.1.4.3.1. The limitation applies with an output data sequence having binary ZEROs in both B-channels and with input data sequences described in a) to c). The limitation applies to the phase of all zero-volt crossings of all adjacent binary ZEROs in the output data sequence.

- A sequence consisting of continuous frames with all binary ONEs in D, D-echo, and both B-channels.
- A sequence, repeated continuously for at least 10 seconds, consisting of :
  - — 40 frames with continuous octets of "10101010" (the first bit to be transmitted is binary ONE) in both B-channels and continuous binary ONEs in D and D-echo channels followed by
  - — 40 frames with continuous binary ZEROs in D, D-echo, and both B-channels.
- A sequence consisting of a pseudo-random pattern with a length of 2^{19} −1 in D, D-echo, and both B-channels. (This pattern may be generated with a shift register

with 19 stages with the outputs of the first, the second, the fifth, and the nineteenth stages added together (modulo 2) and fed back to the input.)

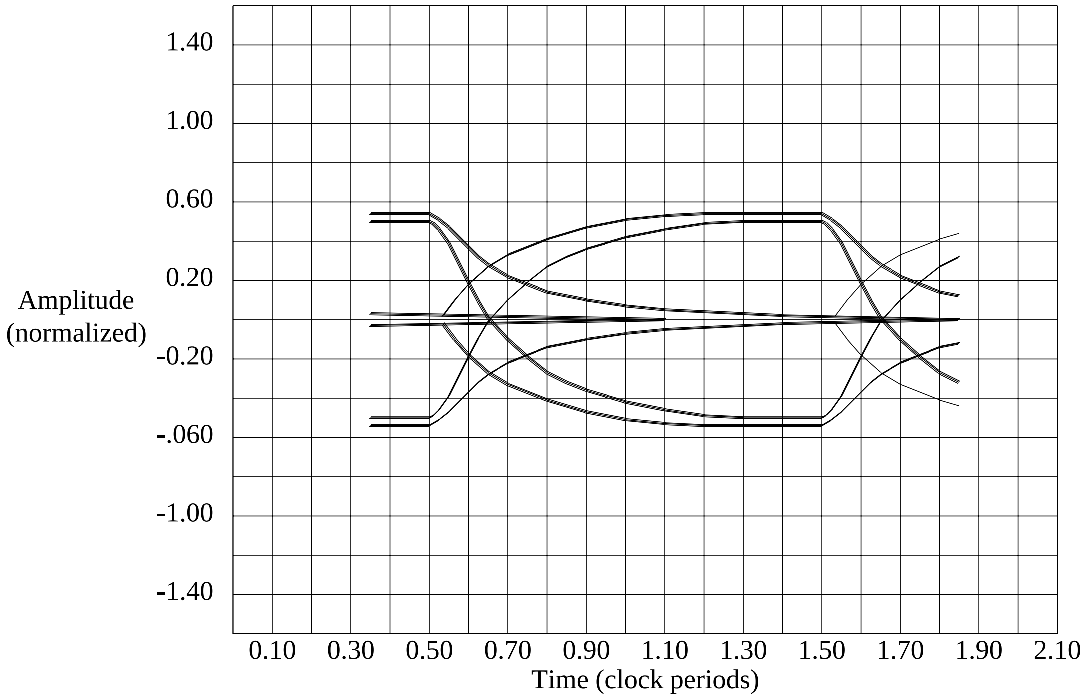


Figure 2.1.4-1 — Waveform for Test Configuration i) - Point-to-Point (6 dB) (C = 120 nF/km)

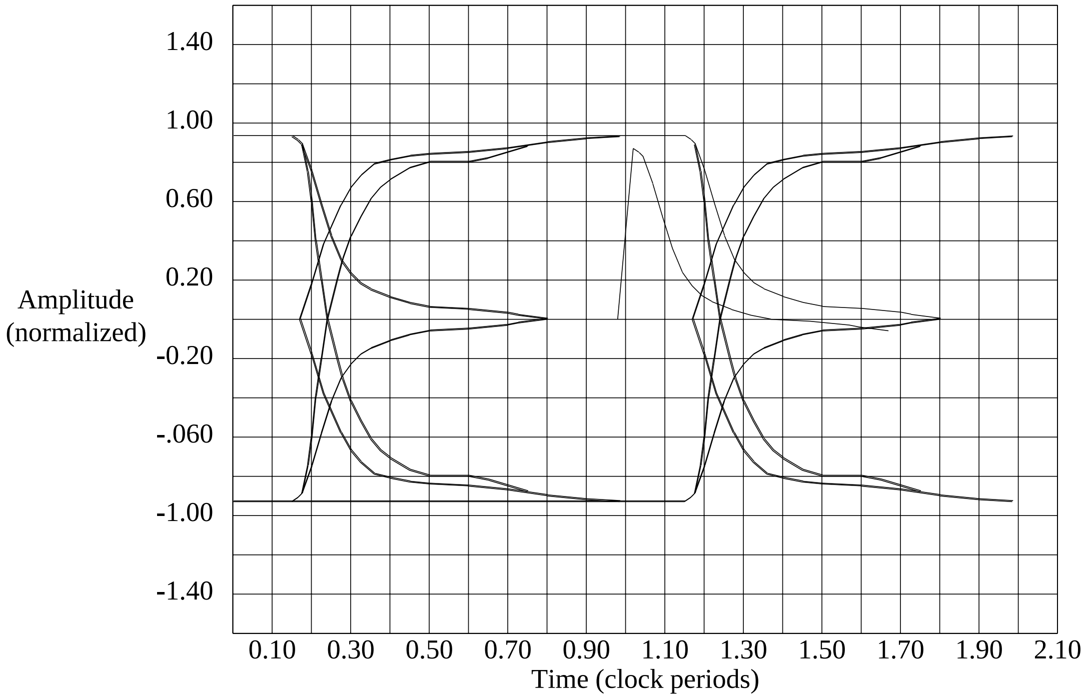


Figure 2.1.4-2 — Waveform for Test Configuration ii) - Short Passive Bus with Eight Clustered TEs at the Far End (C = 120 nF/km)

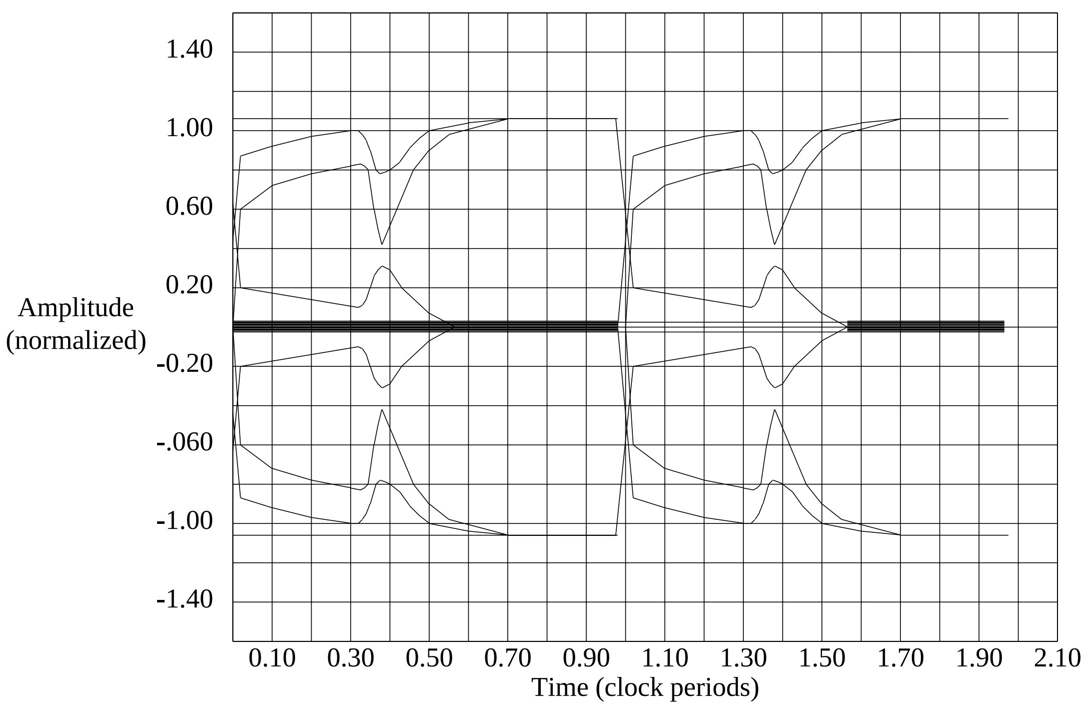


Figure 2.1.4-3 — Waveform for Test Configuration iii a) - Short Passive Bus with One TE Near to NT, and Seven TEs at the Far End (C = 120 nF/km)

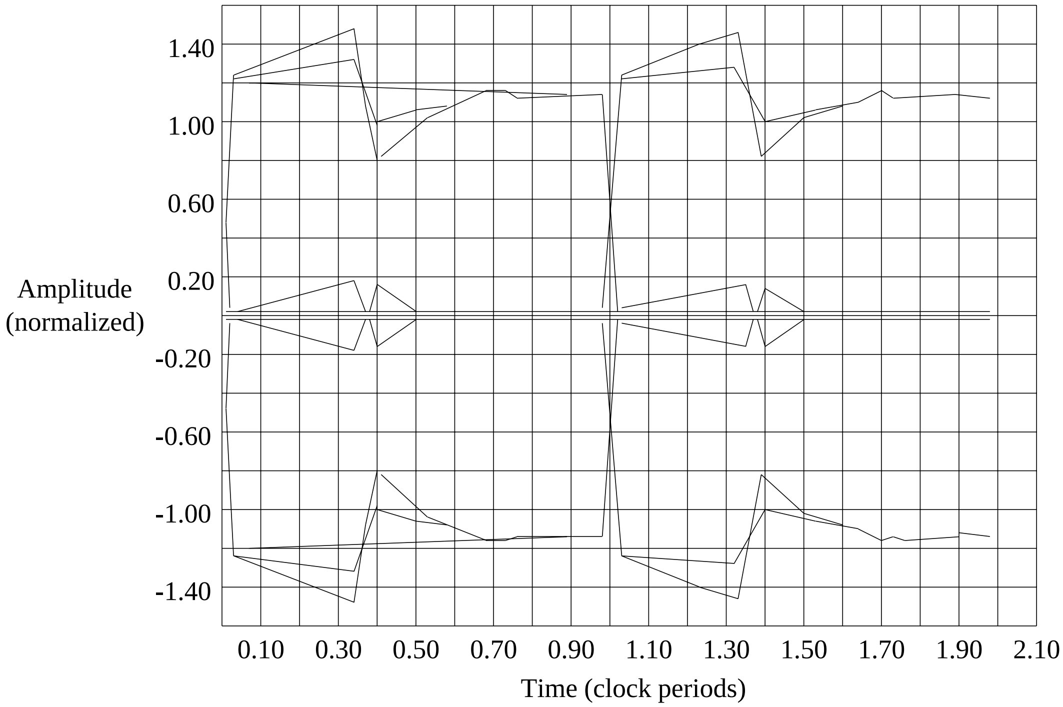


Figure 2.1.4-4 — Waveform for Test Configuration iii b) - Short Passive Bus with One TE Near to NT, and Seven TEs at the Far End (C = 30 nF/km)

2.1.4.3.3 Total Phase Deviation, Input to Output

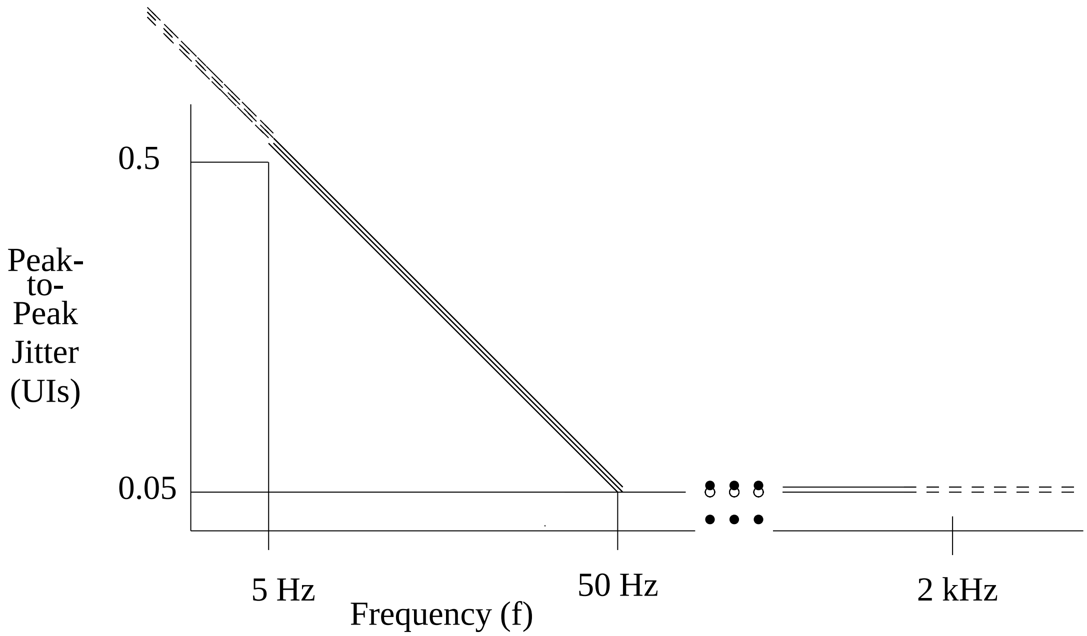
The total phase deviation (including effects of timing extraction jitter in the TE), between the transitions of signal elements at the output of the TE and the transitions of signal elements associated with the signal applied to the TE input, should not exceed the range of −7 percent to +15 percent of a bit period. This limitation applies to the output signal transitions of each frame with the phase reference defined as the average phase of the crossing of zero volts that occurs between the framing pulse and its associated balance pulse at the start of the frame and the corresponding crossings at the start of the three preceding frames of the input signal. For the purpose of demonstrating compliance of an equipment, it is sufficient to use (as the input signal phase reference) only the crossing of zero volts between the framing pulse and its associated balance pulse of the individual frame. This latter method, requiring a simpler test set, may create additional jitter at frequencies higher than about 1 kHz and is therefore more restrictive. The limitation applies to the phase of the zero-volt crossings of all adjacent binary ZEROs in the output data sequence, which shall be as defined in "Timing Extraction Jitter," Section 2.1.4.3.2. The limitation applies under all test conditions described in "Test Configurations," Section 2.1.4.3.1, with the additional input signal conditions specified in a) to d), and with superimposed jitter as specified in Figure 2.1.4-5 over the range of frequencies from 5 Hz to 2 kHz. The limitation applies for input bit rates of 192 kbps ± 100 ppm.

a. A sequence consisting of continuous frames with all binary ONEs in D, D-echo, and both B-channels.

b. A sequence consisting of continuous frames with the octet "10101010" (the first bit to be transmitted is binary ONE) in both B-channels and binary ONEs in D-channels and D-echo channels.

c. A sequence of continuous frames with binary ZEROs in D, D-echo, and both B-channels.

d. A sequence of continuous frames with a pseudo-random pattern, as described in "Timing Extraction Jitter," Section 2.1.4.3.2, in D, D-echo, and both B-channels.



Note 1: (UI) = Unit Interval = Bit Period ~ 5.21 µs

Note 2: For the purpose of the requirements of this section, the significant frequency range is between 5 Hz and 2 kHz.

Figure 2.1.4-5 — Lower Limit of Maximum Tolerable Jitter at TE Input (Log-Log-Scale)

2.1.4.4 NT Jitter Characteristics

The maximum jitter (peak-to-peak) in the output sequence of an NT shall be 5 percent of a bit period when measured using a high-pass filter having a cut-off frequency (3-dB point) of 50 Hz and an asymptotic roll off of 20 dB per decade. The limitation applies for all data sequences, but for the purpose of demonstrating the compliance of an equipment, it is sufficient to measure jitter with an output data sequence consisting of binary ONEs in D- and B-channels and with an additional sequence as described in "Timing Extraction Jitter," Section 2.1.4.3.2, in D- and B-channels. The limitation applies to the phase of all zero-volt crossings of all adjacent binary ZEROs in the output data sequence.

2.1.4.5 Termination of the Line

The interchange circuit pair termination shall be 100 ohms ± 5 percent (see Figure 2.1.1-1). See "Termination of the Line," Section 2.1.6.10, for various ways of providing the termination.

2.1.4.6 Transmitter Output Characteristics

2.1.4.6.1 Transmitter Output Impedance

The following requirements apply at interface point I_A (see Figure 2.1.1-1) for TEs and at interface point I_B for NTs. (See "NT and TE Associated Wiring," Section 2.1.1.3.6, and "Standard ISDN Basic Access TE Cord," Section 2.1.4.11, regarding capacitance of the cord.)

2.1.4.6.1.1 NT Transmitter Output Impedance

A. At all times except when transmitting a binary ZERO, the output impedance, in the frequency range of 2 kHz to 1 MHz, shall exceed the impedance indicated by the template in Figure 2.1.4-6. The requirement is applicable with an applied sinusoidal voltage of 100 mV (r.m.s. value).

Note: In some applications, the terminating resistor can be combined with the NT (see point B of Figure 2.1.1-1). The resulting impedance is the impedance needed to exceed the combination of the template and the 100-ohm termination.

B. When transmitting a binary ZERO, the output impedance shall be ≥ 20 ohms.

Note: The output impedance limit shall apply for two nominal load impedance (resistive) conditions: 50 ohms and 400 ohms. The output impedance for each nominal load shall be defined by determining the peak pulse amplitude for loads equal to the nominal value ±10 percent. The peak amplitude shall be defined as the amplitude at the midpoint of a pulse. The limitation applies for pulses of both polarities.

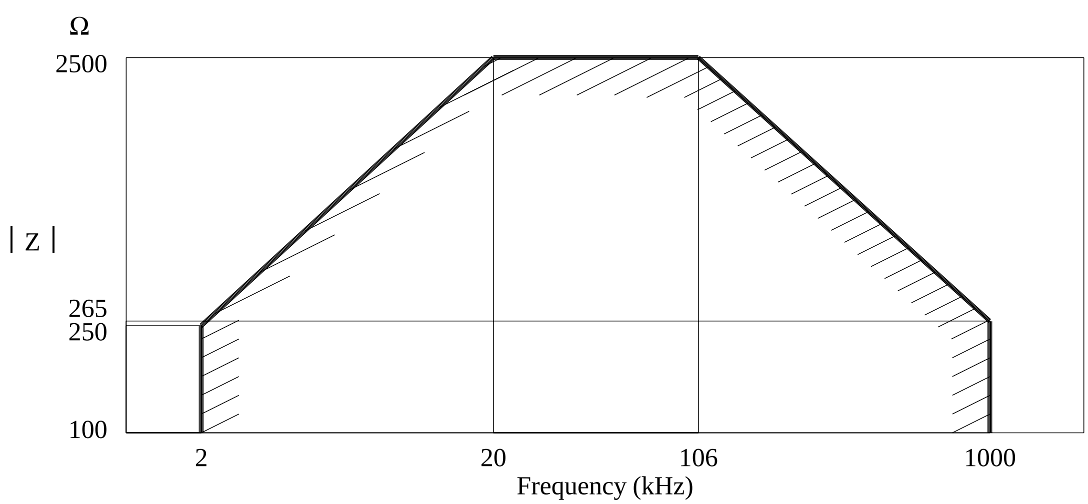


Figure 2.1.4-6 — NT Impedance Template (Log-Log Scale)

2.1.4.6.1.2 TE Transmitter Output Impedance

- At all times except when transmitting a binary ZERO, the following requirements apply.
  - — The output impedance, in the frequency range of 2 kHz to 1 MHz, shall exceed the impedance indicated by the template in Figure 2.1.4-7. This requirement is applicable with an applied sinusoidal voltage of 100 mV (r.m.s. value).

— At a frequency of 96 kHz, the peak current that results from an applied voltage of up to 1.2V (peak value) shall not exceed 0.6 mA (peak value).

- When transmitting a binary ZERO, the output impedance shall be ≥ 20 ohms.

Note: The output impedance limit shall apply for two nominal load impedance (resistive) conditions: 50 ohms and 400 ohms. The output impedance for each nominal load shall be defined by determining the peak pulse amplitude for loads equal to the nominal value ±10 percent. The peak amplitude shall be defined as the amplitude at the midpoint of a pulse. The limitation applies for pulses of both polarities.

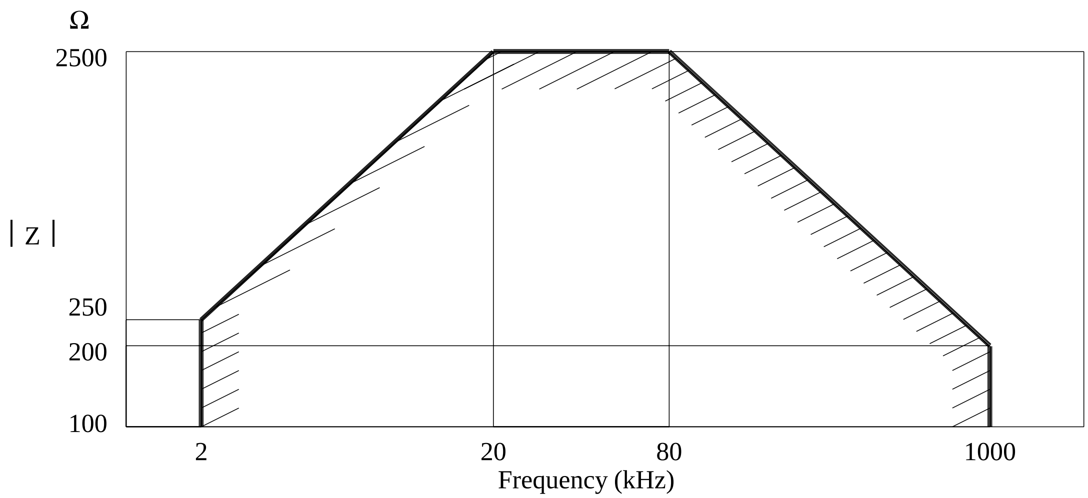


Figure 2.1.4-7 — TE Impedance Template (Log-Log Scale)

2.1.4.6.2 Test Load Impedance

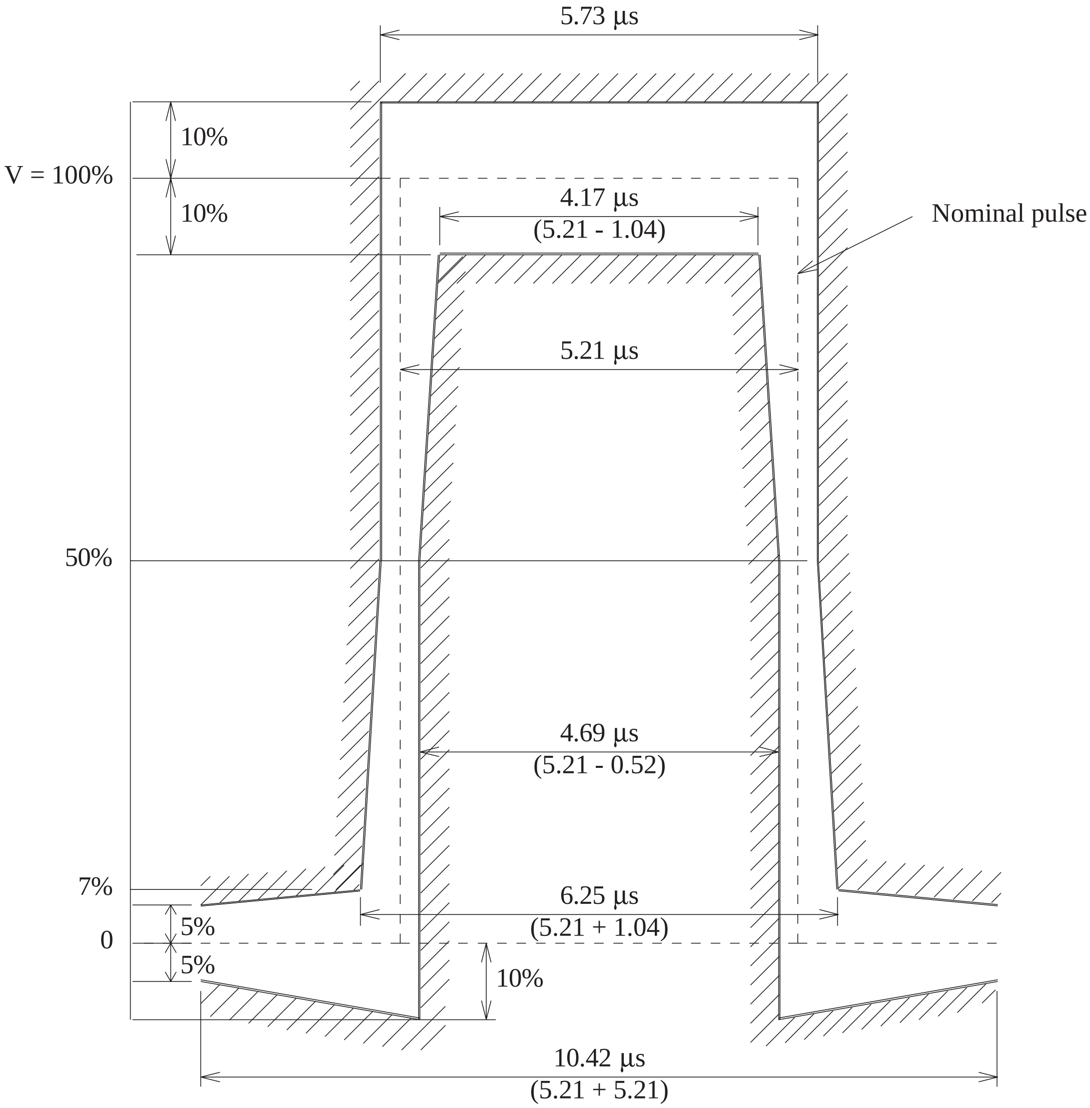
The test load impedance shall be 50 ohms (unless otherwise indicated). The 50-ohm load represents the combined effect of the two 100-ohm terminating impedances. Therefore, the 50-ohm test load impedance applies to the outputs of a TE and of an NT that does not have a built-in terminating impedance. For an NT with a built-in terminating impedance, the test load impedance shall be 100 ohms, representing the terminating impedance at the TE.

2.1.4.6.3 Pulse Shape and Amplitude (Binary Zero)

2.1.4.6.3.1 Pulse Shape

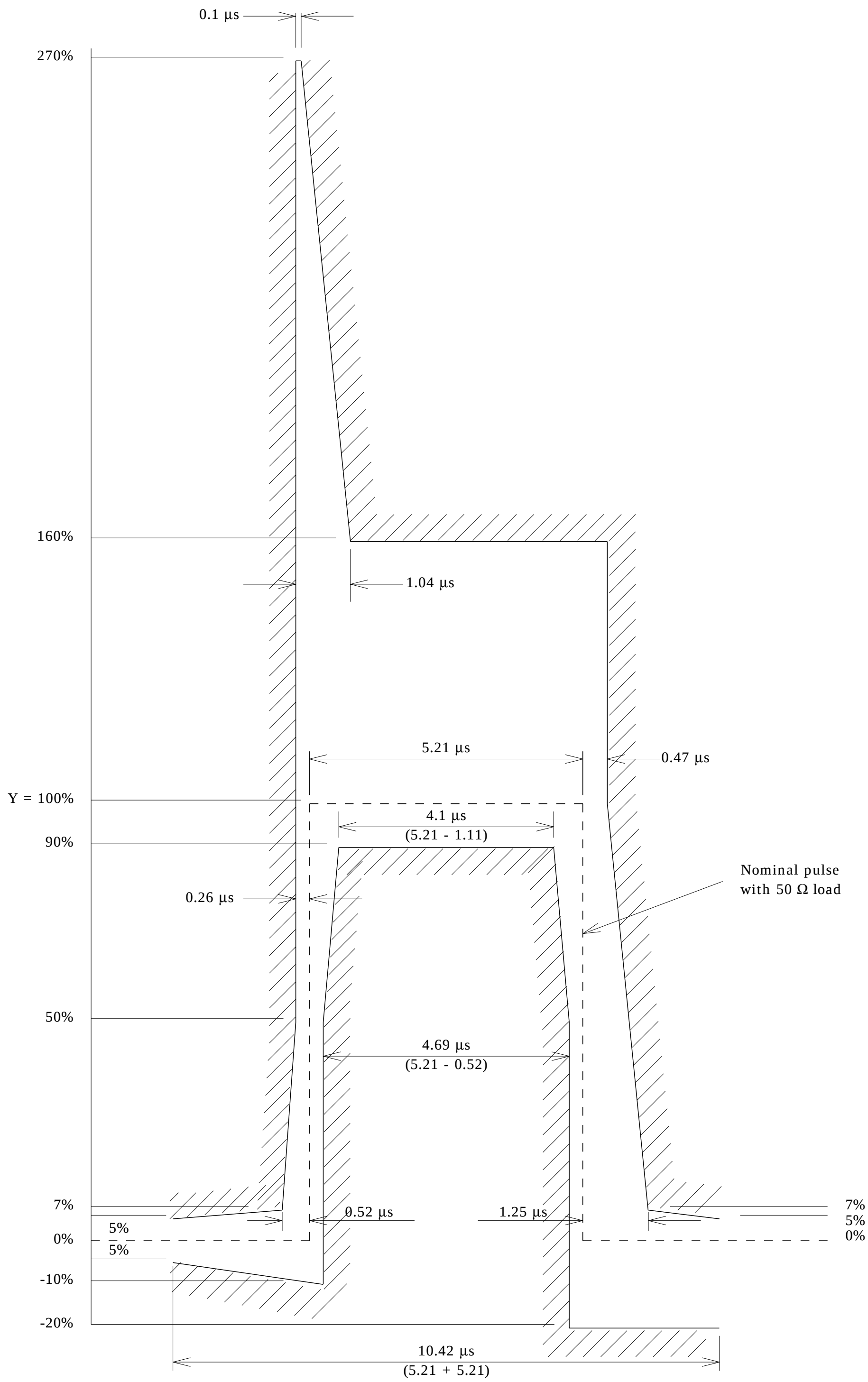
Except for overshoot, limited as follows, pulses shall be within the mask of Figure 2.1.4-8. Overshoot, at the leading edge of pulses, of up to 5 percent of the pulse amplitude at the middle of a signal element, is permitted, provided that such overshoot has, at half of its amplitude, a duration of less than 0.25 µsec.

See "Bit Rate," Section 2.1.4.2, for a precise specification of the bit rate.



NOTE: The above values are based on a pulse width of 5.21 µs. “Bit Rate,” Section 2.1.4.2, provides a precise specification of the bit rate.

Figure 2.1.4-8 — Transmitter Output Pulse Mask



Note: For clarity of presentation, the previously referenced values are based on a pulse width of 5.21 µs.

Figure 2.1.4-9 — Voltage for an Isolated Pulse with a Test Load of 400 Ohms

2.1.4.6.3.2 Nominal Pulse Amplitude

The nominal pulse amplitude shall be 750 mV, zero to peak.

A positive pulse (in particular a framing pulse) at the output port of the NT and TE is defined as a positive polarity of the voltage measured between access leads 5 to 4 and 6 to 3, respectively (Figure 2.1.5-1). (See Table 2.1.6-1 for the relationship to connector pins.)

2.1.4.6.4 Pulse Unbalance

The "pulse unbalance," that is, the relative difference in $\int U(t)\,dt$ for positive pulses and $\int U(t)\,dt$ for negative pulses, shall be ≤ 5 percent.

2.1.4.6.5 Voltage on Other Test Loads (TE Only)

The following requirements are intended to assure compatibility with the condition in which multiple TEs are simultaneously transmitting pulses onto a passive bus.

2.1.4.6.5.1 400-Ohm Load

A pulse (binary ZERO) shall conform to the limits of the mask shown in Figure 2.1.4-9 when the transmitter is terminated in a 400-ohm load. See "Bit Rate," Section 2.1.4.2, for a precise specification of the bit rate.

2.1.4.6.5.2 5.6-Ohm Load

To limit the current flow with two drivers having opposite polarities, the pulse amplitude (peak) with a 5.6-ohm load shall be ≤ 20 percent of the nominal pulse amplitude.

2.1.4.6.6 Unbalance About Earth

The following requirements apply under all possible power feeding conditions, under all possible connections of the equipment to ground, and with two 100-ohm terminations across the transmit and receive ports.

2.1.4.6.6.1 Longitudinal Conversion Loss

Longitudinal conversion loss (LCL), which is measured in accordance with ITU-TS Recommendation G.117, Section 4.1.3 (see Figure 2.1.4-10), shall meet the following requirements:

a. 10 kHz ≤ f ≤ 300 kHz: ≥ 54 dB

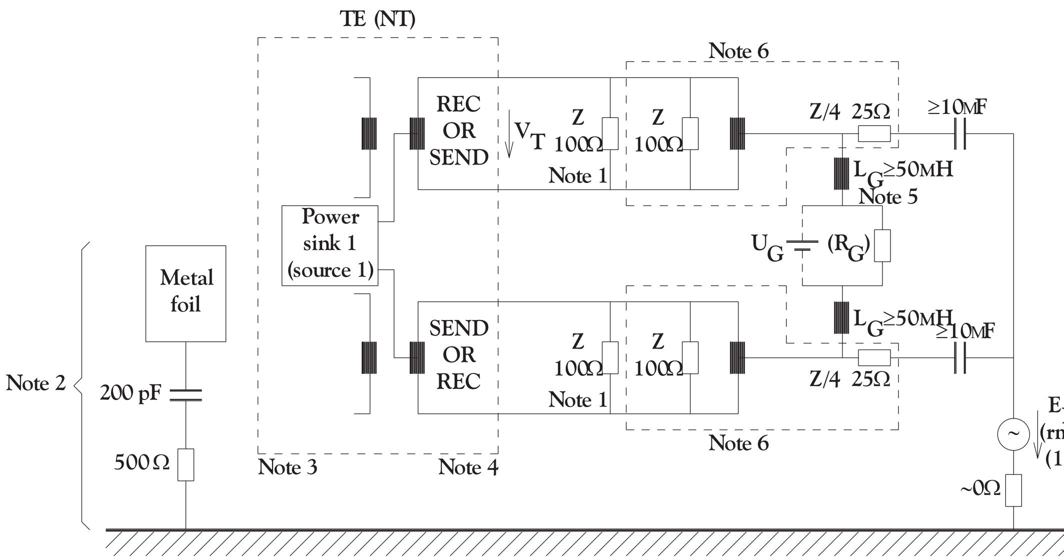
b. 300 kHz < f ≤ 1 MHz: minimum value decreasing from 54 dB at 20 dB/decade.

2.1.4.6.6.2 Output Signal Balance

Output signal balance, which is measured in accordance with ITU-TS Recommendation G.117, Section 4.3.1 (see Figure 2.1.4-11), shall meet the following requirements:

a. 10 kHz ≤ f ≤ 96 kHz: ≥ 54 dB

b. 96 kHz < f ≤ 1 MHz: minimum value decreasing from 54 dB at 20 dB/decade.



The longitudinal conversion loss:

$$LCL = 20\log_{10}\left|\frac{E_L}{V_T}\right| dB.$$

The voltages V_T and E_L should be measured within the frequency range from 10 kHz up to 1 MHz using selective test-measuring equipment.

The measurement should be carried out in the states:

— TE and NT deactivated (receive, send)

— TE power off (receive, send)

— TE and NT activated (receive)

The interconnecting cord shall lie on the metal plate.

Note 1: This resistor must be omitted if the termination is already built into the TE (NT).

Note 2: Hand imitation is a thin metal foil with approximately the size of a hand.

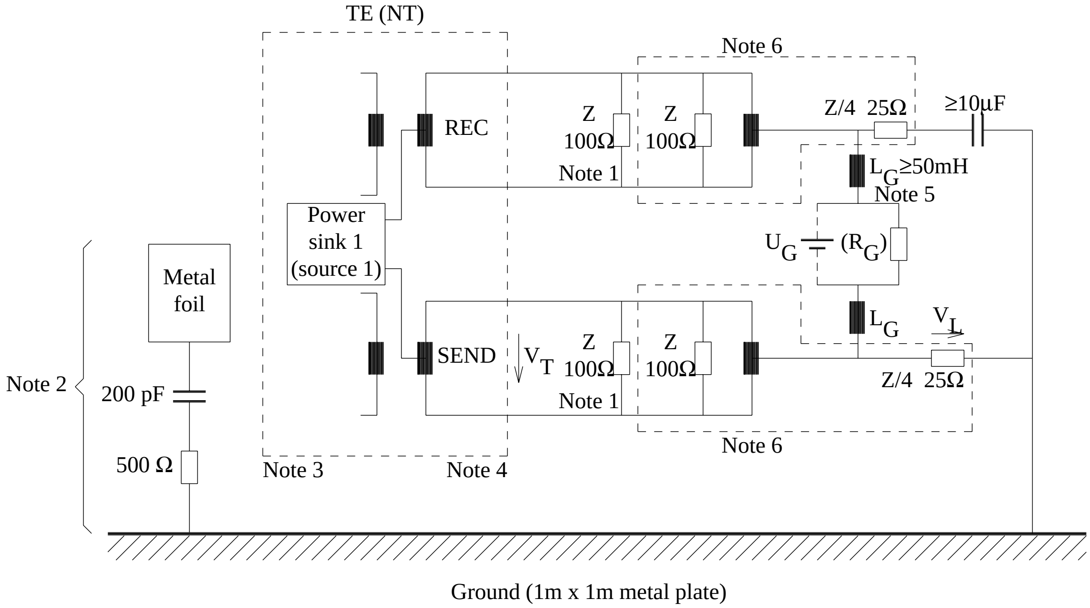
Note 3: TE (NT) with a metallic housing shall have a galvanic connection to the metal plate. Other TE (NT) with nonmetallic housing shall be placed on the metal plate.

Note 4: The power cord for mains-powered TE (NT) shall lie on the metal plate and the earth protective wire of the mains shall be connected to the metal plate.

Note 5: If there is no Power Source 1 in the NT, R_G and L_G are not required.

Note 6: This circuit provides a transverse termination of 100 ohms and a balanced longitudinal termination of 25 ohms. Any equivalent circuit is acceptable. However, for equivalent circuits given in ITU-TS Recommendations G.117 and O.121, powering cannot be provided.

Figure 2.1.4-10 — Receiver Input or Transmitter Output Unbalance About Earth



The output signal balance =

$$20\log_{10}\left|\frac{V_T}{V_L}\right| dB.$$

The voltages V_T and V_L should be measured within the frequency range from 10 kHz up to 1 MHz using selective test-measuring equipment.

The measurement should be carried out in the active state. The pulse patterns should contain all binary ZEROs. However, for the purpose of demonstrating the compliance of an equipment, it is sufficient to measure the output signal unbalance about earth with a pulse pattern of contiguous frames with at least the B1 and B2 channels contains all binary ZEROs.

The interconnecting cord shall lie on the metal plate.

Note 1: This resistor must be omitted if the termination is already built into the TE (NT).

Note 2: Hand imitation is a thin metal foil with approximately the size of a hand.

Note 3: TE (NT) with a metallic housing shall have a galvanic connection to the metal plate. Other TE (NT) with nonmetallic housing shall be placed on the metal plate.

Note 4: The power cord for mains-powered TE (NT) shall lie on the metal plate and the earth protective wire of the mains shall be connected to the metal plate.

Note 5: If there is no Power Source 1 in the NT, R_G and L_G are not required.

Note 6: This circuit provides a transverse termination of 100 ohms and a balanced longitudinal termination of 25 ohms. Any equivalent circuit is acceptable. However, for equivalent circuits given in ITU-TS Recommendations G.117 and O.121, powering cannot be provided.

Figure 2.1.4-11 — Transmitter Output Unbalance About Earth

2.1.4.7 Receiver Input Characteristics

2.1.4.7.1 Receiver Input Impedance

2.1.4.7.1.1 TE Receiver Input Impedance

At all times, TEs shall meet the same input impedance requirements as specified in "TE Transmitter Output Impedance," Section 2.1.4.6.1.2 (for the output impedance of TEs when not transmitting binary ZERO).

2.1.4.7.1.2 NT Receiver Input Impedance

At all times, the following requirements apply:

- The input impedance in the frequency range of 2 kHz to 1 MHz, shall exceed the impedance indicated by the template in Figure 2.1.4-6. This requirement is applicable with an applied sinusoidal voltage of 100 mV (r.m.s. value).
- At a frequency of 96 kHz, the peak current that results from an applied voltage of up to 1.2V (peak value) shall not exceed 0.5mA (peak value).

Note: In some applications, the 100-ohm terminating resistor can be combined with the NT (see point B of Figure 2.1.1-1). The resulting impedance is the impedance needed to exceed the combination of the template and the 100-ohm termination (see "Termination of the Line," Section 2.1.4.5).

2.1.4.7.2 Receiver Sensitivity - Noise and Distortion Immunity

Requirements applicable to TEs and NTs for three different interface wiring configurations are given in the following subsections. TEs and NTs shall receive, without errors (for a period of at least 1 minute), an input with a pseudo-random sequence (word length ≥ 511 bits) in all information channels (combination of B-channel, D-channel and, if applicable, the D-echo channel).

The receiver shall operate, with any input sequence, over the full range indicated by the waveform mask.

2.1.4.7.2.1 TEs

TEs shall operate, as required, with the input signals conforming to the waveforms specified in "Test Configurations," Section 2.1.4.3.1. For the waveforms in Figures 2.1.4-2, 2.1.4-3, and 2.1.4-4, TEs shall operate, as required, with the input signals having any amplitude in the range of +1.5 dB to −3.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2.

For signals conforming to the waveform in Figure 2.1.4-1, operation shall be accomplished for signals having any amplitude in the range of +1.5 dB to −7.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2. In addition, TEs shall operate, as required, with signals conforming to each waveform with jitter up to the maximum permitted (see "NT Jitter Characteristics," Section 2.1.4.4) in the output signal of NTs superimposed on the input signal.

For demonstrating the compliance of an equipment, it shall be sufficient to demonstrate satisfactory operation with jitter of 5 percent peak-to-peak at frequencies of 1000 Hz and 7000 Hz superimposed individually on the input signal. Additionally, for input signals having the waveform shown in Figure 2.1.4-1, the TEs shall operate, as required, with sinusoidal signals having an amplitude of 100 mV (peak-to-peak value) at frequencies of 200 kHz and 2 MHz superimposed individually on the input signal along with jitter.

2.1.4.7.2.2 NTs for Short Passive Bus (fixed timing)

The NTs designed to operate with only short passive bus wiring configurations shall operate, as required, when receiving input signals indicated by the waveform mask shown in Figure 2.1.4-12. NTs shall operate, as required, with the input signals having any amplitude in the range of + 1.5 dB to −3.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2.

In Figure 2.1.4-12 the following applies:

1. Shaded area is the region in which pulse transitions may occur.
2. The waveform mask is based on the "worst case" configuration shown in Figure 2.1.6-11 and waveforms ii) and iii) in "Test Configurations, Section 2.1.4.3.1. The shaded area of -7 percent of 1 clock period accounts for the situation of a single TE connected directly to the NT with a zero-length passive bus. However, the waveform mask does not show the higher possible amplitude of framing and D-channel bit pulses and their associated balancing bits. This waveform mask does not account for transient effects.

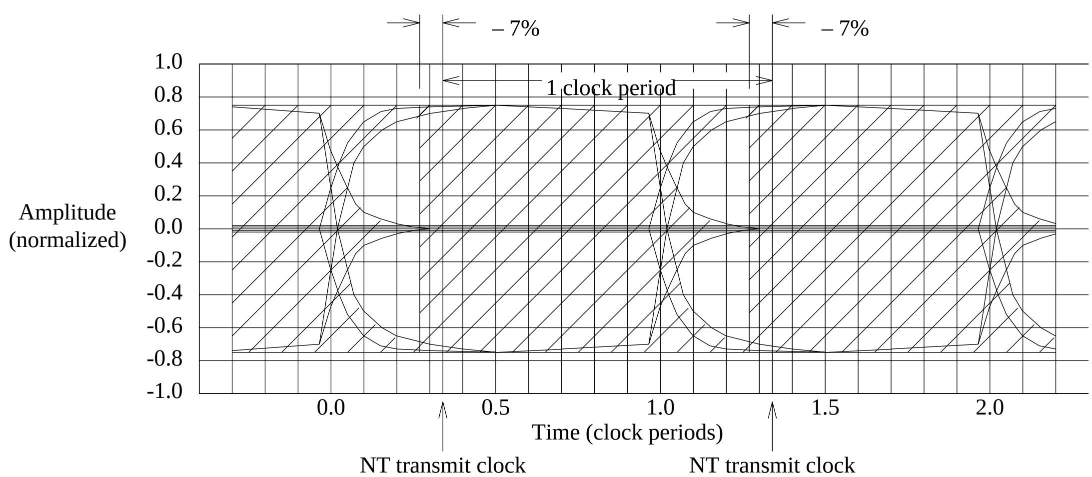


Figure 2.1.4-12 — Short Passive Bus Receive Pulse Waveform Mask

2.1.4.7.2.3 NTs for Both Point-to-Point and Short Passive Bus Configurations (Adaptive Timing)

The NTs designed to operate with either point-to-point or short passive bus wiring configurations shall operate, as required, when receiving input signals indicated by the waveform mask shown in Figure 2.1.4-13. These NTs shall operate, as required, with the input signals having any amplitude in the range of + 1.5 dB to −3.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2.

In Figure 2.1.4-13 the following applies:

1. Shaded area is the region in which pulse transitions may occur.

2. The waveform mask is based on the same "worst case" passive bus configuration as the waveform mask in Figure 2.1.4-12 except that the permitted round-trip delay of the cable is reduced. The shaded area of -7 percent of 1 clock period accounts for the situation of a single TE connected directly to the NT with a zero length passive bus. However, the waveform mask does not show the higher possible amplitude of framing and D-channel bit pulses and their associated balancing bits. This waveform mask does not account for transient effects.

These NTs shall also operate, as required, when receiving signals conforming to the waveform in Figure 2.1.4-1. For signals conforming to this waveform, operation shall be accomplished for signals having any amplitude in the range of +1.5 dB to −7.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2. Additionally, these NTs shall operate, as required, with the sinusoidal signals, as specified in "TEs," Section 2.1.4.7.2.1, and jitter up to the maximum permitted in the output signal of TEs (see "Timing Extraction Jitter," Section 2.1.4.3.2), superimposed on the input signals having the waveform in Figure 2.1.4-1.

For demonstrating the compliance of an equipment, it is sufficient to demonstrate satisfactory operation with jitter of ± 10 percent peak at frequencies of 1,000 Hz and 7,000 Hz superimposed individually on the input signal.

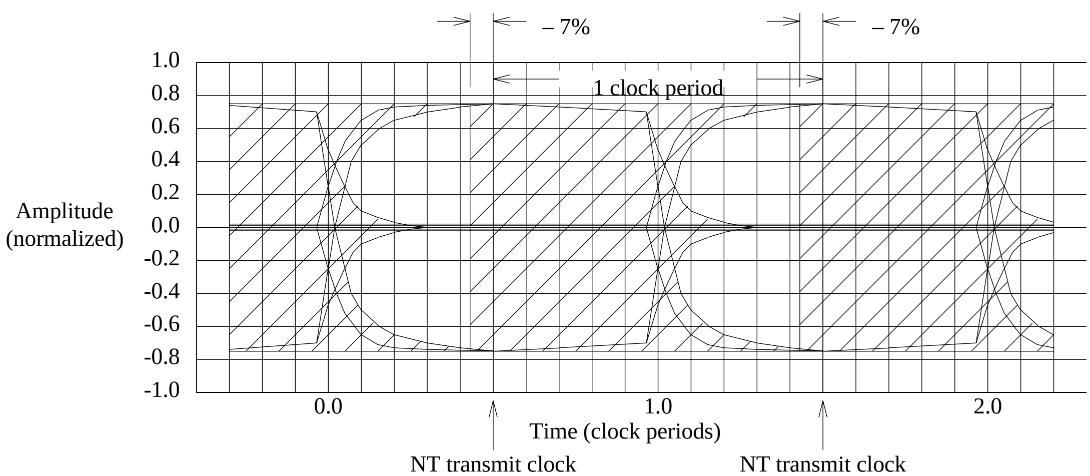


Figure 2.1.4-13 — Passive Bus Receive Pulse Waveform Mask

2.1.4.7.2.4 NTs for Extended Passive Bus Wiring Configurations

The NTs designed to operate with extended passive bus wiring configurations shall operate, as required, when receiving input signals indicated by the waveform mask shown in Figure 2.1.4-14. These NTs shall operate, as required, with the input signals having any amplitude in the range of + 1.5 dB to −5.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2. Additionally, these NTs shall operate with the sinusoidal signals, as specified in "TEs," Section 2.1.4.7.2.1, superimposed on the input signals having the waveform shown in Figure 2.1.4-14. (The previous values assume a maximum cable loss of 3.8 dB. The NTs may be implemented to accommodate higher cable loss.)

In Figure 2.1.4-14 the following applies:

1. Shaded area is the region in which pulse transitions may occur.

2. The waveform mask is based on the "worst case" extended passive bus wiring configuration. It consists of a cable having a characteristic impedance of 75 ohms, a capacitance of 120 nF/km, a loss of 3.8 dB at 96 kHz, four TEs connected such that the differential delay is at the maximum permitted by "Pulse Unbalance," Section 2.1.4.6.4. The waveform mask does not show the higher possible amplitude of framing and D-channel bit pulses and their associated balancing bits. This waveform mask does not account for transient effects.

This discussion also applies to the branched passive bus described in "Branched Passive Bus Wiring Configuration," Section 2.1.6.5.

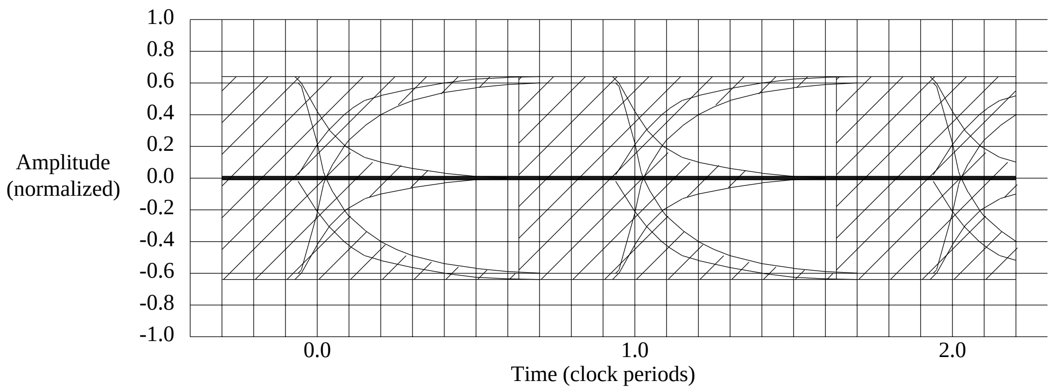


Figure 2.1.4-14 — Extended Passive Bus Receive Pulse Waveform Mask

2.1.4.7.2.5 NTs for Point-to-Point Configurations Only

The NTs designed to operate with only point-to-point wiring configurations shall operate, as required, when receiving input signals having the waveform shown in Figure 2.1.4-1. These NTs shall operate, as required, with the input signals having any amplitude in the range of +1.5 dB to −7.5 dB relative to the nominal amplitude of the transmitted signal as specified in "Nominal Pulse Amplitude," Section 2.1.4.6.3.2. Additionally, these NTs shall operate, as required, with the sinusoidal signals, as specified in "TEs," Section 2.1.4.7.2.1, and with jitter up to the maximum permitted in the output signal of TEs (see "Timing Extraction Jitter," Section 2.1.4.3.2), superimposed on the input signals having the waveform shown in Figure 2.1.4-1. For demonstrating the compliance of an equipment, it is sufficient to demonstrate satisfactory operation with jitter of ± 10 percent peak at frequencies of 1,000 Hz and 7,000 Hz superimposed individually on the input signal.

2.1.4.7.3 NT Receiver Input Delay Characteristics

2.1.4.7.3.1 Round-trip Delay Measurement

Round-trip delay is always measured between the zero-volt crossings of the framing pulse and its associated balance-bit pulse at the transmit and receive side of the NT (see "Wiring Configurations and Round-trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3).

2.1.4.7.3.2 NT for Short Passive Bus

The NTs shall accommodate round-trip delays of the complete installation, including TEs, in the range:

    10 to 14 μs.

2.1.4.7.4 NT for Both Point-to-Point and Passive Bus

The NTs shall accommodate round-trip delays (for passive bus configurations) in the range:

10 to 13 μs.

The NTs shall accommodate round-trip delays (for point-to-point configurations) in the range:

10 to 42 μs.

2.1.4.7.4.1 NT for Extended Passive Bus

The NTs shall accommodate round-trip delays in the range:

10 to 42 μs,

provided that the differential delay of signals from different TEs is in the range:

0 to 2 μs.

2.1.4.7.4.2 NT for Point-to-Point Only

The NTs shall accommodate round-trip delays in the range:

10 to 42 μs.

2.1.4.7.5 Unbalance About Earth

Longitudinal conversion loss (LCL) of receiver inputs, measured in accordance with ITU-TS Recommendation G.117, Section 4.1.3, by considering the power feeding and two 100-ohm terminations at each port, shall meet the following requirements (see Figure 2.1.4-10).

- 10 kHz ≤ f ≤ 300 kHz: ≥ 54 dB
- 300 kHz < f ≤ 1 MHz: minimum value decreasing from 54 dB with 20 dB/decade.

2.1.4.8 Isolation from External Voltages

Precautions shall be taken to ensure that, under power fault conditions, no fire or shock hazard is created by TEs, NTs, terminating resistors, or interface cabling. Test conditions described in Underwriters Laboratories standards on information systems, business equipment, and telephone equipment shall apply; specifically the test conditions described in *UL*[1] 478-1985 and *UL* 1459-1988.

2.1.4.9 Electrical Environment

In order to specify the electrical environment in which TEs and NTs should operate, it is necessary to distinguish between exposed and unexposed wiring. Descriptions of exposed and unexposed wiring may be found in the American National Standard National Electrical Safety Code, *ANSI*[2] C2-1990, and in the Lighting Protection Code, *ANSI* /NFPA 78-1989.

2.1.4.9.1 Unexposed Wiring

The TEs and NTs designed and intended to be connected to only unexposed wiring for the S/T interface should not be damaged by the following conditions:

- DC voltages with the following characteristics:
  - — Amplitude: 56.5 volts

1. Registered trademark of Underwriter's Laboratories, Inc.
2. Registered trademark of American National Standard Institute.

— Current limit: 0.5 amperes

— Duration: continuous

To test for compliance, voltages of each polarity shall be applied between each interface conductor and each other interface conductor and between each interface conductor and the ground reference of the equipment power source, where such power source is not associated with the interface. The application of each voltage shall be maintained for 5 minutes.

- AC voltages with the following characteristics:
  - — Amplitude: 200 volts peak
  - — Source resistance: 1500 ohms
  - — Frequency: 20 Hz
  - — Duration: 2 seconds on, 4 seconds off, continuously

To test for compliance, the voltage shall be applied between each interface conductor and each other interface conductor and between each interface conductor and the ground reference of the equipment power source, where such power source is not associated with the interface. The application of each voltage shall be maintained for 5 minutes.

- Voltage surges with the following characteristics:
  - — Amplitude: 1000 volts peak
  - — Rise time: 1 μs
  - — Fall time: 50 μs
  - — Source impedance: impedance of 0.015 μF capacitance (balanced with respect to individual conductors of circuit pair).

To test for compliance, 50 surges of each polarity shall be applied between all interface conductors and the ground reference of the equipment power source, where such source is not associated with the interface. Each surge should be simultaneously coupled to individual conductors, each through an impedance of 0.015 μF, balanced with respect to individual conductors of the circuit pair. For TEs that use interface Power Source 2, the surge shall also be applied with respect to the reference of this power source.

Equipment should also comply with ITU-TS Recommendation K.22.

2.1.4.9.2 Exposed Wiring

For further study.

2.1.4.10 Interconnecting Media Characteristics

Interface cables (or cabling) shall include twisted metallic pairs (two or four as required). Such pairs will frequently be part of the customers' premises distribution systems. The transmission characteristics of the transmit and receive pairs shall be such that satisfactory operation is assured when used to interconnect (I_A to I_B) equipment having interfaces conforming to the requirements of this section. Examples of cable system parameters that must be considered are loss, frequency response, crosstalk loss, longitudinal balance, and noise. Note that cable characteristics assumed in defining the requirements specified in this section at interface points I_A and I_B are discussed in "Wiring Configurations and Round-trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3, and Table 2.1.6-3. Longitudinal balance, for example, > 43 dB at 96 kHz, is of particular importance to assuring compliance with the EMI limitations that must also be considered in determining suitable interface cables.

2.1.4.11 Standard ISDN Basic Access TE Cord

A connecting cord for use with a TE designed for connection with a "standard ISDN basic access TE cord" shall have a maximum length of 10 meters and shall conform to the following:

- Cords having a maximum length of 7 meters:
  - The maximum capacitance of pairs for transmit and receive functions shall be less than 300 pF.
  - The characteristic impedance of pairs used for transmit and receive functions shall be greater than 75 ohms at 96 kHz.
  - The crosstalk loss, at 96 kHz, between any pair and a pair to be used for transmit or receive functions shall be greater than 60 dB with terminations of 100 ohms.
  - The resistance of an individual conductor shall not exceed 3 ohms.
  - Cords shall be terminated at both ends in plugs (individual conductors shall be connected to the same contact in the plug at each end). The plug connector to be used is as described in "Interface Connector and Contact Assignments," Section 2.1.6.1.
- Cords having a length greater than 7 meters shall conform to the preceding requirements except that a capacitance of 350 pF is permitted.

The TEs may be designed to include a connecting cord that is part of the TE. In this case the requirements for a standard ISDN basic access TE cord do not apply.

2.1.4.12 Electromagnetic Compatibility (EMC)

The electrical characteristics specified within this section do not guarantee that electromagnetic compatibility will be achieved with other user premises equipment, systems, or with applicable EMC regulations. For additional information see ITU-TS Recommendation K.23.

2.1.4.13 Transmission Plan

All BRI switches shall operate in a bit-transparent mode when transporting ISDN BRI voice information.

The ISDN BRI voice terminals connected to a BRI switch shall have a nominal Transmit Objective Loudness Rating (TOLR) of -42 dB and a Receive Objective Loudness Rating (ROLR) of +51 dB.

2.1.5 POWER FEEDING

2.1.5.1 Overview

Neither the *5ESS*® switch nor its remote modules will provide power to TEs. However, Power Sources 1 and 2 may be provided either locally or through an NT1.

All the values referring to power in Watts (or in Power Consumption Units (PCU), defined in "Power Consumption Unit," Section 2.1.5.4.1) shall be measured using an instrument that integrates the measurements over a period of 50 ms.

2.1.5.2 Reference Configuration

The reference configuration for power feeding, which is based on an 8-contact interface connector as specified in "Interface Connector and Contact Assignments," Section 2.1.6.1, is described in Figure 2.1.5-1. The access lead designations, "1" through "8" correspond to the contact assignments of the connector. The use of leads 3, 4, 5, and 6 is mandatory. The use of leads 1, 2, 7, and 8 is optional.

This reference configuration allows unique physical and electrical characteristics, for the interface at reference points S and T, which are independent of the choice of internal or external power source arrangements.

2.1.5.2.1 Location of Power Sources

Power Source 1 derives its power locally (commercial power and/or batteries). The source may be an integral part of the NT or may be physically separate and connected at any point in the interface wiring. In addition, the source for normal conditions may be physically separate from a source for restricted power conditions. Where physically separate sources of power for normal and restricted conditions are provided, provision must be made to resolve power contention. Where a source physically separate from the NT is provided, any effects on the transmission characteristics of interface wiring must be accounted for, for example, the impedance of a power source that bridges the interchange circuit pairs may require a reduction in the number of TEs that can be accommodated on a passive bus.

Power Source 2 derives its power locally (commercial power and/or batteries). Power Source 2 may be located in (or associated with) the NT as indicated in Figure 2.1.5-1, or it may be located separately; for example, in a remote wiring closet.

2.1.5.2.2 Functions Specified at the Access Leads

The eight access leads for TEs and NTs shall be applied as follows:

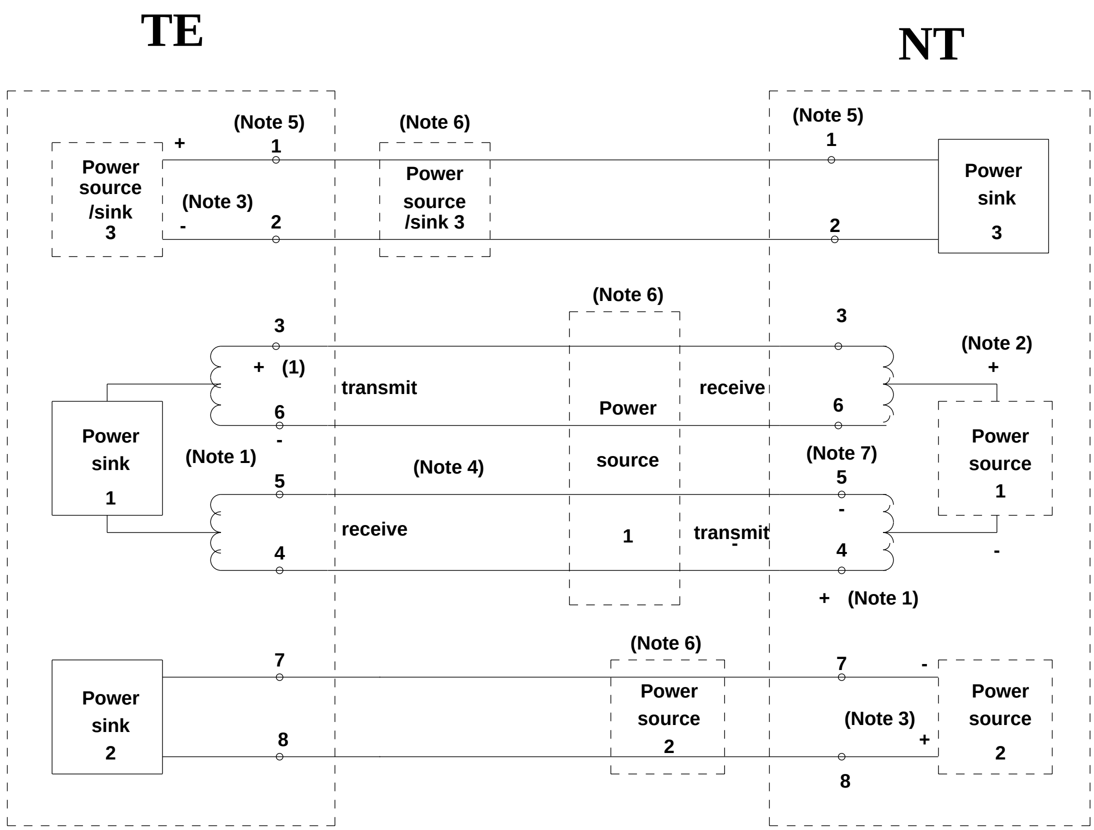
1. Access lead pairs 4-5 and 3-6 are for the bidirectional transmission of the digital signal and may provide a phantom circuit for power transfer to a TE (Power Source 1).
2. Access lead pair 7-8 may be used for additional power transfer to a TE (Power Source 2).
3. Access lead pair 1-2 may also be used for power transfer to an NT or to a TE in TE-to-TE interconnections (Power Source 3).

2.1.5.2.3 Provision of Power Sources and Sinks

Power Source 1 is not provided, but provision is made for Power Sources 1 and 2 to be optional through an NT1. Power Sink 3 is not used.

Power Sources 1, 2, and 3 are optional. Therefore, a TE that is portable (for example from network to network, country to country) cannot rely on the availability of any of the power sources.

The use by TEs of Power Sources 1 and 2 is optional, that is, Power Sinks 1 and 2 are optional and TEs may be locally powered (for example, commercial 60 Hz power).



Note 1: Refers to the polarity of framing pulses.

Note 2: Refers to the polarity of power during normal power conditions (reversed for restricted conditions). When this power source is not floating, the polarity of the voltage with reference to ground shall be negative.

Note 3: Refers to the polarity of power. When this power source is not floating, the polarity of the voltage with reference to ground shall be negative.

Note 4: The access lead assignments indicated in this figure are intended to provide for direct interface cable wiring, that is, each interface pair is connected to a pair of access leads having the same two numbers at TEs and NTs.

Note 5: Numbers are actual contact assignments.

Note 6: Power sources may be an integral part of the NT/TE or may be physically separate and connected at any oint in the interface wiring (see “Reference Configuration,.”Section 2.1.9.2).

Note 7: Resistance to ground for pairs 3–6 and 4–5 of the NT should be less than 1M ohm.

Figure 2.1.5-1 — Reference Configuration for Signal Transmission and Power Feeding in Normal Operating Mode

2.1.5.3 Power Available from Source

The power source shall maintain the output voltage within the specified limits during commercial power disturbances of short duration (less than 100 ms).

2.1.5.3.1 Power Source 1 Normal and Restricted Power Conditions

Power Source 1 may provide power under either normal or restricted power conditions or both.

When Power Source 1 is provided, the power conditions are as follows:

1. Where power is provided under normal conditions, the power available from Power Source 1 (and any separate source as described in "Reference Configuration," Section 2.1.5.2) shall be at least sufficient to provide for the consumption of 10 NPCUs (see "Power Consumption Unit," Section 2.1.5.4.1, for definition) at each TE interface. The power required to be available from the source will depend upon the interface cable configuration.

2. Under restricted power conditions, the minimum power available from Power Source 1 shall be 420 mW. When Power Source 1 enters a condition in which it is able to supply only restricted power, it should indicate this condition by reversing its polarity. In this condition, only the restricted power functions of TEs are allowed to consume power from Source 1.

3. If Power Source 1 (and any separate source combination) can supply power in both normal and restricted power conditions, the change of condition of Power Source 1 from the normal to restricted power condition may occur when Power Source 1 (and any separate source combination) is unable to supply the "nominal" level of power. [The "nominal" level of power is defined as the minimum power that the Power Source 1 (or separate power source) is designed to supply]. In any case, the transition from normal to restricted condition shall occur when the power described in this section is not available from Power Source 1 (as a result of a loss of its source of power).

4. If the PS1 source loses its primary power, it may switch to restricted power condition as an option to conserve secondary power, even though it may still be capable of supplying its full rated normal power output.

2.1.5.3.2 Voltage of Power Source 1

2.1.5.3.2.1 Normal Power Conditions

Under normal power conditions, the voltage of Power Source 1, if provided, shall be within the range of 34 V to 56.5 V at the output of the source when supplying up to the maximum available power.

2.1.5.3.2.2 Restricted Power Conditions

Under restricted power conditions, the voltage of Power Source 1, if provided, shall be within the range of 34 V to 56.5 V at the output of the source when supplying up to its rated maximum power, which shall not be less than 420 mW.

2.1.5.3.3 Voltage of Power Source 2

The maximum voltage of Power Source 2 (optional third pair) shall be 56.5 V, and the minimum voltage shall assure compliance with the requirements specified in "Power Source 2 - Optional Third Pair," Section 2.1.5.4.3, concerning power available at a TE.

2.1.5.3.4 Voltage of Power Source 3

Electrical characteristics of optional Power Source 3 are not specified. However, Power Source 3 may be made to conform to the specification of Power Source 2 in "Voltage of Power Source 2," Section 2.1.5.3.3.

2.1.5.3.5 Short-Circuit Protection

Power sources shall provide short-circuit protection. This requirement may be checked by applying a short circuit for a period of 30 minutes, after which the power source shall be able to provide its rated PCUs within 60 seconds.

2.1.5.4 Power Available at TE

2.1.5.4.1 Power Consumption Unit

The power that a TE is designed to draw from Power Source 1 or 2 should be given in terms of "power consumption units." For normal mode, one power consumption unit (NPCU) shall be equivalent to 100 mW, whereas for restricted mode, one power consumption unit (RPCU) shall be equivalent to 95 mW. (This difference in units is required to allow adequate margins for power consumed by nondesignated terminals in restricted mode.)

Fractional PCU values are not allowed, that is, actual TE power consumption shall be rounded up to the next integer value. The PCU rating of a TE shall be applicable over the full range of specified operating voltage, and shall represent the maximum power drawn by that TE at any voltage within this range.

The use of Power Consumption Unit (to define power consumed by the TE and power available from the source) does not imply any lack of backward compatibility with TEs and power sources designed according to requirements given in earlier issues of this specification, *ANSI*[1] Standard T1.605-1989, and the Red Book and Blue Book versions of ITU-TS Recommendation I.430. A TE or PS1 power source designed to meet those requirements has a rating of 10 NPCUs (normal) and 4 RPCUs (restricted).

The power that a PS1 or PS2 source is designed to provide shall also be given in terms of PCUs, NPCU for normal mode and RPCU for restricted mode. The total PCUs available in this case takes account of the power loss in the loop resistance of the cabling configuration(s) for which the power source is designed, and represents the power available for the TEs to draw. (This may mean that the same power source may, as an option, be given different PCU ratings for different cable configurations, for example, one rating for point-to-point and a different rating for point-to-multipoint.)

A TE may be designed to draw any number of PCUs from Power Source 1 or 2, up to a maximum of 80 NPCUs for normal mode. In restricted mode, the maximum that a TE may be designed to draw is 4 RPCUs for PS1, and 21 RPCUs for PS2.

For a given installation, the sum of the NPCU ratings for all TEs on a bus shall not exceed the NPCU rating of the power source (PS1 or PS2, as applicable). Similarly, the sum of the RPCU ratings for all designated TEs on a bus must not exceed the RPCU rating of the power source. In either case, the connection of TEs with a total PCU rating exceeding the corresponding PCU rating of the respective power source may disrupt operation of all TEs on the bus.

---

1. Registered trademark of American National Standard Institute.

2.1.5.4.2 Power Source 1 - Phantom Mode

2.1.5.4.2.1 Normal Power Conditions

Under normal power conditions, the maximum voltage at the interface of a TE shall be 56.5 V, and the minimum voltage shall be 24 V when drawing up to the designed maximum available NPCUs.

2.1.5.4.2.2 Restricted Power Conditions

In restricted power conditions, the maximum value of the voltages at the interface of a TE (from Power Source 1) shall be 56.5 V and the minimum voltage shall be 32 V when drawing a power of up to 400 mW (4 RPCUs for all designated TEs combined, and 20 mW for all other TEs combined). The power source may, as an option, be designed to provide more than 4 RPCUs. If so, the voltage shall be within the limits given when the TEs are drawing up to the designed maximum available RPCUs.

2.1.5.4.3 Power Source 2 - Optional Third Pair

2.1.5.4.3.1 Normal Power Conditions

Under normal power conditions, the voltage at the interface of a TE shall be a maximum of 56.5 V and a minimum of 32 V when the TE is drawing a power of up to 80 NPCUs.

2.1.5.4.3.2 Restricted Power Conditions

The provision of this restricted power condition is subject to the Power Source 2 provider’s assumed responsibility. The mechanism to indicate this condition to the TEs is the reversal of polarity of the power source.

When Power Source 2 is unable to provide the designed NPCUs for normal mode, it goes to a restricted power condition in which it shall provide a minimum of 21 RPCUs. The maximum value of the voltages at the inputs of the TEs shall be 56.5 V and the minimum shall be 32 V.

If the PS2 source loses its primary power, it may switch to restricted power condition as an option to conserve secondary power, even though it may still be capable of reapplying its full rated normal output.

2.1.5.4.4 Power Source 3 - Optional Fourth Pair

Electrical characteristics of optional Power Source/Sink 3 are not specified. However, Power Source/Sink 3 may be made to conform to the specifications of Power Source/Sink 2 in "Power Source 2 - Optional Third Pair," Section 2.1.5.4.3.

2.1.5.5 Current Transient

The rate of change of current drawn by a TE (for example, when connected or as a result of a change in polarity when a change from the normal condition to the restricted power condition occurs) shall not exceed 5 mA/μs. (This requirement does not apply for the first 100 ms after connection, or after a change in polarity when a change from the normal condition to the restricted power condition occurs. See "Limitations on Power Source and Sink During Transient Conditions," Section 2.1.5.8.)

2.1.5.6 Power Source 1 Consumption

The different values concerning the Power Source 1 consumption are summarized in Table 2.1.5-1.

A TE that is not powered from Power Source 1 and does not use the detection of Power Source 1 as a means of determining connection status shall present a resistance of at least 1 M ohm between the interface local pairs 3-6 and 4-5 and between either pair and ground.

2.1.5.6.1 Normal Power Conditions

Under normal power conditions and in the activated state, a TE that draws power from Power Source 1 shall draw no more than its rated NPCUs, which shall not exceed 80, from Power Source 1. When a TE is not involved in a call, it should minimize its power consumption. [The determination that a TE is "not involved in a call" is based on the status of Layer 2 (link established or not). When this limitation is applied in the design of a TE, a maximum value of 380 mW is recommended.]

When in the deactivated state, a TE that draws power from power source 1 shall draw no more than 100 mW. However, if a local action has to be initiated in the TE when the interface is not activated, this TE shall enter a "local action" state.

In this "local action" state, the TE may consume up to its rated NPCUs if the following conditions are assured:

1. The corresponding power is provided by the source (for example, this service is supported by the source).
2. The "local action" state is not a permanent one. (A typical example of the use of this state is the modification of prestored dialing numbers in the TE.)

Table 2.1.5-1 — Summary of Different Possible Power Source 1 Consumptions for TEs

TE TYPE AND STATE	MAXIMUM CONSUMPTION
NORMAL CONDITIONS	
TE drawing power from PS1 Active state	Rated NPCU[a]
TE drawing power from PS1 Deactivated state	100 mW
TE drawing power from PS1 local action state	Rated NPCU[ab]
RESTRICTED CONDITIONS	
TE drawing power from PS1 Designated TE; Active state	Rated RPCU[c]
TE drawing power from PS1 Designated; Deactivated state	25 mW
TE drawing power from PS1 not designated	0 mW
TE drawing power from PS1 Designated; Local action state	Rated RPCU[bc]
TE not powered from PS1 but using connected detector on PS1; Any state	3 mW
TE not powered from PS1 and not using connected detector on PS1; Any state	0 mW

Note(s):

a. Rated NPCU not to exceed 80. Refer to Section 2.1.5.4.1. For NPCU greater than 10, TE portability is not guaranteed even where PS1 is provided. Refer to Section 2.1.5.3.1.

b. Subject to the provision of the corresponding amount of power by Power Source 1.

c. Rated RPCU not to exceed 4. Refer to Section 2.1.5.4.1.

2.1.5.6.2 Restricted Power Conditions

2.1.5.6.2.1 Power Available to the TE Designated for Restricted Power Operation

A TE that is permitted to draw power from Power Source 1 under restricted power conditions shall consume no more than 4 RPCUs.

In restricted power conditions, a designated TE that is in a low-power mode may consume power from Power Source 1 only to maintain a line activity detector and to retain its terminal endpoint identifier (TEI) value. The value of the low-power mode consumption shall be ≤ 25 mW.

2.1.5.6.2.2 Power Available to Nondesignated TEs

Nondesignated TEs, not powered by PS1, that make use of a PS1 connected/disconnected detector may consume no more than 3 mW from Power Source 1 in restricted power conditions.

Nondesignated TEs, not powered from PS1, that do not make use of a PS1 connected/disconnected detector and nondesignated TEs that are normally powered from Power Source 1 (normal conditions) shall not consume any power from Power Source 1 in restricted power conditions (except the leakage current, for further study).

2.1.5.7 Galvanic Isolation

The TEs that provide power sinks 1 or 2 shall provide galvanic isolation between Power Sources 1 or 2 and the earths of additional sources of power and/or of other equipment. (This provision is intended to preclude earth loops or paths that could result in currents that would interfere with the satisfactory operation of the TE. It is independent of any safety requirement for such isolation described in IEC Guide 105. It shall not be interpreted to require isolation that conflicts with necessary provisions for safety.) The required characteristics of how the galvanic isolation is to be implemented is left for further study.

2.1.5.8 Limitations on Power Source and Sink During Transient Conditions

The requirements on power sources and power sinks during the first 100 ms after start-up or after switching between normal and restricted modes are for further study.

2.1.6 CAPABILITIES OF B-CHANNEL CONNECTIONS AND ELECTRICAL CONFIGURATIONS

2.1.6.1 Interface Connector and Contact Assignments

The connector at each end of the standard ISDN basic access TE connecting cord shall be as specified in ISO 8877:1987. The contact assignments for conductors and pairs shall be consistent with ISO 8877:1987. The material in this section is consistent with the requirements provided in ISO 8877:1987.

2.1.6.1.1 Application

The 8-pole connector (plug and jack) and the assignments of poles/contacts, for use in physical interfaces of ISDN basic access arrangements, are specified in this section. These physical interfaces, where they exist, are located at reference points S and T between TEs and NTs and between NT1s and NT2s, and they shall conform to this section. This section requires plugs and jacks on equipment connecting cords and interface cables as shown in Figure 2.1.1-1 and discussed in "Interface Cabling Arrangements," Section 2.1.6.11. The plug and jack (and contact assignments) shall also be used for the connection of a "Standard ISDN Basic Access TE Cord" as specified in "Standard ISDN Basic Access TE Cord," Section 2.1.4.11. For the purpose of this section, when viewed from an NT1, an NT2 may be considered to be a TE.

The term "pole," as used in this section, refers to a position (numbered) for a contact. The term "contact" refers to the electrical contact element that, for many connectors, is referred to as a "pin." The terms "plug" and "jack" refer to the male and female connector parts, respectively. Interface cabling is the wiring that connects TEs and NTs together. Examples of interface cabling configurations, showing the cord, extension cord, and interface cable parts are given in "Interface Cabling Arrangements," Section 2.1.6.11.

2.1.6.1.2 Connector

Eight-pole plugs and jacks are specified for the interconnection of TEs and NTs. One plug and jack pair is used to connect the TE connecting cord to the interface cable at interface point I_A in Figure 2.1.1-1, and a second plug and jack pair is used (optionally)[1] to connect the NT connecting cord to the interface cable at interface point I_B in Figure 2.1.1-1. Eight-pole plug and jack pairs shall also be provided for the connection of "Standard ISDN Basic Access TE Cords (SBAC)." Interface cabling may have a passive bus or a point-to-point configuration. Both configurations are illustrated in "Interface Cabling Arrangements," Section 2.1.6.11.

Note: The interface cable may or may not be directly connected to an NT. Where the NT is a multi-port device, for example, a PABX, the connection to the NT may involve a large connector arrangement that accommodates multiple interfaces.

TE and NT connecting cords shall be terminated in plugs. SBACs shall be terminated in plugs at both ends. Figure 2.1.6-1 illustrates the cord-terminating plug that provides for 4, 6, or 8 contacts. The number of physical contacts provided or required is dependent upon the use by the associated equipment, TE or NT, of the optional provisions for powering across the interface (see "Reference Configuration," Section 2.1.5.2).

1. The interface cable may or may not be directly connected to an NT. Where the NT is a multi-port device, for example, a PABX, the connection to the NT may involve a large connector arrangement that accommodates multiple interfaces.

Interface cables shall be terminated in jacks and an 8-pole jack shall be provided on TE equipment for the connection of SBACs. Figure 2.1.6-2 illustrates the jack that provides 4, 6, or 8 contacts. As with the cord-terminating plug, the number of contacts provided or required is dependent upon the provision of the powering options discussed in "Reference Configuration," Section 2.1.5.2.

Connector dimensions[2] necessary to assure mating of plugs and jacks are specified in Figures 2.1.6-3, 2.1.6-4, and 2.1.6-5. Connectors for use in the applications covered by this section shall conform[3] to the dimensions specified in these figures. No additional provisions for keying shall be provided. The complete detailed mechanical specifications of the plugs and jacks will be the subject of an IEC standard. Figure 2.1.6-3 gives the plug/jack contact specification for mating. Figure 2.1.6-4 gives the mechanical specification for mating of the 8-pole plug. Figure 2.1.6-5 gives the mechanical specification for mating of the 8-pole jack. While physical contacts are indicated for poles 1, 2, 7, and 8 of the plug and jack, contacts corresponding to these numbers are not required in some applications and, in such applications, may be omitted.

Note 1: Only dimensions essential to assure intermatability are specified. All other dimensions are the subject of standardization by IEC.

Note 2: Compliance with this section does not depend on compliance with any other standards dealing with plugs and jacks.

2.1.6.1.3 Assignment of Contact Numbers

Four contact numbers are assigned for the conductors of the two pairs used for the signal transmission from NT to TE and from TE to NT. Two contacts each are assigned for TRANSMIT and RECEIVE directions at TEs and, correspondingly, for RECEIVE and TRANSMIT directions at NTs. Contacts are also assigned, for sources and sinks at TEs and NTs, individually, for the two optional conductor pairs used for powering TEs from NTs or from other TEs (or NTs from TEs). The provision of twisted pair TRANSMIT and RECEIVE circuits and of conductors for powering shall be in conformance with "Power Feeding," Section 2.1.5, in all applications. The assignments applicable to the interface on the NT1 side of NT2s shall be the same as for the interface at TEs.

The contact number assignments for plugs and jacks are given in Table 2.1.6-1. The same numbered assignments are given to the leads in Figure 2.1.5-1. The individual contacts for each circuit pair (1-2, 3-6, 4-5, and 7-8) are designated "+" or "−."

For TRANSMIT and RECEIVE pairs (pole numbers 3 through 6), the contact designated "+" indicates the lead of the pair (3-6 or 4-5) for which the framing pulse should be relatively positive. However, it is unnecessary to distinguish the individual conductors of transmit and receive circuit pairs in interface cables or extension cords in point-to-point interconnections.

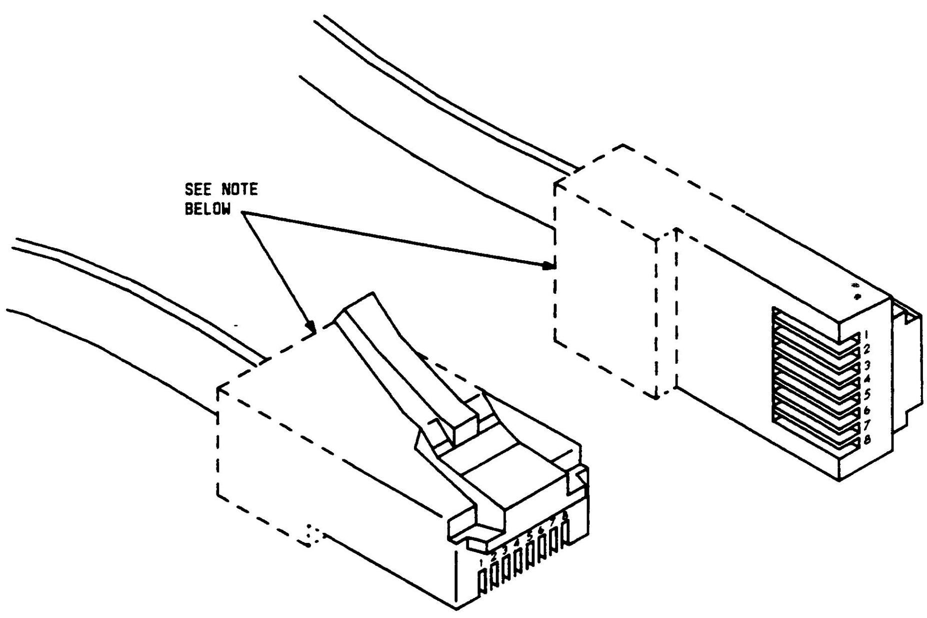
For pairs (1-2 and 7-8) used for powering across the interface (see Source 2 or 3 in "Power Feeding," Section 2.1.5), the contact designated "+" indicates the lead of the pair that carries the relatively positive DC voltage. For the polarity of power provided

2. Only dimensions essential to assure intermatability are specified. All other dimensions are the subject of standardization by IEC.
3. Compliance with this section does not depend on compliance with any other standards dealing with plugs and jacks.

in the phantom mode (Source 1), Figure 2.1.5-1 designates the TE transmit pair (3-6) as positive relative to the NT transmit pair (4-5).

Table 2.1.6-1 — Pole (Contact) Assignments for 8-Pole Connections (Plugs and Jacks)

POLE NUMBER	FUNCTION[a]		POLARITY OF POWER	POLARITY OF FRAMING PULSES
	TE	NT		
1	Power Source/Sink 3	Power Sink 3	+	
2	Power Source/Sink 3	Power Sink 3	−	
3	Transmit	Receive	+	+
4	Receive	Transmit	−	+
5	Receive	Transmit	−	−
6	Transmit	Receive	+	−
7	Power Sink 2	Power Source 2	−	
8	Power Sink 2	Power Source 2	+	
Note(s): a. This reference is provisional.				



Note :

This portion of the plug is illustrative of a structure necessary for securing the cord and is not pertinent to proper mating with the jack.

Figure 2.1.6-1 — Male Part (Plug) - 8 Pole

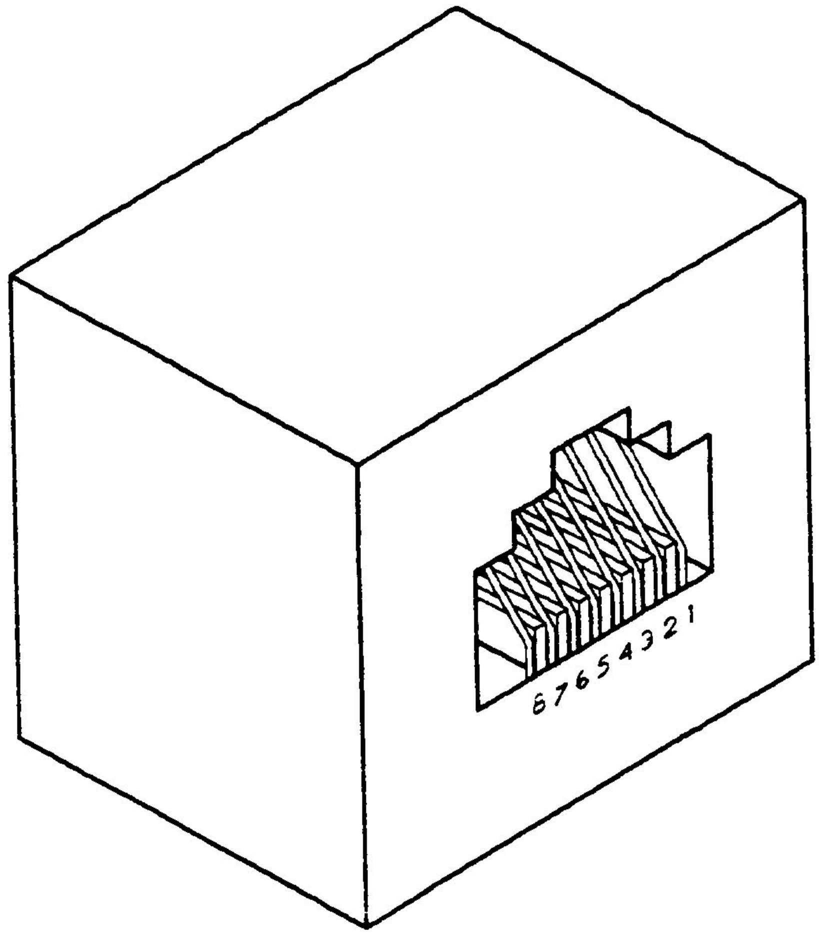
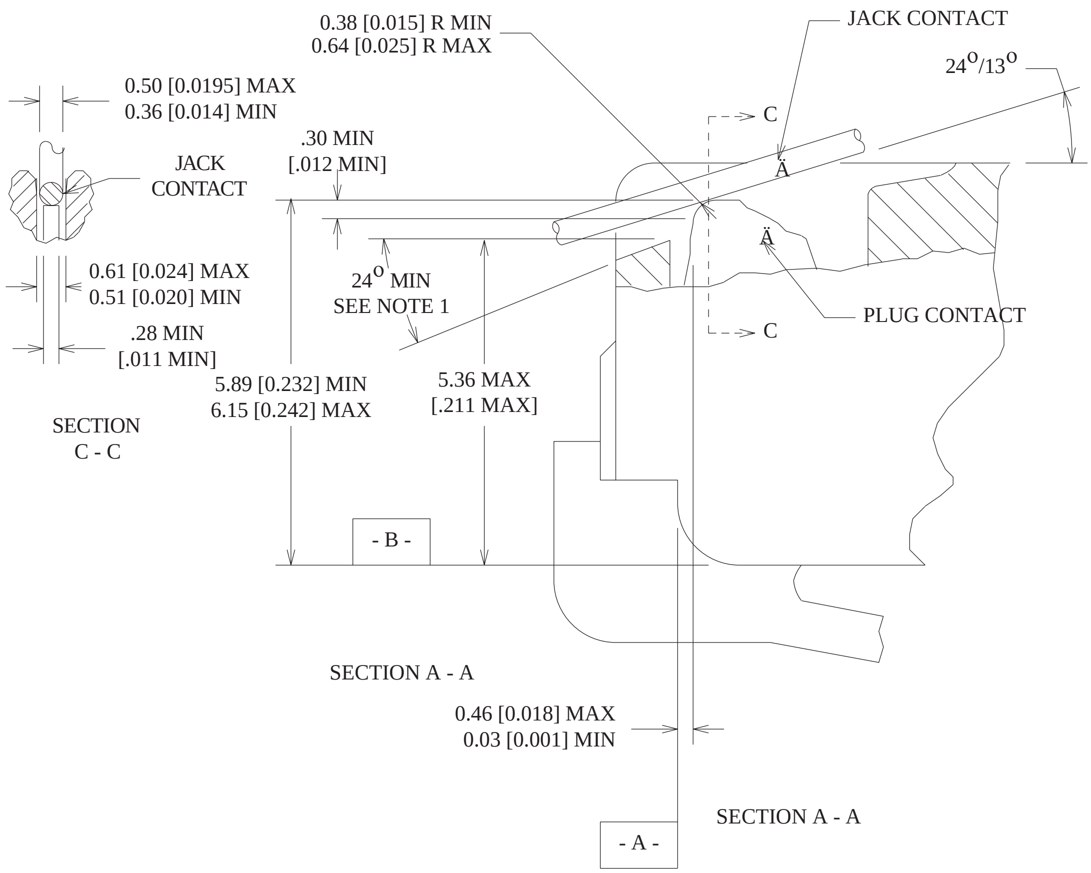


Figure 2.1.6-2 — Female Part (Jack) - 8 Pole

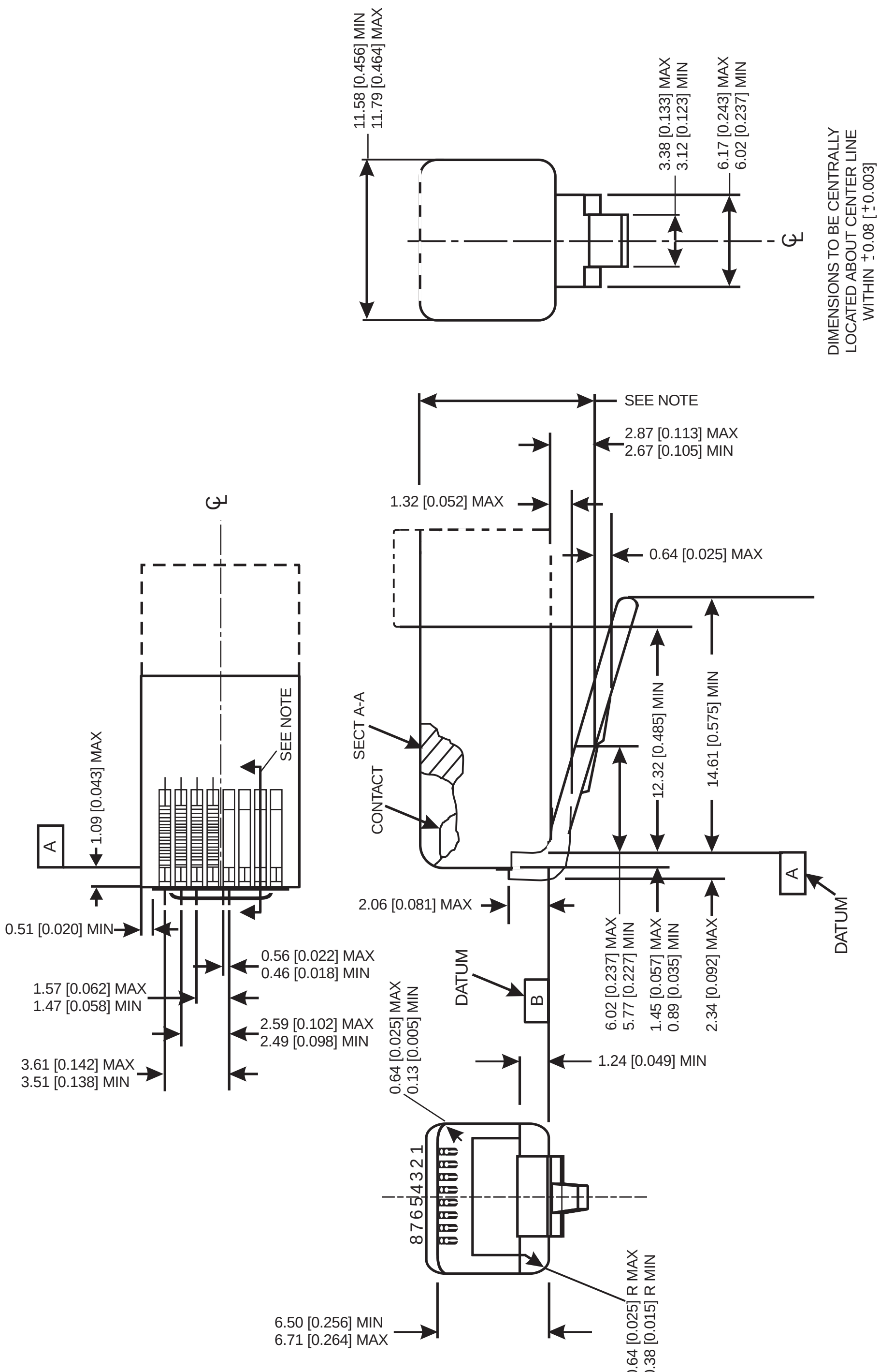


Note 1: For Section A - A, refer to Figures 2.1.6-4 and 2.1.6-5

Note 2: The 24-degree minimum angle applies to only those plugs with front plastic walls higher than 4.83 mm (.190 in).

Note 3: Jack contacts may be rectangular with a width of 0.50 [0.0195] max and 0.36 (0.014) min.

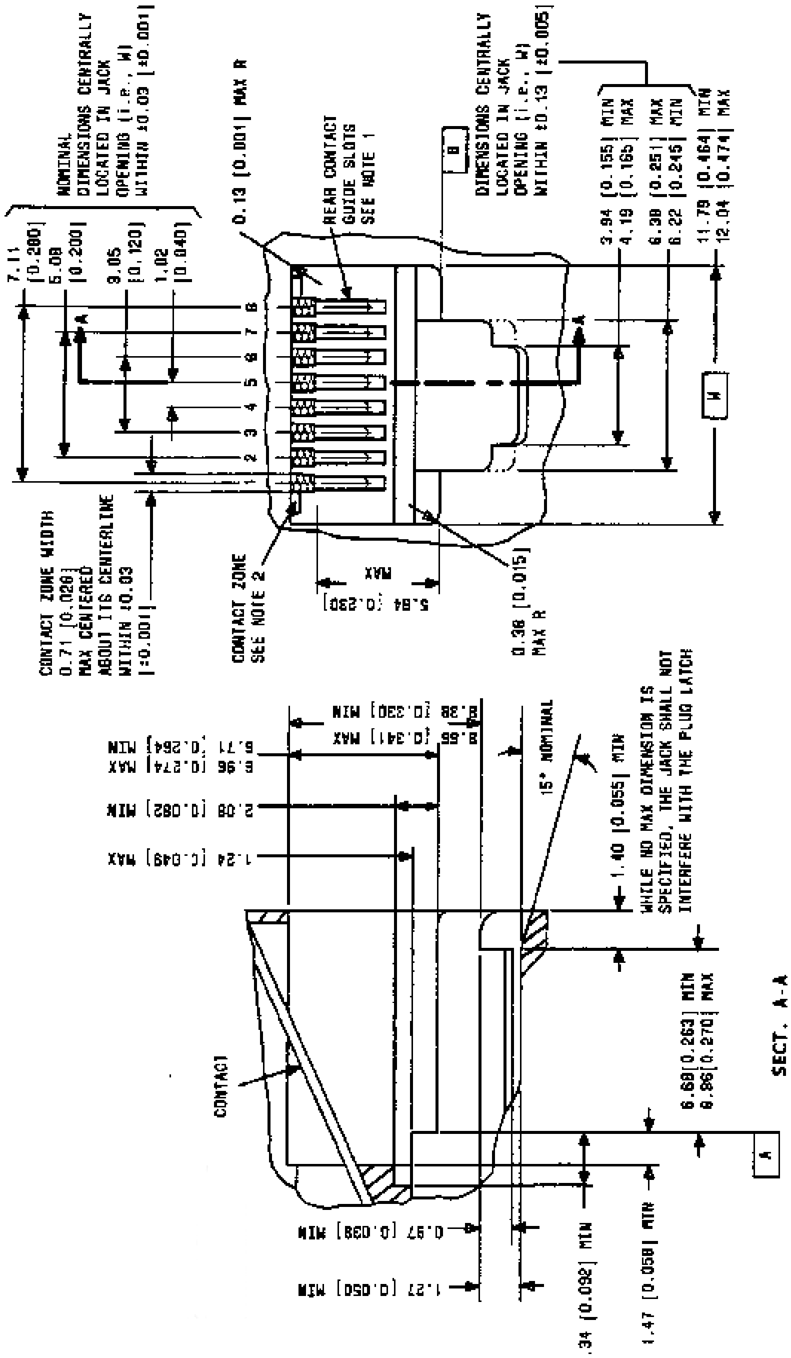
Figure 2.1.6-3 — Plug/Jack Contact Specification



Note 1: All dimensions are displayed as millimeters [inches].

Note 2: With the latch depressed, this dimension shall be 8.36 mm [0.329 in] maximum.

Figure 2.1.6-4 — Plug Mechanical Specification



Note 1: All dimensions are displayed as millimeters [inches].

Note 2: Guide slots will prevent any individual contact from being displaced from its associated slot while permitting movement within individual slots.

Note 3: Jack contacts will be within their individual contact zone to assure proper mating as a plug is inserted.

Figure 2.1.6-5 — Jack Mechanical Specification

2.1.6.2 Transmission Mode—Restricted/Unrestricted 64-kbps Capabilities

2.1.6.2.1 Restricted/Unrestricted Capabilities

The terms restricted and unrestricted, as used here, refer to the capabilities of B-channel connections either between TEs or from a TE to a network service termination, such as on a packet handler, within a network. Unrestricted capabilities permit the transmission of any sequence of bits at the full 64-kbps rate of B-channels. On restricted capabilities, the transmission of an "all ZEROs" octet is not permitted. A connection (TE to TE or NT2 to NT2 through a network) or access is unrestricted only if all facilities involved in the connection are unrestricted, otherwise it is restricted. D-channels in ISDN basic access capabilities are assumed to be unrestricted. Note that restricted operation is not a consideration of the S/T interface. However, from an overall network perspective (that is, end-to-end), the inverted mode described in the following section may be permitted in a termination device to overcome the shortcomings of the network.

2.1.6.2.2 Normal Mode

In the normal transmission mode, all data and voice signals are transmitted on B- and D-channels, as indicated in this section. In this mode, a binary ONE is transmitted as the absence of a pulse and a binary ZERO is transmitted as a pulse (see "Line Code," Section 2.1.1.4.5). This mode of transmission is satisfactory for all data rates and all data sequences in which the connection involved is unrestricted. As indicated in "Restricted/Unrestricted Capabilities," Section 2.1.6.2.1, D-channels in basic access connections are unrestricted and therefore transmission on such channels uses the normal mode.

The normal mode is also satisfactory for transmission over B-channel connections that have a restricted capability, provided that the transmitted sequence does not violate the restricted capability limitation. All data sequences at rates up to 56 kbps may be transmitted in the normal mode over B-channels by setting every eighth bit to a binary ONE. This is consistent with the provisions of ITU-TS Recommendation I.464 (Multiplexing, Rate Adaptation, and Support of Existing Interfaces for Restricted 64-kbps Transfer Capability). All voice signals coded according to North American μ law PCM may be transmitted in the normal mode over connections that are restricted.

2.1.6.2.3 Inverted Mode

The inverted mode is satisfactory for the transmission of data sequences using an HDLC-based protocol over B-channel connections independent of whether such connection is restricted or unrestricted. In the inverted mode, a binary ONE is sent as a pulse and a binary ZERO is sent as the absence of a pulse. An "abort" must be restricted to a sequence of seven consecutive binary ONEs, and an all-ONEs idle must be sent as repeated transmissions of a sequence of seven consecutive binary ONEs followed by a binary ZERO. The all-ONEs idle appears as a string of continuous aborts. A receiver, which must distinguish the all-ONEs idle, shall interpret two or more consecutive aborts as idle. Where continuous aborts cause difficulties at higher layers, the Layer 1 receiver must include the capability of converting continuous aborts to an all-ONEs idle. Provision of the inverted mode is an option for TEs and does not necessarily imply a Layer 1 implementation.

For Passive Bus compatibility, the continuous absence of pulses during idle intervals (no connection) on B-channels must be maintained where the inverted mode is used. As viewed from an NT or from TEs operating in the Normal Mode, the continuous absence of pulses represents the required all-ONEs idle. However, in the inverted mode a TE should initiate the transmission of HDLC flags (01111110) when it is allocated and seizes a B-channel. It should continue the transmission of flags until the initiation of the transmission of a frame by Layer 2. Interframe time fill shall be flags.

The use of the inverted mode may be an option set at the factory or at installation or it may be selectable by higher layers. The selection by higher layers may be the result of direct user action or the result of information provided through the Layer 3 signaling procedures. It is equally applicable for the ISDN packet-mode service provided over a B-channel and for circuit-mode transmission.

2.1.6.3 Wiring Configurations and Round-Trip Delay Considerations Used as a Basis for Electrical Characteristics

This section is not part of the specification — for information only.

2.1.6.3.1 Introduction

This section is not part of the specification — for information only.

The wiring arrangements given in this section are for illustrative purposes only. They are not intended to specify any required characteristics of the wiring configurations that may appear on the user premises. Although configurations including up to eight (short passive bus) and four (extended passive bus) TEs are used in this section, there is no limitation on the number of TEs in passive bus configurations. Other configurations can be provided to accommodate many more than eight TEs. The requirements that must be met by any wiring configuration are the electrical characteristics described in "Electrical Characteristics," Section 2.1.4, for the user-network interfaces (I_A and I_B in Figure 2.1.1-1). The configurations described by Figures 2.1.6-6, 2.1.6-7, and 2.1.6-8 are the bases from which the required electrical characteristics of the user-network interfaces were determined. However, any interface wiring configuration that meets the required electrical characteristics at the user-network interfaces is an acceptable interface wiring configuration.

In "Types of Wiring Configuration," Section 2.1.1.3, two major wiring arrangements are identified. These are a point-to-point configuration and a point-to-multipoint configuration using a passive bus.

While these configurations may be considered to be the limiting cases for the definition of the interfaces and the design of the associated TE and NT equipments, other significant arrangements should be considered.

The values of overall length, in terms of cable loss and delay assumed for each of the possible arrangements, are indicated in "Wiring Configurations," Section 2.1.6.3.2.

Figure 2.1.1-1 is a composite of the individual configurations. These individual configurations are shown in this section.

2.1.6.3.2 Wiring Configurations

2.1.6.3.2.1 Point-to-Multipoint

The point-to-multipoint wiring configuration identified in "Point-to-Multipoint Configuration," Section 2.1.1.3.3, may be provided by the "short passive bus" or other configurations such as an "extended passive bus."

For the T-interface that is directly connected to the network without the use of a physically separate NT1, both the short passive bus and the extended passive bus point-to-multipoint configurations are fully supported as described in *ANSI*[4] Standard T1.605-1991 and in this section. Additionally, a variety of branched (see "Branched Passive Bus Wiring Configuration," Section 2.1.6.5) point-to-multipoint configurations are supported. For a complete description of configurations that are supported, refer to the Branched Multipoint subsection of the Wiring Architecture section in "*ISDN Customer Premises Equipment Planning Guide*" (document 533-700-100).

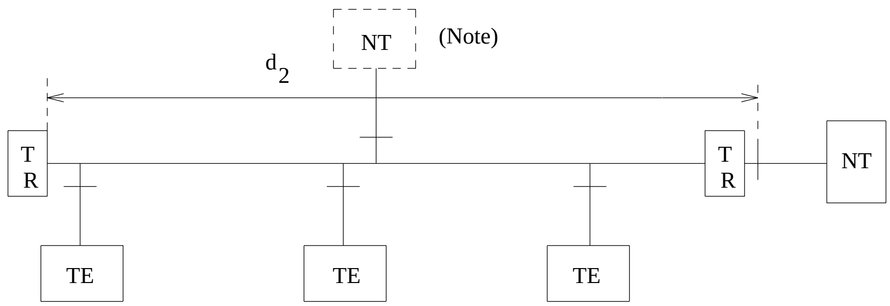
2.1.6.3.2.1.1 Short Passive Bus

An essential configuration to be considered is a passive bus (see Figure 2.1.6-6) in which the TE devices may be connected at random points along the full length of the cable. This means that the NT receiver must cater for pulses arriving with different delays from various terminals. For this reason, the length limit for this configuration is a function of the maximum round-trip delay and not of the attenuation.

An NT receiver with fixed timing can be used if the round-trip delay is between 10 to 14 µs. This relates to a maximum operational distance from the NT in the order of 100 to 200 meters [d_2 in Figure 2.1.6-6; 200 meters in the case of a high-impedance cable (Z_c 150 ohms) and 100 meters in the case of a low-impedance cable Z_c 75 ohms)]. Note that the TE connections act as stubs on the cable, thus reducing the NT receiver margin over that of a point-to-point configuration. A maximum number of eight TEs with connections of 10 meters in length are to be accommodated.

The range of 10 to 14 µs for the round-trip delay is composed as follows. The lower value of 10 µs is composed of two bits offset delay (see Figure 2.1.1-2) and the negative phase deviation of −7 percent (see "Total Phase Deviation, Input to Output," Section 2.1.4.3.3). In this case the TE is located directly at the NT. The higher value of 14 µs is calculated assuming the TE is located at the far end of a passive bus. This value is composed of the offset delay of two bits (10.4 µs) between frames, the round-trip delay of the unloaded bus installation (2 µs), the additional delay due to the load of the TEs (that is, 0.7 µs) and the maximum delay of the TE transmitter according to "Total Phase Deviation, Input to Output," Section 2.1.4.3.3, (15% = 0.8 µs).

4. Registered trademark of American National Standard Institute.



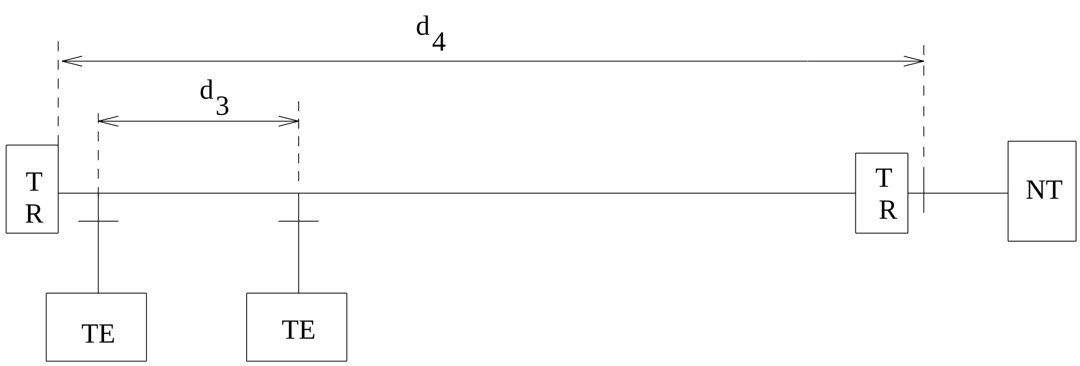
TR = terminating resistor

Note: In principle, the NT may be located at any point along the passive bus. The electrical characteristics in this section, however, are based on the NT located at one end. The conditions related to other locations require confirmation.

Figure 2.1.6-6 — Short Passive Bus

2.1.6.3.2.1.2 Extended Passive Bus

A configuration that may be used at an intermediate distance (100 to 1000 meters) is known as an extended passive bus (see Figure 2.1.6-7). This configuration takes advantage of the fact that terminal connection points are restricted to a grouping at the far end of the cable from the NT. This places a restriction on the differential distance between TEs. The differential round-trip delay is defined as that between zero-volt crossings of signals from different TEs and is restricted to 2 µs.



TR = terminating resistor

Figure 2.1.6-7 — Extended Passive Bus

This differential round-trip delay is composed of a TE differential delay of 22 percent or 1.15 µsec according to "Total Phase Deviation, Input to Output," Section 2.1.4.3.3, the round-trip delay of the unloaded bus installation of 0.5 µsec (line length: 25 to 50 meters), and an additional delay due to the load of four TEs (0.35 µs).

The distance d_3 depends on the characteristics of the cable to be used.

The objective for this extended passive bus configuration is a total length of at least 500 meters (d_4 in Figure 2.1.6-7) and a differential distance between TE connection points of 25 to 50 meters (d_3 in Figure 2.1.6-7). However, an appropriate combination of the total length, the differential distance between TE connection points and the number of TEs connected to the cable may vary.

2.1.6.3.2.2 Point-to-Point

This configuration provides for one transmitter/receiver only at each end of the cable (see Figure 2.1.6-8). It is, therefore, necessary to determine the maximum permissible attenuation between the ends of the cable to establish the transmitter output level and the range of receiver input levels. In addition, it is necessary to establish the maximum round-trip delay for any signal that must be returned from one end to the other within a specified time period (limited by D-echo bits).

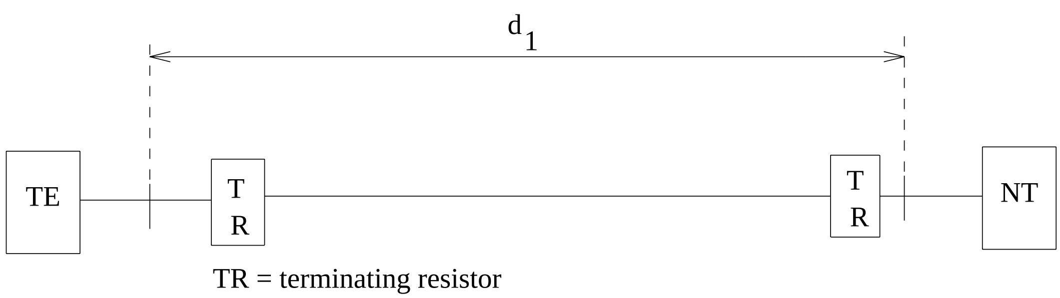


Figure 2.1.6-8 — Point-to-Point

A general objective for the operational distance between TE and NT or NT1 and NT2 is up to 1.0 km, depending on gauge and quality of the cable (d1 in Figure 2.1.6-8). It is agreed to satisfy this general objective with a maximum cable attenuation of 6 dB at 96 kHz.

Note that the 1 Km interface cable length is an objective. The interface electrical characteristics are specified with the objective of accommodating the 6 dB loss.[5] The round-trip delay is between 10 to 42 µs. The lower value of 10 µs is derived in the same way as for the passive bus configuration. The upper value is composed of the following elements:

- Two bits due to frame offset (2 x5.2 µs = 10.4 µs, see "Relative Bit Positions," Section 2.1.1.4.4.2.4
- Maximum 6-bit delay permitted due to the distance between NT and TE and the required processing time (6 x5.2 µs = 31.2 µs)

5. However, neither the 1-km nor 6-dB values are intended to be interface cable limitations. Interface cable limitations are not explicitly defined in this specification. The 1-km and 6-dB values are a part of the basis (specific values of signal distortion are also assumed) of the interface requirements specified, but the corresponding limitations for interface cables depend upon cable characteristics. Such cables shall be designed, such that, taking into account relevant cable characteristics and interface specifications, conforming TEs and NTs will interface properly.

- The fraction [+15 percent of a bit period due to phase deviation between TE input and output (see "Total Phase Deviation, Input to Output," Section 2.1.4.3.3), 0.15x 5.2 µs = 0.8 µs].

Note that an adaptive timing device at the receiver is required at the NT to meet these limits.

For the NT used for both point-to-point and passive bus configurations (see "NT for Both Point-to-Point and Passive Bus," Section 2.1.4.7.4) the tolerable round-trip delay in passive bus wiring configurations is reduced to 13 µs due to the extra tolerance required for the adaptive timing. Using this type of wiring configuration, it is also possible to provide point-to-multipoint mode of operation at Layer 1.

2.1.6.4 Example of NT that Supports Multiple T-Interfaces to Accommodate Multipoint Operation with More Than Eight TEs

This section is not part of the specification — for information only.

The NT1 STAR illustrated in Figure 2.1.6-9 is one example of a configuration that supports multiple T-interfaces, can use multiple point-to-point configurations to accommodate the multipoint mode of operation, and permits many more than eight TEs. Each point of the NT1 STAR arrangement may itself accommodate a point-to-point or a point-to-multipoint (short or extended) wiring configuration, and any mix of such configurations is possible on a single NT1 STAR. The entire NT1 STAR arrangement operates effectively as one large bus, and the required electrical characteristics are provided at all user-network interface points. In such an implementation, bit streams from TEs must be buffered to provide for operation of the D-echo channel(s) for contention resolution, but only Layer 1 functionality is required. Support of this configuration does not affect the provisions of this section, or of ITU-TS Recommendations I.441 or I.451.

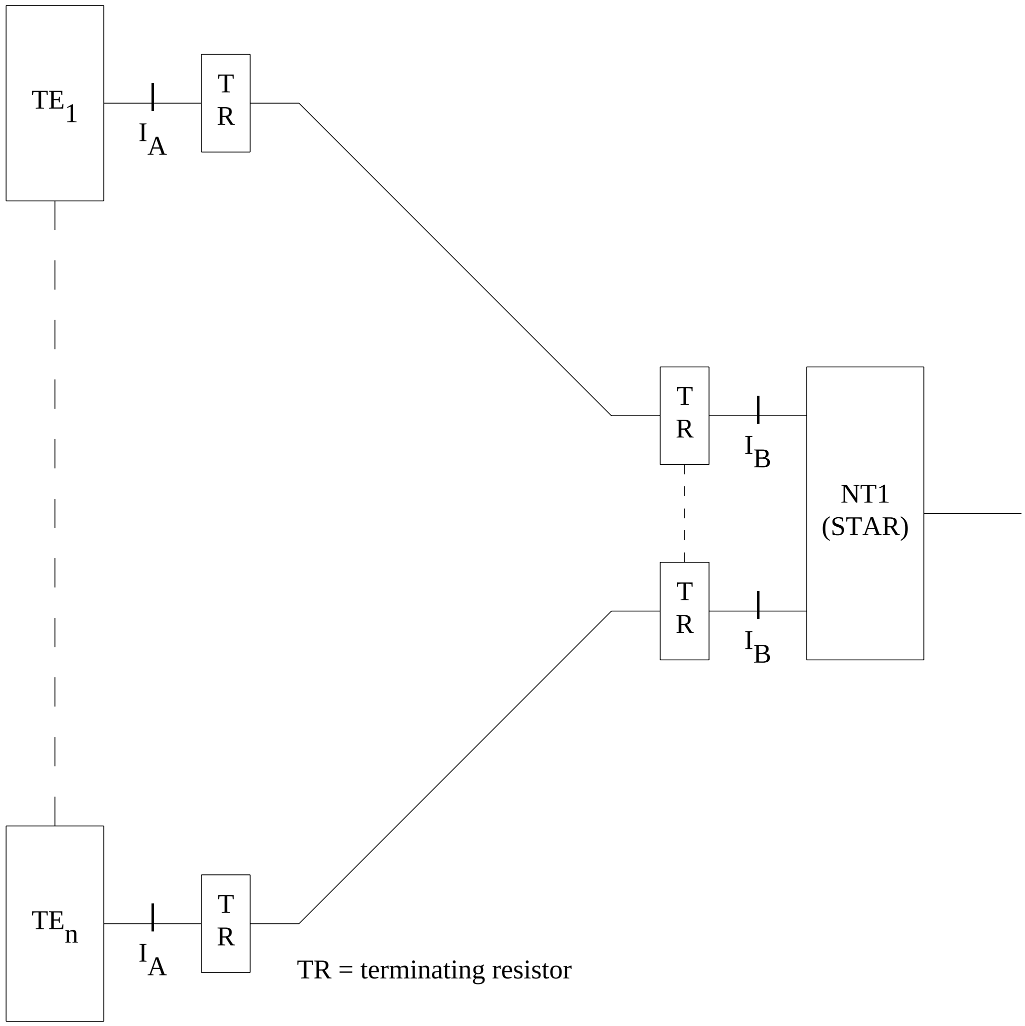


Figure 2.1.6-9 — NT1 STAR

2.1.6.5 Branched Passive Bus Wiring Configuration

This section is not part of this specification — for information only.

The branched passive bus wiring configuration illustrated in Figure 2.1.6-10 agrees well with practices used for wiring of office buildings. It allows provisioning and reconfiguration of ISDN basic access service to be implemented at the building wiring nodes.

The branched passive bus represents a wiring configuration that has similar performance characteristics as the extended passive bus in "Extended Passive Bus," Section 2.1.6.3.2.1.2. This configuration has the advantage of a branched nature at the end of the bus. The differential round-trip delay is defined as that between zero-volt crossings of signals from different TEs and is restricted to 2.0 µs.

This differential round-trip delay is composed of a TE differential delay of 22 percent or 1.15 µs in accordance with "Total Phase Deviation, Input to Output," Section 2.1.4.3.3, the round-trip delay of the longest branch (distance d_5), and an additional delay due to the loading from the branches (0.13 µs).

An appropriate combination of the maximum branch length d_5, the main bus length d_1, and the number of TEs may vary.

This is only one of the many other possible wiring configurations that are different from those illustrated in "Wiring Configurations and Round-trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3, and that meet the interface requirements. Any interface wiring configuration that meets the required electrical characteristics at the user-network interfaces is an acceptable interface wiring configuration. There is no limitation other than meeting the interface requirements.

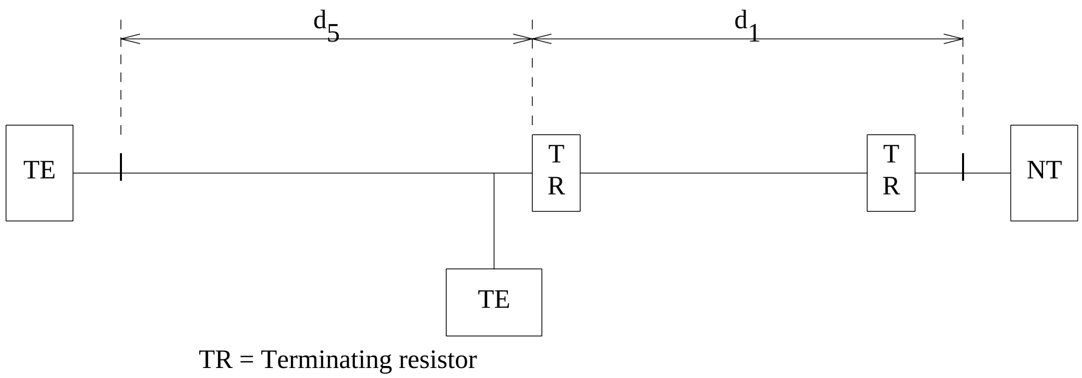


Figure 2.1.6-10 — Branched Passive Bus

2.1.6.6 SDL Representation of a Possible Implementation of the D-Channel Access

This section is not part of this specification — for information only.

See Figure 2.1.6-11 for an example representation of D-channel access.

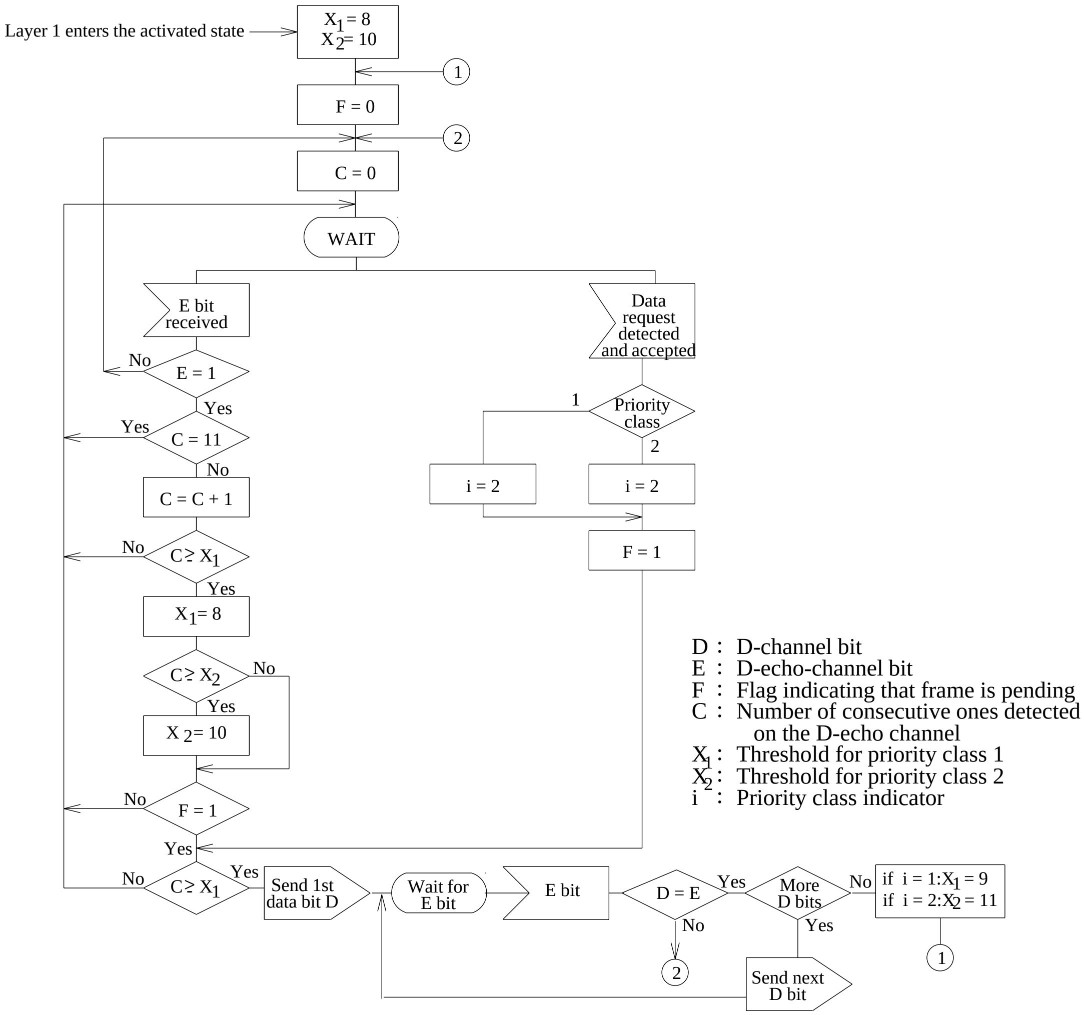


Figure 2.1.6-11 — An SDL Representation Example

2.1.6.7 Activation of the S/T Interface without Intervention of the Network Interface to the NT

This section is not part of this specification — for information only.

Normally, when the S/T interface activates, it does so through coordination with the activation procedures at the network interface to the NT. However, when the network interface cannot be activated, it is desirable to be able to activate the S/T interface (for example, for maintenance purposes).

When a TE needs to activate an inactive S/T interface, it sends INFO 1 toward the NT. Normally, with directions from the network interface, the NT responds with INFO 2 with the optional SC1 subchannel in the Idle state. However, when the NT determines that the network interface cannot be activated after receiving INFO 1, it transmits INFO 2 synchronized to a free-running clock on the NT and sends the "Loss of Received Signal" message in the optional SC1 subchannel if that subchannel is used. The S/T interface continues to activate with INFO 3 being transmitted by the TE(s) and INFO 4 being transmitted by the NT.

Through the reception of INFO 4, the TE receives the activation indication primitive but becomes aware that no calls can be originated or received when Layer 2 fails to activate. If the optional SC1 subchannel is used and the TE recognizes the SC1-subchannel message, it can inform the user that the problem is with the network interface.

Through the transmission of INFO 3 and INFO 4, the optional Q- and S-channels can be active and all Layer 1 maintenance functions can be performed on the S/T interface. These functions include the capability to establish loopback C (individual B-channels looped back toward the TE) so the user can perform bit error rate testing.

2.1.6.8 Loopback Notation

This section is not part of the specification — for information only.

2.1.6.8.1 Introduction

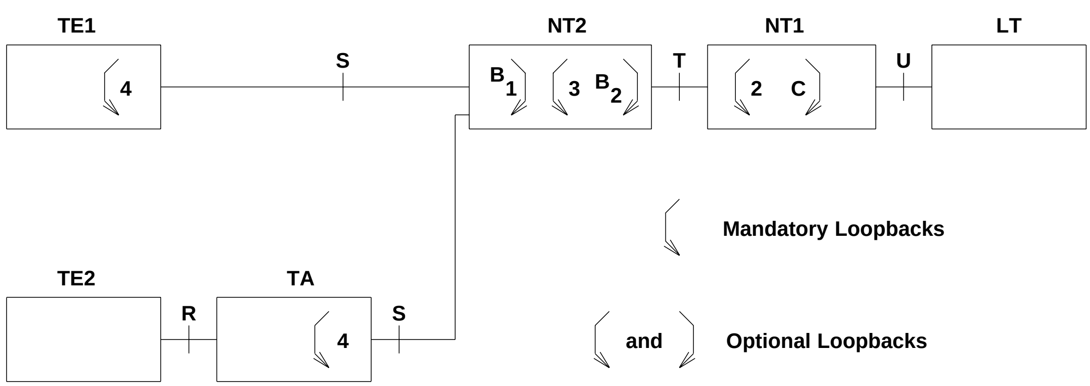
This section is not part of the specification — for information only.

The overall maintenance capabilities for ISDN basic access are described in "Interface Procedures," Section 2.1.2. ITU-TS Recommendation I.603 includes an overall approach to maintenance of basic access. Looping mechanisms are an integral part of the capabilities. The designations of Layer 1 loopbacks used in ITU-TS are presented in this section for easy reference.

2.1.6.8.2 Test Loopback Reference Configuration

Figure 2.1.6-12 shows the possible locations of test loopbacks pertaining to the maintenance of the ISDN basic access user-network interfaces. It also shows the corresponding designations. The designation of two B loopbacks (B_1 and B_2), at different locations within the functional entity, is not intended to imply any universal requirement concerning the location, in a particular equipment, of such loopbacks or the need for a loopback to be close to a particular interface.

Note: Loopbacks B_1 and 3 are applicable to each individual S interface.



Note: **Loopbacks B_1 and 3 are applicable to each individual S interface.**

Figure 2.1.6-12 — Location of Test Loopbacks

2.1.6.8.3 Test Loopback Characteristics

Table 2.1.6-2 lists channels to be looped for each of the loopbacks designated in Figure 2.1.6-12.

Table 2.1.6-2 — Characteristics of Layer 1 Loopbacks Defined in ITU-T Recommendations

LOOPBACK[a]	CHANNEL(S) LOOPED
2	2B+D channels[b] B1, B2
3	2B+D channels
4	B1, B2
C	B1, B2
B_1 or B_2	2B+D channels B1, B2

Note(s):

a. See Figure 2.1.6-12.

b. ITU-T Recommendation G.960, Digital Section for ISDN Basic Rate Access, states that when a transparent loopback 2 is applied, the NT1 should send INFO 4 frames toward the TE/NT2 with the D-echo channel bits set to binary ZERO.

2.1.6.9 Test Configurations

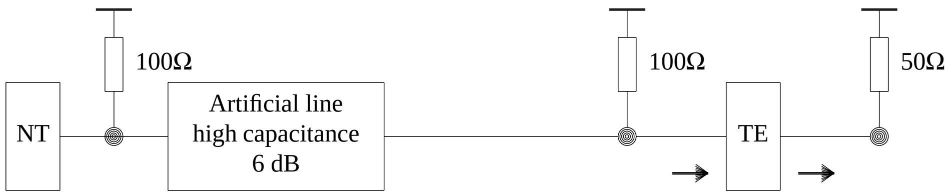
This section is not part of the specification — for information only.

In "Electrical Characteristics," Section 2.1.4, waveforms are shown that are a part of the specification of the interfaces of NT and TE equipment. This section describes configurations on which these waveforms are based and can be used for testing TE equipment (see Figure 2.1.6-13). Similar configurations can be used to test NT equipment.

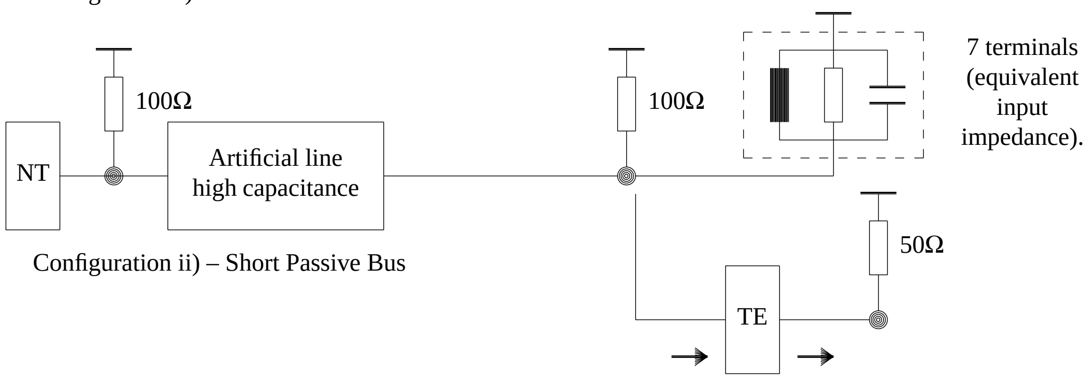
Table 2.1.6-3 gives the parameters for the artificial lines reproduced in Figure 2.1.6-13. The artificial lines are used to derive the waveforms. For test configurations ii) and iii), the cable length used corresponds to a signal delay of 1 µs.

Table 2.1.6-3 — Parameters for Artificial Lines

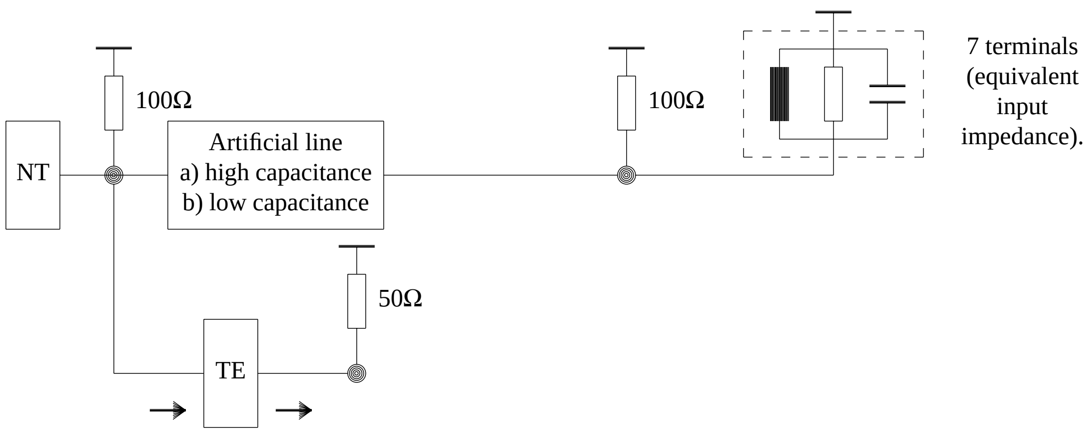
PARAMETERS	HIGH CAPACITANCE CABLE	LOW CAPACITANCE CABLE
R (96 kHz)	160 ohms/km	160 ohms/km
C (1 kHz)	120 nF/km	30 nF/km
Z_o (96 kHz)	75 ohms	150 ohms
Wire diameter	0.6 mm	0.6 mm



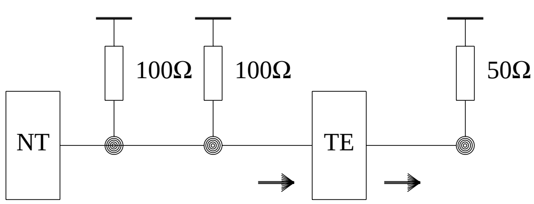
Configuration i) – Point-to-Point



Configuration ii) – Short Passive Bus



Configuration iiia), iiib) – Short Passive Bus



Configuration iv) – Ideal Test Signal

Figure 2.1.6-13 — Test Configurations

2.1.6.10 Termination of the Line

This section is not part of the specification — for information only.

This section expands on the information contained in "Termination of the Line," Section 2.1.4.5. The interchange circuit pair termination impedance should be 100 ohms ± 5 percent (see Figure 2.1.1-1) and at least 90-percent resistive in the 20 kHz to

1 MHz frequency range. Any higher tolerance would have to be compensated, for example, by changing the cable length.

The S/T-loop termination could consist of a resistor and capacitor in series, or a resistor reflected through a transformer. The values should be such that when this termination is placed in parallel with a 100-ohm resistor and used as a load for the S/T-transmitter, that the pulse mask requirements of Figure 2.1.4-9 are satisfied.

Since the S/T interface is intended for inside premises use, the protection of the S/T interface termination from 200 volts DC may be adequate. The termination should be protected from damage by environmental stresses such as those described in "Unexposed Wiring," Section 2.1.4.9.1. However, although the interface is intended for connection of equipments within the customer premises, it is possible that a portion of the connection could be exposed in some applications, and more severe conditions than those specified in "Unexposed Wiring," Section 2.1.4.9.1, may exist.

2.1.6.11 Interface Cabling Arrangements

This section is not part of the specification — for information only.

The interface cabling arrangements, implied by the requirements in "Types of Wiring Configuration," Section 2.1.1.3, are described in this section. The sketches in Figure 2.1.6-14 illustrate the cabling arrangements for the ISDN basic access interface, and they define the three different parts of the physical interconnection: "Connecting Cord," "Extension Cord," and "Interface Cable."

The same contact numbers assigned at the interface (point I_A in Figure 2.1.1-1) of TEs for TRANSMIT and RECEIVE conductor pairs are assigned at the interface (point I_B in Figure 2.1.1-1) of NTs for RECEIVE and TRANSMIT conductor pairs, respectively. This provides for a given conductor to be connected to the same contact in jacks at both ends of interface cables. However, it means that interface cables are suitable for NT-to-TE and NT1-to-NT2 interconnections only.

For TE-to-TE interconnections, an adaptor with a crossover to connect TRANSMIT to RECEIVE is required. The same crossover requirement applies to contacts/conductors (pairs assigned to contact numbers 1-2 and 7-8) for optional power transfer.

As indicated in "Types of Wiring Configuration," Section 2.1.1.3, interface cables are terminated in the same type of connector part (jack) at both ends. This means that NTs or TEs may be connected at either end of point-to-point cables.

Extension cords have a plug at one end and a jack at the other end. They cannot be used to extend TE connecting cords in connections to Passive Bus wiring configurations because the bridging impedance of an extension cord (of even a short length) can adversely affect operation of all TEs in Passive Bus configurations. The total length of extension cord(s) associate with a TE in point-to-point configurations is limited to 25 meters.

Connecting cords provide a plug for connection to an interface cable (or extension cord). The acceptable maximum length of connecting cords will generally be limited by the need for compliance with transmit- and receive-circuit impedance requirements in "Electrical Characteristics," Section 2.1.4. Although there is no restriction on the minimum length of such cords in a particular application, TEs are required to include the option of a cord of at least 5 meters in length. TE and NT connecting cords may be detachable from associated TE and NT equipment, and the connector[6] for these applications is specified in "Connector," Section 2.1.6.1.2.

It is also significant that, in most ISDN applications, the interface cable will be the wiring on the user premises, and the jack must be available in a form suitable for wall mounting. Available assemblies of the specified jack, which are intended for such mounting, may provide a housing for a suitable mounting of the transmit- and receive-pair terminating resistors. As specified in Figure 2.1.1-1. the terminating resistors must be located, for point-to-point wiring configurations, in or at the jack and must be connected across contact pairs 4-5 and 3-6. For passive bus wiring configurations, the terminating resistors may be mounted in such jack assemblies located at the ends of the bus.

It is equally important to recognize that the interface cable may be wired directly to NTs without the interface connector and with the interchange circuit terminating resistors provided internal to the equipment. This is possible where the interface cable is provided in association with, or as part of, the NT. In such applications, the only interface of significance (at which the requirements of this section apply) may be at the jack(s) (point I_A in Figure 2.1.1-1) for the connection of TEs. In addition, the combination of the NT connecting cord and interface cabling may be of zero length.

Another alternative NT connection arrangement uses a jack mounted on the NT equipment entity, which includes the terminating resistors. The jack may not conform to "Interface Connector and Contact Assignments," Section 2.1.6.1, but where the jack does conform, the contact assignments are as specified. Where a cord, terminated at each end with a plug, is used to connect to the interface wiring, the cord is considered a part of such wiring.

For NT2s (for example, PABX) serving multiple TEs, multiple interface cables may be connected to the NT2 with a larger connector, which does not conform to "Interface Connector and Contact Assignments," Section 2.1.6.1.

6. A "standard ISDN basic access TE cord," which may optionally be used with a TE, is specified in this section. A standard for a connector and contact assignments for the attachment (to a TE) of such a cord is the subject of an addendum to ISO 8877:1987.

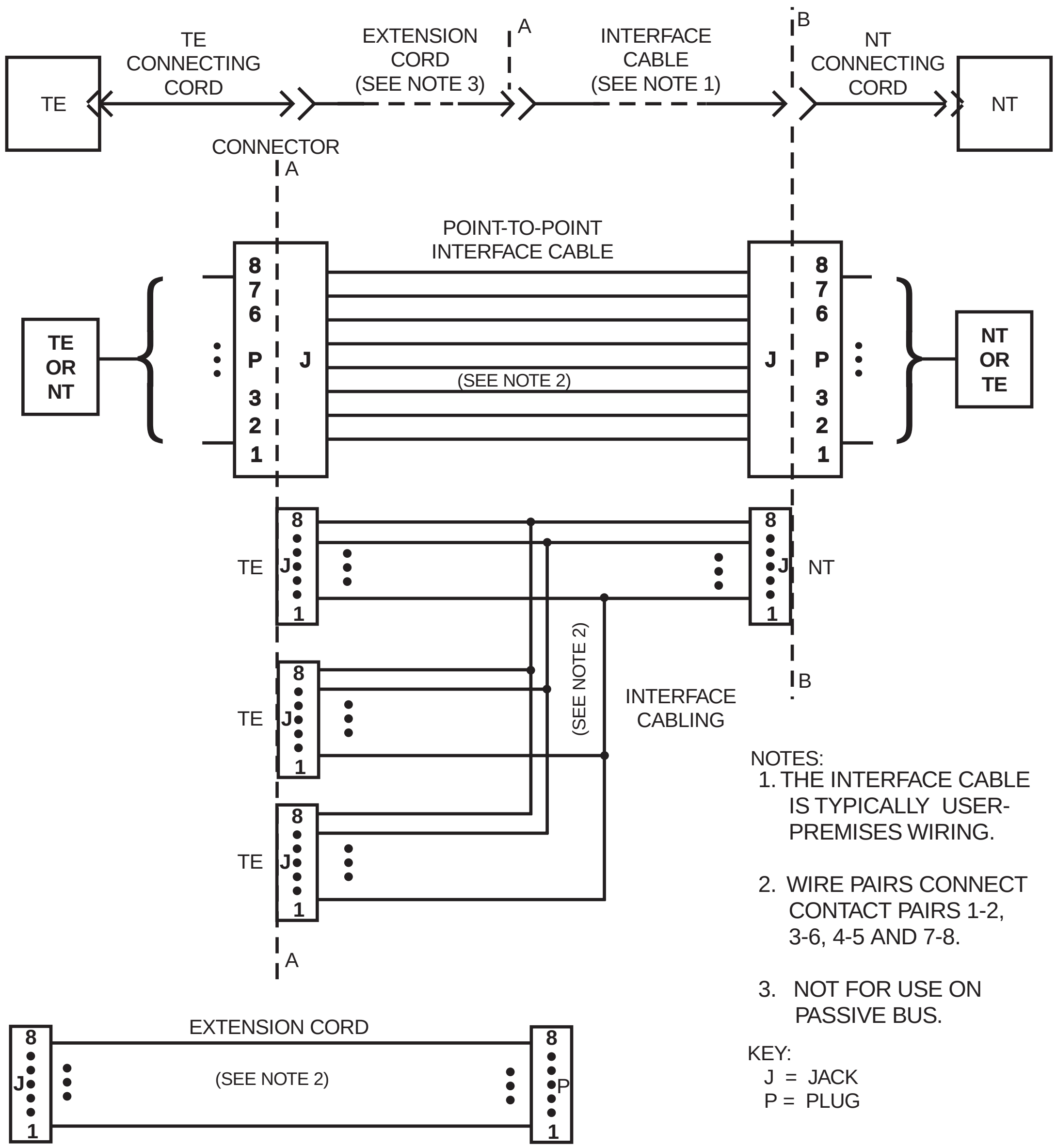


Figure 2.1.6-14 — Cabling and Connector Arrangements

2.1.6.12 Summary of Limited Options and Departures from *ANSI* STANDARD T1.605-1991

This section is not part of this specification — for information only.

The specified options, additions, and departures of this section from the provisions of *ANSI* Standard T1.605-1991 are summarized in this section.

Primitives Between Layer 1 and Other Entities Section 2.1.1.1.3
The primitives shown in *ANSI* Standard T1.605-1991 for activation and

deactivation are not included in Table 2.1.1-1 because it is assumed that it is appropriate for TEs and NTs to remain active at all times.

"Line Code," Section 2.1.1.4.5
During an interim period, transport capabilities available in some networks may not support the use of B-channels without a restriction on the sequences that may be transmitted. The necessary restrictions and means of conforming to the restrictions while using the full 64-kbps rate are described in "Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities," Section 2.1.6.2. The same description appears in an appendix in *ANSI* Standard T1.605-1991.

"Interframe (Layer 2) Time Fill," Section 2.1.2.1.1
The *5ESS*® switch sends all binary ONEs on the D-channel as interframe time fill when there are no Layer 2 frames to transmit. The HDLC flags are not used as interframe time fill. However, it is still appropriate for one HDLC flag to define both the end of one Layer 2 frame and the beginning of the next Layer 2 frame.

"Activation/Deactivation," Section 2.1.2.2
Provision of this function and compliance with the associated procedures specified in *ANSI* Standard T1.605-1991 is not required. Therefore, various subsections of *ANSI* Standard T1.605-1991, Section 7.2.3 (Activation/Deactivation), including the TE and NT state tables and the discussion of valid primitive sequences, are not included in this section. Notes, from the TE and NT state tables, pertaining to INFO 0 are moved to Figure 2.1.2-1. Conformance notes from the TE and NT state tables are moved into "Deactivation Times," Section 2.1.2.2.6. Another note concerning TEs that cannot initiate activation is moved to "General TE Procedures," Section 2.1.2.2.3. Another note concerning the TE transmission of INFO 0 or INFO 3 after INFO 1 is moved into "TE Activation Times," Section 2.1.2.2.5.1.

"Layer 1 Maintenance," Section 2.1.3
The possibility is given for monitoring the D-echo channel in point-to-point configurations for crude S/T-interface performance monitoring.

"Transmission Plan," Section 2.1.4.13
Objective loudness ratings are stated for TEs. The switches operate in a bit-transparent mode. No such section appears in *ANSI* Standard T1.605-1991.

"Power Feeding," Section 2.1.5
Power is not provided by the network (the *5ESS* switch or its remotes).

"Transmission Mode - Restricted/Unrestricted 64-kbps Capabilities," Section 2.1.6.2
This section applies to the US environment. It describes Restricted/Unrestricted Capabilities, Normal Mode, and Inverted Mode. This material appears as an appendix in *ANSI* Standard T1.605-1991.

"Wiring Configurations and Round-Trip Delay Considerations Used as a Basis for Electrical Characteristics," Section 2.1.6.3
The 1-km general objective operating distance between TE and NT in a point-to-point configuration is more carefully qualified in this section than in *ANSI* Standard T1.605-1991.

ANSI Standard T1.605-1991 Annex E, SDL Representation of Activation/Deactivation Procedures
This annex is not included in this section because it is assumed that it is appropriate for all NTs and TEs to remain active at all times.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

LIST OF EXHIBITS

2.2 *ANSI*[1] U INTERFACE

This section of the interface specification provides the minimal set of requirements for satisfactory transmission between the network and the network termination (NT). The specifications in this section are consistent with *ANSI* Standard T1.601-1991. This section also conforms, wherever possible, with the I Series of International Telecommunications Union - Telecommunications Standardization Sector (ITU-TS) Recommendations, without compromising the principles of evolution expressed therein. Equipment may be implemented with additional functions and procedures.

This section presents the electrical characteristics of the integrated services digital network (ISDN) basic access signal appearing at the network side of the NT at the customer side of the interface. It also describes the physical interface between the network and the NT. The transport medium of the signal is a single twisted-wire pair that supports full-duplex (that is, simultaneous 2-way) service.

1. Registered trademark of American National Standard Institute.

2.2.1 OVERVIEW OF *ANSI*[1] U CONFIGURATION AND OPERATION

2.2.1.1 Scope of this Document

The requirements of this standard apply to a single digital subscriber line (DSL) consisting of a line termination (LT) (at the network side of the interface), a 2-wire metallic cable pair, and an NT (at the customer side of the interface). The transmission system is designed to operate on 2-wire twisted metallic cable pairs with mixed gauges and with bridged taps.

The specifications in this section are based on the use of cables without loading coils, but bridged taps are acceptable with the exception of unusual situations. See "Received Line Signal Characteristics," Section 2.2.1.6.4, for a definition of cable plant over which the system should operate.

Specifically, the scope of this section is as follows:

- It describes the transmission technique used to support full-duplex service on a single twisted-wire pair.
- It specifies both the input signal with which the NT must operate and the output signal that the NT must produce.
- It defines the line code to be used, and the spectral composition of the transmitted signal.
- It describes the electrical and mechanical specifications of the network interface.
- It describes the organization of transmitted data into frames and superframes.
- It defines the functions of the operations channel.
- It describes the maintenance modes of the NT.

While this section does not include, except for some aspects of the frame structure, any direct requirements concerning the network side of the interface, such requirements are implied. It shall be understood that the network side conforms to the specification if it interfaces appropriately with any conforming NT or equivalent. Appropriate interfacing shall be understood to mean that the aspects of the network service related to physical characteristics associated with the interface can be provided.

2.2.1.2 Structure of this Document

"Referenced Publications," Section 2.2.1.3, lists referenced documents. "Definitions," Section 2.2.1.4, lists definitions helpful in interpreting the specifications. "Physical Characteristics," Section 2.2.1.5, describes the transmission media over which the transmission method specified in the document in "Transmission Method," Section 2.2.1.6, is intended to operate. "Functional Characteristics," Section 2.2.1.7, describes the coding and framing arrangements of the transmission method, whereas "Electrical Characteristics," Section 2.2.2, specifies its electrical characteristics. "M-Channel Bit Functions," Section 2.2.3.1, describes the functions and operating procedures associated with the overhead bits included with the transmitted data. "Environmental Conditions," Section 2.2.3.2, describes the environmental conditions.

Information on testing is given in "Test Loops and Performance Measurements," Section 2.2.3.3, and information on surge protection and out-of-band energy is given in

---

1. Registered trademark of American National Standards Institute.

"Overvoltage, Surge Protection, and EMC," Section 2.2.3.4. "DSL Start-up and Activation," Section 2.2.3.5, provides information on activation, "Linearity," Section 2.2.3.6, provides information on linearity measurements, "Discussion of eoc Addressing," Section 2.2.4.1, is a discussion on embedded operations channel addressing, and "Supporting Information Relating to DC Metallic Termination," Section 2.2.4.2, gives supporting information relating to DC metallic termination. "Primary Constants of Typical Telephone Cable," Section 2.2.4.3, provides tables of primary constants for telephone cable. "Optional Powering across the Interface," Section 2.2.4.4, gives a description of a method of NT powering using pins of the interface connector.

2.2.1.3 Referenced Publications

The following is a list of referenced publications:

- *ANSI* T1.216-1990, ISDN Management - Basic Rate Physical Layer
- *ANSI* T1.601-1991, Integrated Services Digital Network (ISDN) - Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT (Layer 1 Specification)
- *ANSI* T1.605-1991, Integrated Services Digital Network (ISDN) - Basic Access Interface for S and T Reference Points (Layer 1 Specification)
- ITU-TS Recommendation G.960, Digital Section for ISDN Basic Rate Access
- ITU-TS Recommendation G.961, Digital Transmission System on Metallic Lines for ISDN Basic Rate Access
- ITU-TS Recommendation I.411, ISDN User-Network Interface Reference Configurations
- ITU-TS Recommendation I.412, ISDN User-Network Interfaces - Basic Interface Structure
- ITU-TS Recommendation I.430, Basic User-Network Interface - Layer 1 Specification
- ITU-TS Recommendation I.603, Application of Maintenance Principles to ISDN Basic Access
- ITU-TS Recommendations I, K, G, O, M Series
- Bellcore, Circuit-Switched Digital Capability Network Interface Specification, Appendix A, Cable Characteristics 1 Hz to 5 MHz, Issue 1, Piscataway, NJ; Bellcore; 1984, July
- Title 47, Code of Federal Regulations, section 68, Subpart F, Section 68.500 (b)
- International Standard for Information Processing Systems - Interface Connector and Contact Assignments for ISDN Basic Access Interface Located at Reference Points S and T, ISO 8877-1987

2.2.1.4 Definitions

ANSI: The domestic U-interface standard was produced for *ANSI* by the Accredited Standards Committee on Telecommunications, T1, which is sponsored by the Exchange Carriers Standards Association.

B-Channel: A 64-kbps channel that carries customer information such as voice calls, circuit-switched data, or packet-switched data.

Basic Access: A term used to describe a simple standardized combination of access channels that constitute the access arrangements for the majority of ISDN users; specifically, any of the following combinations of access channels:

- One D-channel
- One B-channel plus one D-channel
- Two B-channels plus one D-channel.

D-Channel: An access channel carrying control or signaling information and, optionally, packetized information and telemetry. When a part of basic access, the D-channel has a capacity of 16 kbps.

DSL: A technology that provides full-duplex service on a single twisted metallic pair at a rate sufficient to support ISDN basic access and additional framing, timing recovery, and operations functions. The physical termination of the DSL at the network end is the LT; the physical termination at the user end is the NT.

Echo Cancellation: A technique for implementing a DSL in which a record of the transmitted signal is used to remove echoes of this signal that may have mixed with and corrupted the received signal. (See "Transmission Method," Section 2.2.1.6 and Figure 2.2.1-2.)

ISDN: An ISDN provides a wide range of voice and nonvoice services within the same network using a limited set of connection types and multipurpose user-network interface arrangements. A variety of implementation configurations is supported, including circuit-switched, packet-switched, and nonswitched connections and their concatenations. New services are arranged to be compatible with 64-kbps switched digital connections. Service features, maintenance capabilities, and network management functions are provided through intelligence built into the network and compatible intelligence in the user terminals.

The ISDNs will evolve over one or more decades from the existing telephone network into comprehensive ISDNs by progressively incorporating additional functions to provide for both existing and new services. Until then, interworking arrangements will provide for the inclusion of other capabilities such as circuit switching and packet switching of data. During the transition, existing equipment such as digital transmission systems using techniques such as frequency-division multiplexing, time-division multiplexing, time-compression multiplexing, time-division multiplex switching, and space-division multiplex switching equipment will provide for the digital end-to-end connectivity of ISDNs. In the early stages of the evolution of ISDNs, some interim user-network arrangements may be needed to facilitate early penetration of digital service capabilities.

Interface Point: The location of the interface of the access line with respect to the NT is commonly called the U-interface, (see Figure 2.2.1-1). The location of the interface shall be on the customer's premises at a location mutually agreed upon by the service provider or administration and the customer.

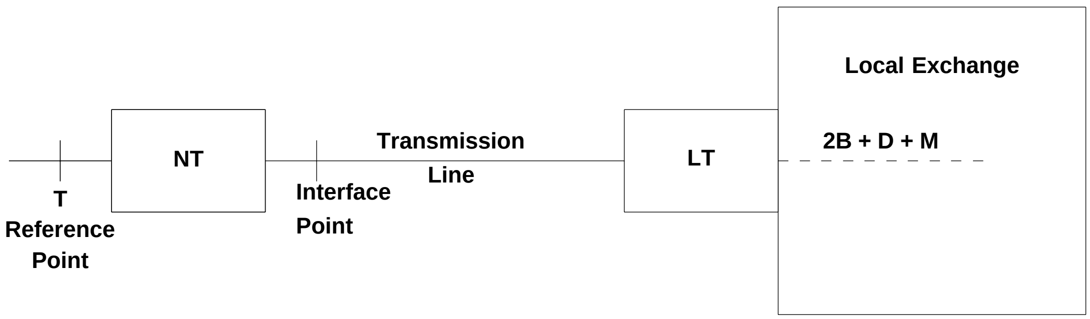


Figure 2.2.1-1 — Interface on the Network Side of the NT

International Telecommunications Union (ITU): The ITU is a specialized agency of the United Nations (since 1948) and is an international treaty organization. It traces its formal beginnings to 1865.

ITU-TS: The ITU-TS is one of seven ITU organizations. The ITU-TS has responsibility for standards work done in the ITU. The general purpose of the ITU-TS is to promote and ensure the operation of international telecommunications systems.

LT: Equipment that terminates the access line at the network end.

NT: The term NT is used in this section to refer to equipment that terminates the DSL on the customer side of the interface. The NT function may be in an NT1, an NT2, or a TE. An NT1 is a network termination of an access line that provides minimal physical layer functionality. An NT2 is a network termination with functionality that can include interfacing higher layer protocols. A TE is customer terminal equipment, for example, a computer terminal, and may include network termination functions.

Network or Network Side: The terms network and network side are used in this section to refer to the network side of the interface or the network functions as seen from the interface.

2.2.1.5 Physical Characteristics

2.2.1.5.1 Wiring Polarity Integrity

The NT shall not be dependent on a specific polarity for the two wires of the access line as the pair may be reversed.

2.2.1.5.2 Connector

For single mountings, the NT shall connect to the network through a miniature 8-position nonkeyed jack. The cord from the NT shall terminate in a miniature 8-position nonkeyed plug. For multiple mountings (and PBXs) other connection arrangements may be appropriate. Except for pin assignments, specifications for the 8-position plug and jack shall be as described in ISO Standard ISO 8877:1987. The jacks are equipped with the center two contacts (pins), which are used for the cable pair, commonly called tip (T) and ring (R). The terms tip and ring will not be used in this document where their use can be avoided because of the requirement given in "Wiring Polarity Integrity," Section 2.2.1.5.1. Table 2.2.1-1 gives the pin assignments for the 8-position jack and the 8-position plug.

Table 2.2.1-1 — Pin Assignments for 8-Position Jack and Plug

PIN NUMBER	FUNCTION	NOTES
1	Battery status	Optional battery status indication as described in Section 2.2.4.4.
2	Battery status	Optional battery status indication as described in Section 2.2.4.4.
3	No connection	Reserved for future specification.
4	Signal	Tip or Ring of pair to and from the network interface.
5	Signal	Tip or Ring of pair to and from the network interface.
6	No connection	Reserved for future specification.
7	Powering	Optional powering as described in Section 2.2.4.4.
8	Powering	Optional powering as described in Section 2.2.4.4.

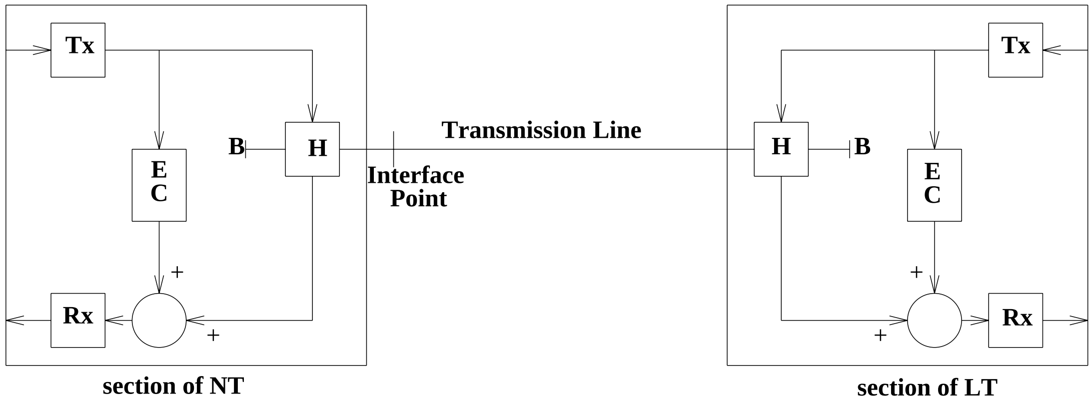
2.2.1.6 Transmission Method

2.2.1.6.1 Overview of Transmission System

The transmission system uses the echo canceler with hybrid (ECH) principle to provide full duplex operation over a 2-wire subscriber loop. With the ECH method, as illustrated in Figure 2.2.1-2, the echo canceler (EC) produces a replica of the echo of the near-end transmission, which is then subtracted from the total received signal.

The system is intended for service on twisted-pair cables, including about 99-percent coverage of the North American nonloaded loop population. This equates to operation over cables up to the limits of 18 kft (5.5km) 1,300-ohm resistance design, or about 42-dB loss at 40 kHz.

The foregoing is a general description that is not a specific performance requirement. For laboratory test requirements, see "Received Line Signal Characteristics," Section 2.2.1.6.4. Performance requirements for equipment and systems installed on actual loops are beyond the scope of this section.



B - Hybrid Balance Impedance
Tx - Transmitter
Rx - Receiver
EC - Echo Canceler
H - Hybrid
❍ - Subtractor

Figure 2.2.1-2 — Echo Canceler with Hybrid Principle

2.2.1.6.2 Line Code

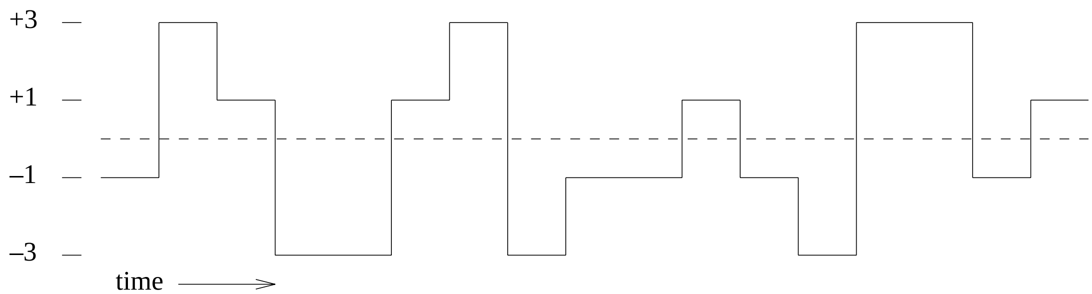
The line code shall be 2B1Q (2 bits mapped into one quaternary symbol). This is a 4-level pulse amplitude modulation (PAM) code without redundancy.

The user-data bit stream, comprised of two 64-kbps B-channels and a 16-kbps D-channel, entering the NT from the S/T interface (that is, entering the S/T interface toward the NT) and the equivalent bit stream on the network side shall be grouped into pairs of digits (bit fields) for conversion to quaternary symbols that in the sequel are also called quats. In each pair of bits so formed, the first bit is called the sign bit and the second is called the magnitude bit. Each successive pair of scrambled bits in the binary data stream is converted to a quaternary symbol to be output from the transmitter at the interface, as specified in the following:

First Bit (Sign)	Second Bit (Magnitude)	Quaternary Symbol (Quat)
1	0	+3
1	1	+1
0	1	−1
0	0	−3

The four values listed under "Quaternary Symbol" should be understood as symbol names, not numerical values.

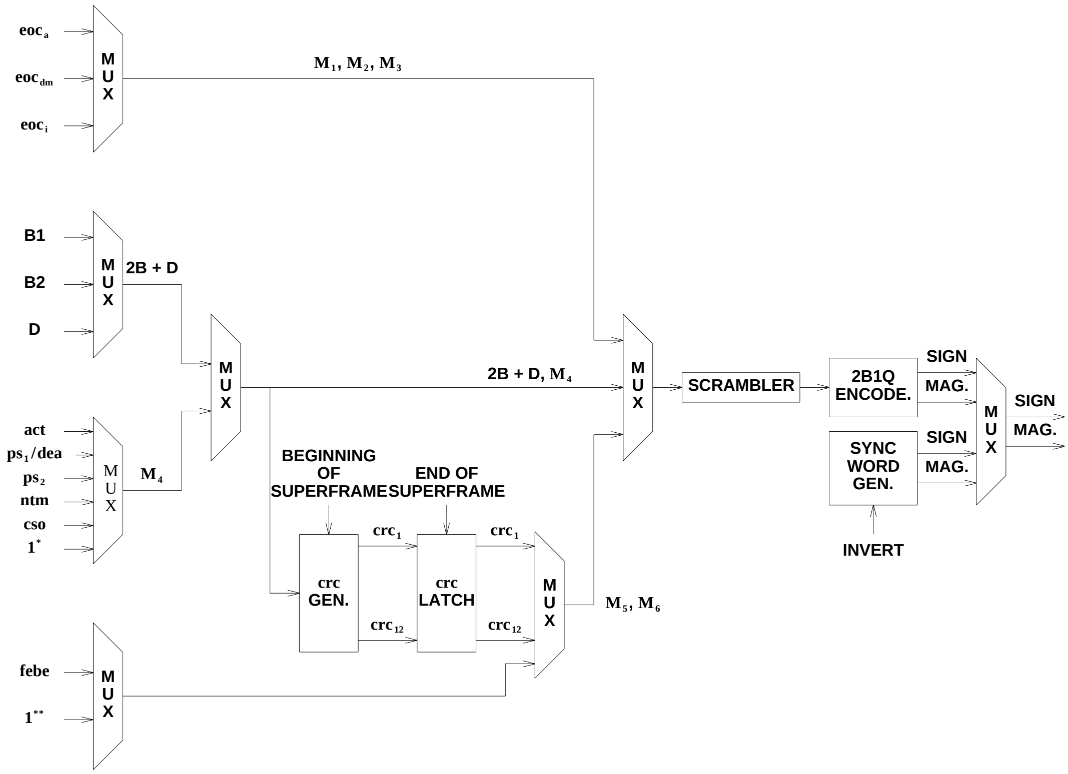
Figure 2.2.1-3 is an example of 2B1Q pulses over time. Square pulses are used for only the convenience of display and do not in any way represent the specified shape of real 2B1Q pulses (see "Pulse Shape," Section 2.2.1.6.3.2). Quat identifications and bit representations, after scrambling (see "Scrambling," Section 2.2.1.7.3), are given beneath the waveform. Time flows from left to right.



Quats	–1	+3	+1	–3	–3	+1	+3	–3	–1	–1	+1	–1	–3	+3	+3	–1	+1
Bits	0 1	1 0	1 1	0 0	0 0	1 1	1 0	0 0	0 1	0 1	1 1	0 1	0 0	1 0	1 0	0 1	1 1

Figure 2.2.1-3 — Example of 2B1Q Quaternary Symbols

The B- and D-channel bits are also scrambled before coding. M_1 through M_6 bits are also paired, scrambled, and coded in the same way. See "Frame Structure," Section 2.2.1.7.2, "Scrambling," Section 2.2.1.7.3, and Figure 2.2.1-4 for a functional description of the coding, framing, and scrambling operations of the transceiver.



* M 4 bits reserved for future specification (included in crc check).

** M 5 and M 6 bits reserved for future specification (excluded from crc check).

Figure 2.2.1-4 — DSL Framer Functional Description

Figure 2.2.1-5 shows the relationship of the bits in the B- and D-channels to quats.

At the receiver, each quaternary symbol is converted to a pair of bits by reversing the table in Figure 2.2.1-4, de-scrambled, and finally formed into a bit stream or bit streams (by reversing the relationship in Figure 2.2.1-4) representing B- and D-channels, and M-channel bits for maintenance and other purposes as described in "Functional Characteristics," Section 2.2.1.7, and "M-Channel Bit Functions," Section 2.2.3.1. The bits in the B- and D-channels are properly placed by reversing the relationship in Figure 2.2.1-5.

Time →

Data	B_1				B_2				D
Bit Pairs	$b_{11} b_{12}$	$b_{13} b_{14}$	$b_{15} b_{16}$	$b_{17} b_{18}$	$b_{21} b_{22}$	$b_{23} b_{24}$	$b_{25} b_{26}$	$b_{27} b_{28}$	$d_1 d_2$
Quat # (relative)	q_1	q_2	q_3	q_4	q_5	q_6	q_7	q_8	q_9
# Bits	8				8				2
# Quats	4				4				1

Where:

b_{11} = first bit of B_1 octet as received at the S/T interface
b_{18} = last bit of B_1 octet as received at the S/T interface
b_{21} = first bit of B_2 octet as received at the S/T interface
b_{28} = last bit of B_2 octet as received at the S/T interface
$d_1 d_2$ = consecutive D-channel bits (d_1 is first bit of pair as received at the S/T interface)
q_i = ith quat relative to start of given 18-bit 2B+D data field There are twelve 2B+D 18-bit fields per 1.5 msec basic frame.

Note: There are twelve 2B+D 18-bit fields per 1.5 msec basic frame.

Figure 2.2.1-5 — 2B1Q Encoding of 2B+D Bit Fields

2.2.1.6.3 Pulses Originating at the NT

2.2.1.6.3.1 Resistance Requirement

For measurement reference purposes, the termination impedance shall be 135 ohms resistive over a frequency band of 0 Hz to 160 kHz for all the requirements of this section.

2.2.1.6.3.2 Pulse Shape

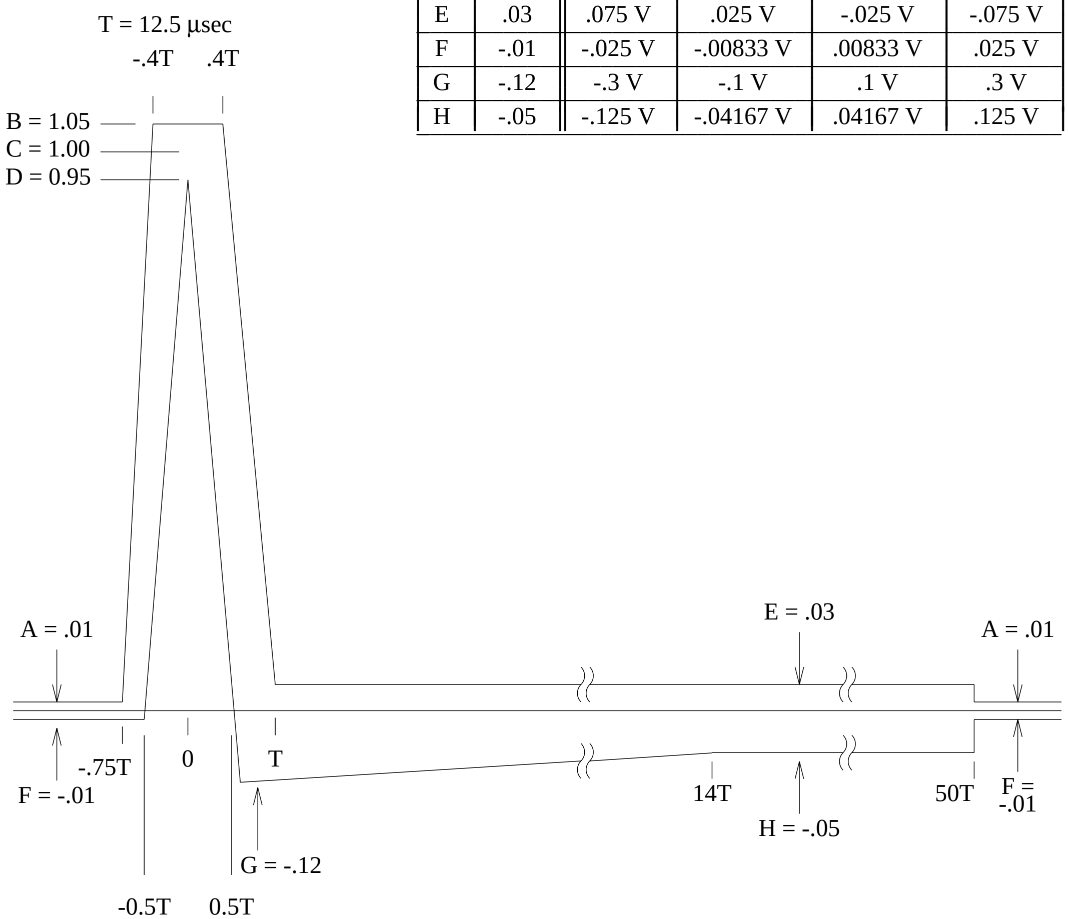
The transmitted pulse shall have the shape specified in Figure 2.2.1-6.

The pulse mask for the four quaternary symbols shall be obtained by multiplying the normalized pulse mask shown in Figure 2.2.1-6 by 2.5 V, 5/6 V, −5/6 V, or −2.5 V. When the signal consists of a framed sequence of symbols with a synchronization word as described in "Baud Rate, Timing, and Synchronization," Section 2.2.1.7.1, and equiprobable symbols in all other positions, the nominal average power is 13.5 dBm (see "Signal Power," Section 2.2.1.6.3.3).

Note 1: Any NT that uses only a 2.0 V line pulse may cause a range reduction on the order of 2 dB.

Note 2: In Figure 2.2.1-6, compliance of transmitted pulses within boundaries of the pulse mask is not sufficient to assure compliance with the power spectral density requirement and the absolute power requirement. Compliance with the requirements in "Power Spectral Density," Section 2.2.1.6.3.3.1, and "Total Power," Section 2.2.1.6.3.3.2, is also required.

Normalized Level:		Quaternary Symbols: +3	+1	-1	-3
A	.01	.025 V	.00833 V	-.00833 V	-.025 V
B	1.05	2.625 V	.8750 V	-.8750 V	-2.625 V
C	1.00	2.5 V	5/6 V	-5/6 V	-2.5 V
D	0.95	2.375 V	.79167 V	-.79167 V	-2.375V
E	.03	.075 V	.025 V	-.025 V	-.075 V
F	-.01	-.025 V	-.00833 V	.00833 V	.025 V
G	-.12	-.3 V	-.1 V	.1 V	.3 V
H	-.05	-.125 V	-.04167 V	.04167 V	.125 V



NOTE: Compliance of transmitted pulses within boundaries of the pulse mask is not sufficient to assure compliance with the power spectral density requirement and the absolute power requirement. Compliance with the requirements in Sections 2.2.1.6.3.3.1 and 2.2.1.6.3.3.2 is also required.

Figure 2.2.1-6 — Normalized Pulse from NT Appearing at Interface

2.2.1.6.3.3 Signal Power

2.2.1.6.3.3.1 Power Spectral Density

The upper bound of the power spectral density of the signal transmitted by the NT shall be as shown in Figure 2.2.1-7. Measurements to verify compliance with this requirement are to use a noise power bandwidth of 1.0 kHz.

2.2.1.6.3.3.2 Total Power

The average power of a signal consisting of a framed sequence of symbols with a synchronization word and equiprobable symbols at all other positions shall be between 13.0 dBm and 14.0 dBm over the frequency band from 0 Hz to 80 kHz. The nominal peak of the largest pulse shall be 2.5 volts (see "Pulse Shape," Section 2.2.1.6.3.2).

Note: Consistent with "Pulse Shape," Section 2.2.1.6.3.2, during an interim period, until 1992, a corresponding reduction in transmitted power (that is, with a nominal pulse peak of 2.0 V, the average power shall be between 11.1 and 12.1 dBm) will be acceptable.

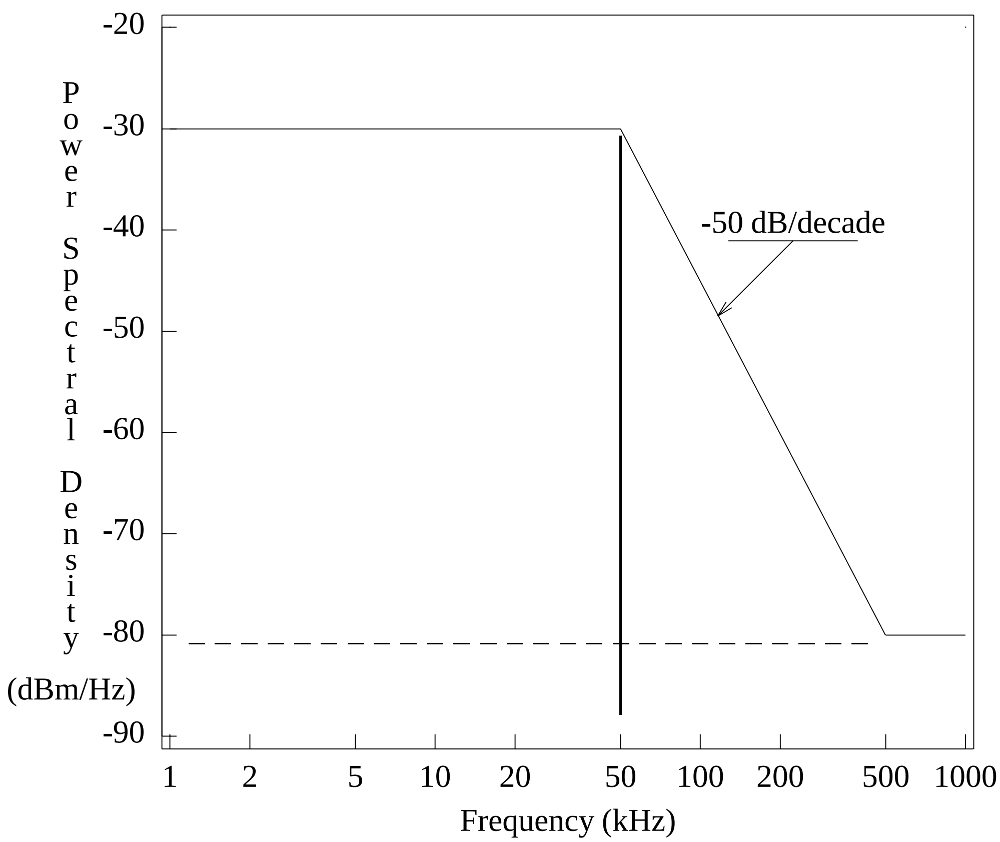


Figure 2.2.1-7 — Upper Bound of Power Spectral Density of Signal from NT at Interface

2.2.1.6.3.4 Transmitter Linearity

The pulses at the interface from the NT toward the network, corresponding to the symbol names +3, +1, −1, and −3, shall nominally all have the same shape and have the ratio 3 : 1 : −1 : −3. The pulses at the interface received from the network, though distorted by the transmission medium, shall have the same property, though this property is best checked at the source. Impairment resulting from deviations from this ratio is called nonlinearity. This nonlinearity is defined as the residual after subtracting a perfectly linear signal (a linearity standard) from the transmitter output line signal. The linear signal is constructed from the same random data as is input to the transmitter and processed through a linear filter. The parameters of the linear filter are first optimized to reduce the residual to a minimum. The test principles, hardware, and procedures are described further in "Linearity Measurement," Section 2.2.3.6.

The transmitted and received signals shall have sufficient linearity so that the residual rms signal is at least 36 dB below the rms signal at the interface. This requirement applies under all normal transceiver conditions and over the prescribed range of sealing current. (See "Sealing Current," Section 2.2.2.5.1.)

2.2.1.6.4 Received Line Signal Characteristics

When the pulses described in the preceding section are transmitted over the telephone plant, as defined in "Definition of Telephone Plant," Section 2.2.1.6.4.1, the NT shall receive any random sequences of these pulses with a bit error ratio (BER) of less than 10^{-7}, as described in the following paragraphs.

2.2.1.6.4.1 Definition of Telephone Plant

For the purpose of this section, the telephone loop plant is defined as a set of 16 loops, 1 being a null (0 length) loop, with crosstalk and other impairments as specified in this section and in "Test Procedure," Section 2.2.1.6.4.4. The makeups of the 15 nonnull loops and further information on the test loops may be found in "Test Loops and Performance Measurements," Section 2.2.3.3.

2.2.1.6.4.2 Performance Test Requirement

Satisfactory performance (BER < 10^{-7}) with sufficient margin (see "Margin," Section 2.2.1.6.4.3) is required when the NT is receiving a pseudo-random sequence of pulses attenuated and distorted as would result from transmission over each loop from a nominal source and with simulated crosstalk, and other impairments superimposed, and while transmitting a pseudo-random sequence. The added impairments are described specifically in "Test Procedure," Section 2.2.1.6.4.4, and "NT Input Signal Jitter Tolerance," Section 2.2.2.4.1. The following detailed description of the performance requirement in the presence of simulated crosstalk and other impairments is in terms of a laboratory test, though the test description is intended only to clarify the interface requirement.

2.2.1.6.4.3 Margin

Satisfactory performance shall be obtained, as described in "Test Procedure," Section 2.2.1.6.4.4, with a margin of at least 6 dB with the null loop and with test loops 4-15, listed in "Test Loops and Performance Measurements," Section 2.2.3.3. It is desirable to obtain satisfactory performance with a margin of at least 0 dB with test loops 1-3.

Note: Consistent with "Pulse Shape," Section 2.2.1.6.3.2, during an interim period until 1992, a corresponding reduction in margin is allowed for performance tests of transceivers receiving signals from transmitters with reduced nominal pulse amplitudes. For instance, when the transmitter has a 2.0-volt nominal pulse amplitude, the margin at the receiver on all 16 loops is reduced by 2 dB. The level of the simulated NEXT described in "Simulated Crosstalk," Section 2.2.1.6.4.4.1, applies to all transceivers.

2.2.1.6.4.4 Test Procedure

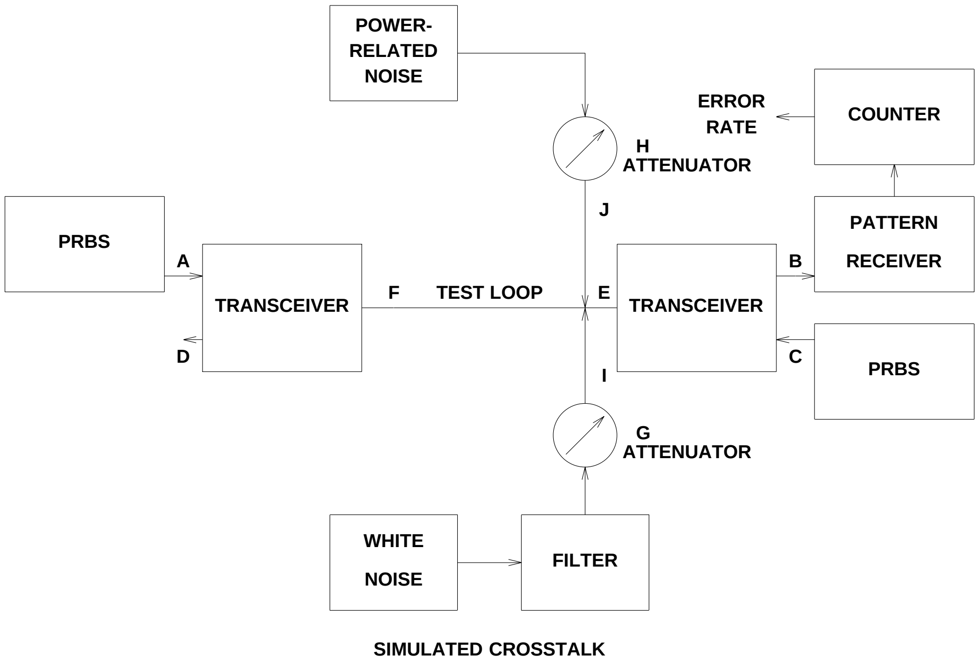
To perform the test, two transceivers are required, one for each end of the test loop, as shown in Figure 2.2.1-8. A pseudo-random binary source (PRBS) test signal (binary sequence) shall be applied at point A and received at point B. Another PRBS shall be applied at point C to create realistic echo conditions for the receiver at that end. No pattern receiver is required at point D because only one direction is under test at one time.

Point F shall be on a transceiver controlled by an independent external clock signal; point E shall be on a transceiver that derives timing from the received signal. When these tests are performed in a laboratory, the test loops are likely to be assembled from pairs on cable reels with both ends of the pair appearing in the same laboratory. The tests shall be performed with no connections other than the test loop between the two transceivers. The loops for testing received signal performance, numbered 1 through 15 in "Test Loops and Performance Measurements," Section 2.2.3.3, are individually inserted between points F and E in Figure 2.2.1-8. The test shall be repeated for each direction on each test loop; that is, point F (Figure 2.2.1-8) at the end labeled LT (see figures in "Notes on the Class of Test Loops," Section 2.2.3.3.1) and point E at the end labeled NT, and then again with point F at the end labeled NT and point E at the end labeled LT.

2.2.1.6.4.4.1 Simulated Crosstalk

2.2.1.6.4.4.1.1 Overview of Simulated Crosstalk

Simulated crosstalk is introduced at point E in Figure 2.2.1-8 by applying a calibrated filtered Gaussian random white noise source to the receiver input terminals. The source is frequency-shaped and its level set to simulate near end crosstalk (NEXT) from 49 disturbers in a binder group. The assumed power spectral density (PSD) of these disturbers is greater at high frequencies (above 50 kHz) than any 2B1Q signal that meets the specification. The details of the assumed PSD of the disturbers are discussed in "Test Loops and Performance Measurements," Section 2.2.3.3.



Key to Labels:

A	Far End Transceiver Binary Input
B	Near End Transceiver Binary Output
C	Near End Transceiver Binary Input
D	Far End Transceiver Binary Output
E	Near End Transceiver Interface (Noise Sum Point)
F	Far End Transceiver Interface (Not Under Test)
G	Attenuator for Calibration of Simulated NEXT
H	Attenuator for Calibration of Power-Related Noise
I	High-Impedance Coupling Circuit for Simulated NEXT
J	High-Impedance Coupling Circuit for Power-Related Noise

Figure 2.2.1-8 — Laboratory Test Setup for Measuring BER

After application of a simplified NEXT model to the assumed PSD of the disturbers, one obtains the PSD of the NEXT, as given in Figure 2.2.1-9 and as an equation for P_{NEXT}.

The equation and the figure are single-sided PSDs, meaning that the integral of P_{NEXT}, with respect to f, from 0 to ∞, gives the power in watts.

The simplified NEXT model has decreasing loss with a constant slope of 15 dB per decade of frequency, and 57-dB loss at 80 kHz.

Note that P_{NEXT} has a significant amount of power in its 160- to 320-kHz lobe, and continues to have significant power in successive lobes above that. However, as discussed in "Test Loops and Performance Measurements," Section 2.2.3.3, a bandlimiting filter may be used to sharply limit the PSD at frequencies above 320 kHz.

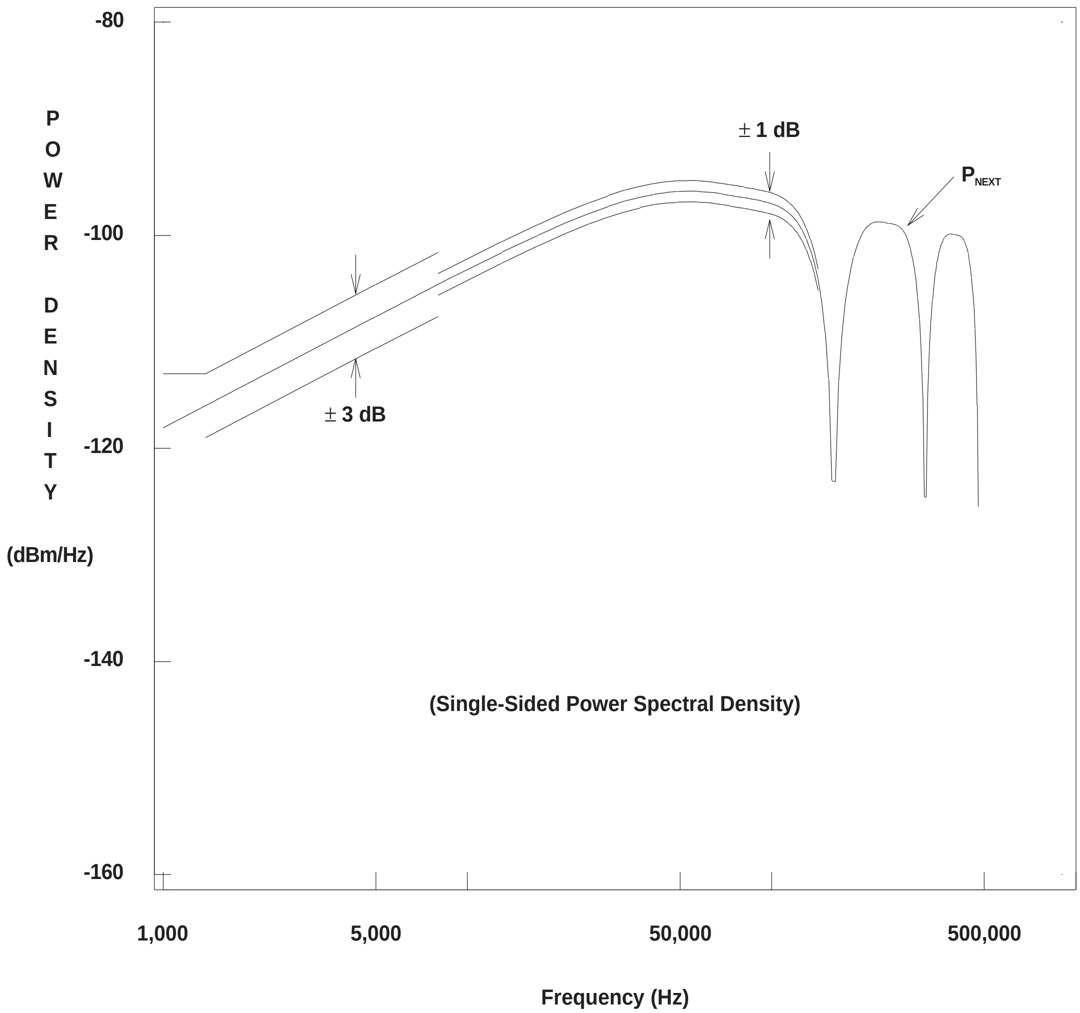
The simulated crosstalk shall be applied in such a way as to achieve the appropriate voltage level without disturbing the impedance of the cable or the transceiver. See note in "Margin," Section 2.2.1.6.4.3.

2.2.1.6.4.4.1.2 Calibration of Crosstalk Simulation Filter

To set the simulated NEXT at the reference level (also called the point of 0 margin) the simulated NEXT must have the power and power spectral density implied by the equation for P_{NEXT}. However, the accuracy obtained will depend on the design of the filter used to create the simulated crosstalk. The greatest accuracy is required at the highest points of the P_{NEXT} function. In the band 0 to 320 kHz, the highest point is at approximately 50 kHz, and a second peak occurs at approximately 220 kHz. The value of P_{NEXT} is approximately -95.9 dBm/Hz at 50 kHz. The accuracy of the PSD obtained must be ± 1 dB at all values of PSD between the peak, -95.9 dBm/Hz, and -106 dBm/Hz. This is the case approximately over the two frequency ranges 8 to 145 kHz, and 175 to 300 kHz. Elsewhere, the accuracy shall be ± 3 dB. At the notches (0 kHz, 160 kHz, and 320 kHz) the upper bound never goes below -113 dBm/Hz, and the lower bound is absent in the same frequency ranges. Some of the tolerance limits are plotted in Figure 2.2.1-9 in order to illustrate the tolerance requirements. To allow for the bandlimiting filter, there is no lower bound at frequencies higher than 270 kHz.

The integral of the P_{NEXT} function over the limits 0 to 320 kHz is -44.2 dBm. However, the total power in the simulated crosstalk should take into account the effects of the bandlimiting filter. The theoretical value of the total simulated NEXT power should be recomputed after P_{NEXT} is multiplied by the transfer function of the bandlimiting filter used.

The total power of the simulated NEXT shall be within ± 0.1 dB of the theoretical value computed as indicated.



$$P_{NEXT} = \left[K \times \frac{1}{f_o} \times \frac{\left[\sin\left(\frac{\pi f}{f_o}\right)\right]^2}{\left(\frac{\pi f}{f_o}\right)^2} + K \times \frac{2}{2f_o} \times \frac{\left[\sin\left(\frac{\pi f}{2f_o}\right)\right]^2}{\left(\frac{\pi f}{2f_o}\right)^2}\right] \times \frac{f^{\frac{3}{2}}}{1.134 \times 10^{13}}$$

where

f = frequency in Hz

$f_o = 80{,}000$ Hz

$K = \frac{5}{9} \times \frac{V_p{}^2}{R}$

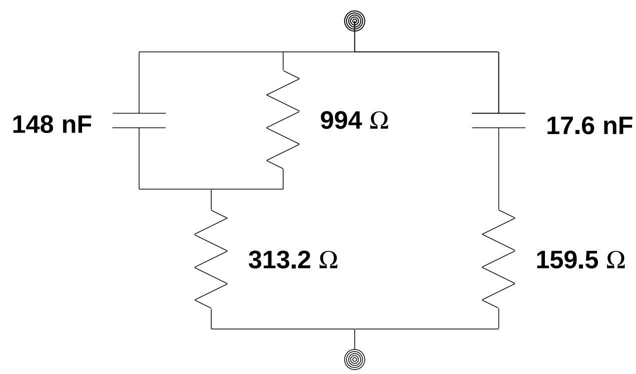
$V_p = 2.33$ volts

$R = 135$ ohms.

Figure 2.2.1-9 — PSD for Simulated Near-End Crosstalk (NEXT) for Testing 2B1Q System

2.2.1.6.4.4.1.3 Measurement of Simulated NEXT Power and PSD

The PSD of the simulated NEXT, and its average power, shall be measured at the output of a voltage source of between 4,000 and 6,000 ohms Thevenin impedance, terminated in a load consisting of a parallel combination of 135 ohms and Z_c, the network shown in Figure 2.2.1-10. The power dissipated in the 135-ohm resistor represents the power at the receiver input; thus, the NEXT power is the power dissipated in this resistor. Z_c is a complex load, and the calibration mechanism must ensure that the required simulated crosstalk PSD, P_{NEXT}, is coupled into the 135-ohm resistor within limits specified in Figure 2.2.1-9.



Note: **Component tolerances ± 1%**

Figure 2.2.1-10 — Crosstalk Calibration Impedance, Z_c

2.2.1.6.4.4.2 Longitudinal Noise

Noise simulating longitudinal power line induction (60 Hz and associated harmonics) shall also be introduced at point E (Figure 2.2.1-8). The method of introducing the longitudinal noise, and the amplitude and waveform of the induced signal shall be as follows:

1. For the loop under test (for example, one of the test loops) use an induction-type neutralizing transformer to inductively couple longitudinal voltage/current to the loop. To metallic signals, the transformer looks like a few hundred feet of cable. The loop make-up should be maintained by accounting for the length and gauge characteristic of that particular transformer. Insert the neutralizing transformer at 40 percent to 60 percent (nominal 50 percent of the distance from the network side). (The end labeled LT in the figures in "Notes on the Class of Test Loops," Section 2.2.3.3.1.)
2. Use a sawtooth longitudinal voltage waveform because it has a harmonic content similar to power line induction. See Figure 2.2.1-11. The applied voltage should be 50 volts RMS. Average value (DC) and even harmonics are negligible.
3. If desired, the test may be run with a low-impedance longitudinal termination on the network side. (The end labeled LT in the figures in "Notes on the Class of Test Loops," Section 2.2.3.3.1.) For that case, the longitudinal termination shall be adjusted so that the longitudinal current in the termination is between 3.6 and 4 mA RMS.

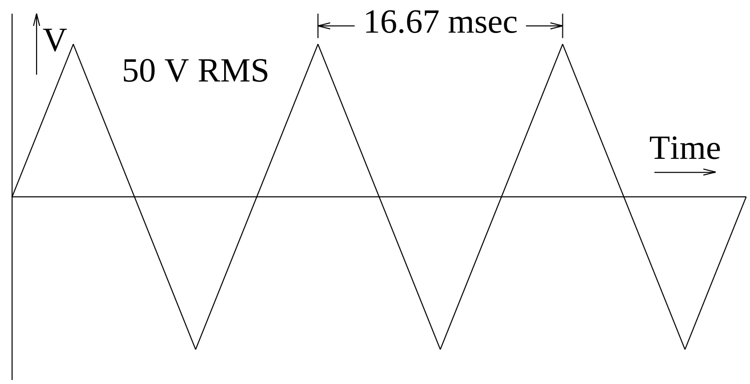


Figure 2.2.1-11 — Waveform for Longitudinal Noise

2.2.1.6.4.4.3 Power-Related Metallic Noise

Noise simulating power line induction (60 Hz and associated harmonics) shall also be introduced at point E (Figure 2.2.1-8). The noise will consist of any two of the harmonics at the power level indicated. The harmonics shall be coupled to the line through a high-impedance coupling circuit (J in Figure 2.2.1-8) and the power measured by the same technique indicated in "Measurement of Simulated NEXT Power and PSD," Section 2.2.1.6.4.4.1.3. The noise test shall be conducted with all combinations of two of the harmonics listed in the following table at the power level indicated.

Frequency (Hz)	Tone Power (dBm into 135 ohms)
60	-47
180	-49
300	-59
420	-65
540	-70
660	-74

2.2.1.6.4.4.4 Procedure

The BER measurements may be performed on one or more subchannels (for example, B, 2B, or 2B+D). The B- or D-channels not used for BER measurements shall also be driven by a PRBS. The averaging time for determination of error rate shall be at least 10 minutes when the bit stream under test is 144 kbps, at least 13 minutes when the bit stream is 128 kbps, and at least 25 minutes when the bit stream under test is only 64 kbps.

For each test loop, and for each direction of transmission, the measurement procedure shall be as follows:

BER is tested with noise applied at point E. The noise applied at point E includes simulated NEXT (see "Simulated Crosstalk," Section 2.2.1.6.4.4.1), longitudinally induced voltage (see "Longitudinal Noise," Section 2.2.1.6.4.4.2), and power-line-related noise (see "Power-Related Metallic Noise," Section 2.2.1.6.4.4.3). Jitter, as specified in "NT Input Signal Jitter Tolerance," Section 2.2.2.4.1, also must be present. The attenuator G in Figure 2.2.1-8 shall be set so that the power spectral density of the resulting simulated NEXT on the line is greater, by a margin specified in "Margin," Section 2.2.1.6.4.3, than the calculated power spectral density P_{NEXT}.

2.2.1.7 Functional Characteristics

2.2.1.7.1 Baud Rate, Timing, and Synchronization

The NT shall operate, as required, with the received signal baud rate in the range of 80 kbaud ±5 ppm.

The digital subscriber line shall operate in a master-slave mode with the NT slaved to the signal received from the network; that is, the signals transmitted from the NT toward the network shall be synchronized to a clock that is synchronized to the received signal.

Note: NT implementations intended for other applications in addition to providing network access; such as behind an NT2; for example, PBX; or other piece of network equipment operating in stand-alone mode; should be designed to operate with a received signal having a tolerance as large as ±32 ppm.

2.2.1.7.2 Frame Structure

2.2.1.7.2.1 Overview of Frame Structure

The information flow across the interface point shall utilize frames and superframes as shown in Figures 2.2.1-12, 2.2.1-13, and 2.2.1-14.

As shown in Figure 2.2.1-12, a frame shall be 120 quaternary symbols. The nominal time for the frame is 1.5 msec.

A functional description of the framing process is shown in Figure 2.2.1-4.

	← 1.5 milliseconds →		
FRAME	**SW/ISW**	**12 × (2B+D)**	**M**
Function	**Sync Word**	**2B+D**	**''Overhead''**
# Quats	9	108	3
Quat Positions	1-9	10-117	118-120
# Bits	18	216	6
Bit Positions	1-18	19-234	235-240

Frames in the NT-to-Network direction are offset from frames in the Network-to-NT direction by 60 ± 2 quats

Symbols & Abbreviations:

quat	= quaternary symbol = 1 baud
− 3, − 1, + 1, + 3	= symbol names
2B+D	= Customer data channels B_1, B_2, and D
SW	= Synchronization Word (9-Symbol Code)
	= +3 +3 −3 −3 −3 +3 −3 +3 +3
ISW	= Inverted (or complementary) Sync Word
	= −3 −3 +3 +3 +3 −3 +3 −3 −3
M	= M-Channel Bits, M_1-M_6

Figure 2.2.1-12 — ISDN Basic Access 2B1Q DSL 1.5-Millisecond Basic Frame

2.2.1.7.2.2 Synchronization Word

The first nine symbols of the frame shall be a synchronization word (SW), with the quaternary symbols in the following sequence, except as noted in "Superframes," Section 2.2.1.7.2.6:

SW = +3 +3 −3 −3 −3 +3 −3 +3 +3

2.2.1.7.2.3 User Data (2B+D)

Following the synchronization word, the next 108 quaternary symbols in the frame shall be as shown in Figure 2.2.1-3. Each frame includes 12 groups of 2B+D user data. Each 2B+D group of user data includes 18 bits (9 symbols). Except during start-up, the channels shall be transparent to user data bits (see "Transparency," Section 2.2.1.7.4.7.6). When one or more B- or D- channels are not in use in either direction, the time slots allocated to the channel(s) shall contain idle code as specified in "Start-Up and Control," Section 2.2.1.7.4, and "Baud Rate, Timing, and Synchronization," Section 2.2.1.7.1. This idle code is generated by a layer higher than Layer 1.

2.2.1.7.2.4 M-Channel

The last three symbols (6 bits) form a 4-kbps M channel for maintenance and other purposes (see Figures 2.2.1-13 and 2.2.1-14).

2.2.1.7.2.5 Frame Offset

Received and transmitted frames at the NT shall be offset by 60±2 quaternary symbols (that is, about 0.75 msec), as shown in Figure 2.2.1-15.

		FRAMING	2B+D	Overhead Bits (M_1-M_6)					
	Quat Positions	1-9	10-117	118s	118m	119s	119m	120s	120m
	Bit Positions	1-18	19-234	235	236	237	238	239	240
Super Frame #	Basic Frame #	Sync Word	2B+D	M_1	M_2	M_3	M_4	M_5	M_6
A	1	ISW	2B+D	eoc_{a1}	eoc_{a2}	eoc_{a3}	act	1	1
	2	SW	2B+D	eoc_{dm}	eoc_{i1}	eoc_{i2}	dea	1	febe
	3	SW	2B+D	eoc_{i3}	eoc_{i4}	eoc_{i5}	1	crc_1	crc_2
	4	SW	2B+D	eoc_{i6}	eoc_{i7}	eoc_{i8}	1	crc_3	crc_4
	5	SW	2B+D	eoc_{a1}	eoc_{a2}	eoc_{a3}	1	crc_5	crc_6
	6	SW	2B+D	eoc_{dm}	eoc_{i1}	eoc_{i2}	1	crc_7	crc_8
	7	SW	2B+D	eoc_{i3}	eoc_{i4}	eoc_{i5}	uoa	crc_9	crc_{10}
	8	SW	2B+D	eoc_{i6}	eoc_{i7}	eoc_{i8}	aib	crc_{11}	crc_{12}
B, C, ...									

NT-to-Network superframe delay offset from Network-to-NT superframe by 60±2 quats (about 0.75 ms).
All bits other than the Sync Word are scrambled.

Symbols & Abbreviations:

"1" = reserved bit for future specification (set = 1)
eoc = embedded operations channel
a = address bit
dm = data/message indicator (0 = data, 1 = message)
i = information (data or message)
SW = synchronization word
ISW = inverted synchronization word
aib = alarm indication bit (set = 1 during start-up)
quat = pair of bits forming quaternary symbol
s = sign bit (first in quat)
m = magnitude bit (second in quat)

act = start-up bit (set = 1 during start-up)
crc = cyclic redundancy check: covers 2B+D & M_4
1 = most significant bit
2 = next most significant bit
etc.
febe = far end block error bit (set = 0 for errored superframe)
dea = turn-off bit (set = 0 to announce turn-off)
uoa = U-only-activation bit (optional, set = 1 to activate S/T)
2B+D = user data, bits 19-234 in frame
M = M channel, bits 235-240 in frame

NOTE: 8 x 1.5 msec Basic Frames ⇒ 12 msec Superframe

Figure 2.2.1-13 — Network-to-NT 2B1Q Superframe Technique & Overhead Bit Assignments

		FRAMING	2B+D	Overhead Bits (M_1-M_6)					
	Quat Positions	1-9	10-117	118s	118m	119s	119m	120s	120m
	Bit Positions	1-18	19-234	235	236	237	238	239	240
Super Frame #	Basic Frame #	Sync Word	2B+D	M_1	M_2	M_3	M_4	M_5	M_6
1	1	ISW	2B+D	eoc$_{a1}$	eoc$_{a2}$	eoc$_{a3}$	act	1	1
	2	SW	2B+D	eoc$_{dm}$	eoc$_{i1}$	eoc$_{i2}$	ps$_1$	1	febe
	3	SW	2B+D	eoc$_{i3}$	eoc$_{i4}$	eoc$_{i5}$	ps$_2$	crc$_1$	crc$_2$
	4	SW	2B+D	eoc$_{i6}$	eoc$_{i7}$	eoc$_{i8}$	ntm	crc$_3$	crc$_4$
	5	SW	2B+D	eoc$_{a1}$	eoc$_{a2}$	eoc$_{a3}$	cso	crc$_5$	crc$_6$
	6	SW	2B+D	eoc$_{dm}$	eoc$_{i1}$	eoc$_{i2}$	1	crc$_7$	crc$_8$
	7	SW	2B+D	eoc$_{i3}$	eoc$_{i4}$	eoc$_{i5}$	sai	crc$_9$	crc$_{10}$
	8	SW	2B+D	eoc$_{i6}$	eoc$_{i7}$	eoc$_{i8}$	1^*	crc$_{11}$	crc$_{12}$
2, 3, ...									

**NT-to-Network superframe delay offset from Network-to-NT superframe by 60±2 quats (about 0.75 ms).
All bits other than the Synch Word are scrambled.**

Symbols & Abbreviations:

"1" = reserved bit for future specification (set = 1)
"1^*" = network indicator bit
(reserved for network use, set = 1)
eoc = embedded operations channel
a = address bit
dm = data/message indicator (0 = data, 1 = message)
i = information (data or message)
SW = synchronization word
ISW = inverted synchronization word
quat = pair of bits forming quaternary symbol
s = sign bit (first in quat)
m = magnitude bit (second in quat)
sai = S-activation-indication bit
(optional, set = 1 for S/T activity)

act = start-up bit (set = 1 during start-up)
ps$_1$, ps$_2$ = power status bits (set = 0 to indicate power problems)
ntm = NT in Test Mode bit (set = 0 to indicate test mode)
cso = cold-start-only bit (set = 1 to indicate cold-start-only)
crc = cyclic redundancy check: covers 2B+D & M_4
1 = most significant bit
2 = next most significant bit
etc.
febe = far end block error bit (set = 0 for errored superframe)
2B+D = user data, bits 19-234 in frame
M = M channel, bits 235-240 in frame

NOTE: 8 x 1.5 msec Basic Frames ⇒ 12 msec Superframe

Figure 2.2.1-14 — NT-to-Network 2B1Q Superframe Technique & Overhead Bit Assignments

2.2.1.7.2.6 Superframes

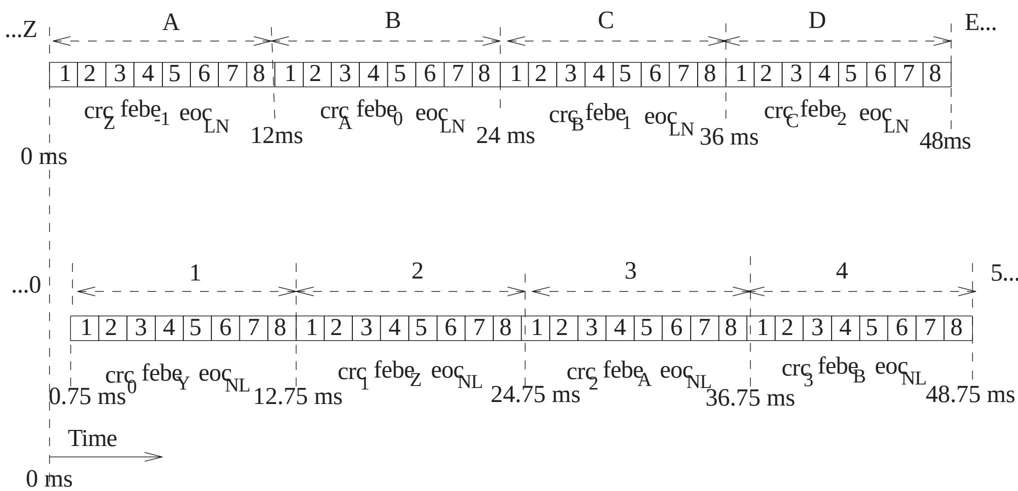
Frames shall be organized into superframes, as shown in Figures 2.2.1-13 and 2.2.1-14. Eight frames (12 msec) shall constitute a superframe. The first frame in the superframe shall be identified by inverting the polarity of the synchronization word (SW) in this frame. The inverted synchronization word is abbreviated ISW:

ISW = −3 −3 +3 +3 +3 −3 +3 −3 −3

The first frame in the superframe of the signal transmitted from the NT shall be the next frame following the first frame in the superframe of the signal received from the network. See "Frame Offset," Section 2.2.1.7.2.5, and Figure 2.2.1-15 for specific alignment of transmitted and received frames.

The 48 M bits in the superframe shall be assigned as indicated in Figures 2.2.1-13 and 2.2.1-14, and as summarized here:

eoc	24 bits - Embedded operations channel (both directions)
crc	12 bits - Cyclic redundancy check (both directions)
febe	1 bit - Far end block error (both directions)
dea	1 bit - Turn-off (network to NT)
act	1 bit - Start-up (both directions)
$ps_{1,2}$	2 bits - Power status (NT to network)
ntm	1 bit - NT in test mode (NT to network)
cso	1 bit - Cold start only (NT to network)
uoa	1 bit - U-interface-only activation (network to NT)
sai	1 bit - S/T-interface activity indicator (NT to network)
aib	1 bit - Alarm indicator bit (network to NT)
1^*	1 bit - Network indicator bit (NT to network, reserved for network use)
1	4 bits - NT to network (reserved for future specification)
1	7 bits - Network to NT (reserved for future specification)



Where:

..., Y, Z, A, B, C, ... = Network-to-NT Superframes
..., -1, 0, 1, 2, 3, ... = NT-to-Network Superframes
[i] = ith 1.5 ms Basic Frame in given Superframe
crc_γ = Cyclic Redundancy Check Code for Superframe γ
$febe_\delta$ = Far End Block Error Bit for Superframe δ
eoc_{ij} = Embedded Operations Channel
ij = LN = Network-to-NT direction
or
= NL = NT-to-Network direction

Figure 2.2.1-15 — DSL Framing and Overhead Function Temporal Relationships

2.2.1.7.3 Scrambling

The data stream in each direction shall be scrambled with a 23rd-order polynomial (see Figures 2.2.1-4 and 2.2.1-16) prior to the insertion of SW.

The polynomial shall be as shown in Equation 2.2.1-1. In the network-NT direction the polynomial shall be:

Exhibit 2.2.1-1 — 23rd-order Polynomial

$1 \oplus x^{-5} \oplus x^{-23}$

where:
$\oplus$ = modulo 2 summation.

In the NT-network direction the polynomial shall be:

$1 \oplus x^{-18} \oplus x^{-23}$

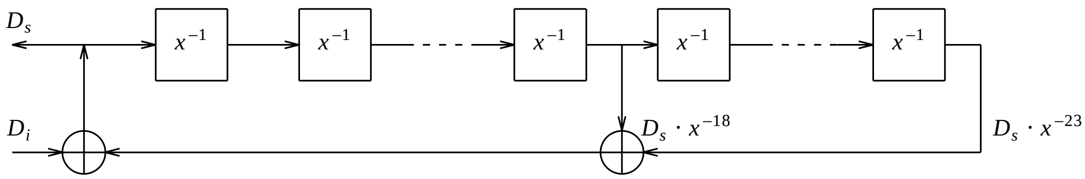
where:
$\oplus$ = modulo 2 summation.

The binary data stream shall be recovered in the receiver by applying the same polynomial to the scrambled data as was used in the transmitter.

Note 1: Binary ONEs and ZEROs entering the NT transceiver from the S/T interface or entering the network side transceiver from the network must appear as binary ONEs and ZEROs, respectively, at the input of the scrambler. Also, during transmission/reception of the synchronization word or inverted synchronization word, the state of the scrambler must remain unchanged.

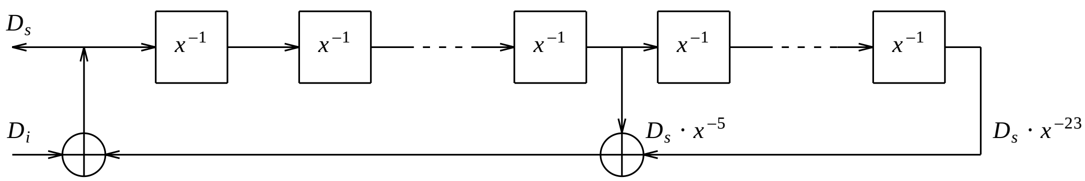
Note 2: It is common for the input bits to be all binary ONEs, for example during idle periods or during start-up. For the binary ONEs to become scrambled, the initial state of the scrambling shift register must not be all binary ONEs.

NT Transmit Scrambler (NT to LT):



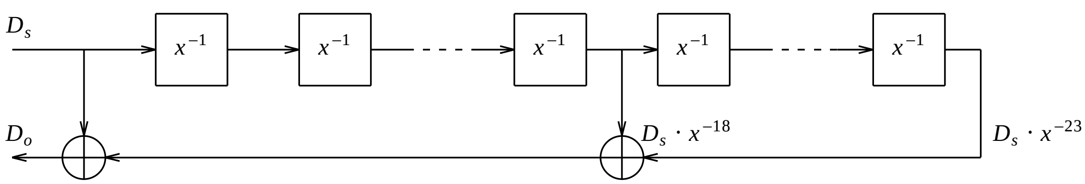
$$D_s = D_i \oplus D_s \cdot x^{-18} \oplus D_s \cdot x^{-23}$$

LT Transmit Scrambler (LT to NT):



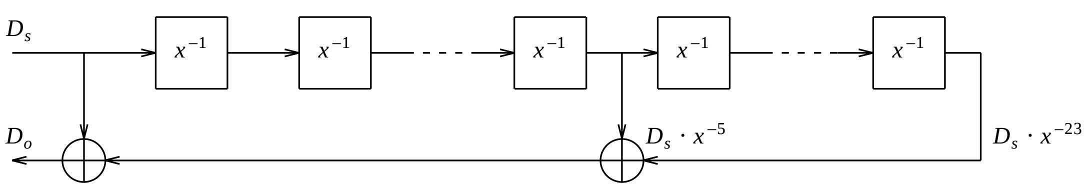
$$D_s = D_i \oplus D_s \cdot x^{-5} \oplus D_s \cdot x^{-23}$$

LT Receive Descrambler (NT to LT):



$$D_o = D_s \cdot (1 \oplus x^{-18} \oplus x^{-23})$$

NT Receive Descrambler (LT to NT):



$$D_o = D_s \cdot (1 \oplus x^{-5} \oplus x^{-23})$$

Figure 2.2.1-16 — Scrambler and De-scrambler

2.2.1.7.4 Start-Up and Control

2.2.1.7.4.1 Overview of Start-Up and Control

The current software release is designed to accommodate a basic access U-interface that remains active at all times. All start-up attempts are assumed to occur under cold-start conditions. NTs that have transceivers with the optional warm-start capabilities will operate appropriately and will meet the cold-start activation time requirements.

The master-slave mode described in "Baud Rate, Timing, and Synchronization," Section 2.2.1.7.1, does not apply immediately after connecting the transmission line to the NT and/or turning on its power. This happens at the time of installation, following power failures, or after temporarily disconnecting the NT or temporarily switching off its power. In these situations, the network may begin a start-up sequence in order to achieve the master-slave mode. The NT is responsible for initiating the start-up sequence upon power-up or upon a request for service from the customer terminal (TE).

Also, for NTs that have the optional warm-start capability, master-slave mode does not apply until start-up has been requested and synchronization achieved.

While the system is not in master-slave mode, that is, during the start-up sequence or while in the RESET or RECEIVE RESET state, the transmission is not transparent to user data (B_1-, B_2-, or D-channel bits); the signals that are present at the interface are generated by the network and the NT transceivers.

2.2.1.7.4.2 Definitions

The following definitions are for the purpose of clarifying requirements.

2.2.1.7.4.2.1 Total Activation

The phrase "total activation" is used in this section to describe a process that includes the start-up process as described here for this interface (see "Start-Up," Section 2.2.1.7.4.2.2) and activation of the S/T-interface as described in *ANSI* Standard T1.605-1991.

2.2.1.7.4.2.2 Start-Up

Start-up is a process characterized at the interface by a sequence of signals produced by the network and by the NT. Start-up results in establishment of the training of equalizers and echo cancelers to the point that two-way transmission requirements are met.

2.2.1.7.4.2.3 Warm Start

Warm start is the start-up process that applies to transceivers meeting the start-up time requirements for the warm-start option. Qualifying transceivers have been synchronized once and have subsequently responded to a turn-off announcement. Warm start applies only if there have been no changes in line characteristics and equipment. Transceivers that meet warm-start requirements are called warm-start transceivers.

2.2.1.7.4.2.4 Cold Start

Cold start is the start-up process that applies to transceivers that either do not meet start-up time requirements for the warm-start option, or have not been continuously in a RESET state that resulted from a turn-off announcement to the NT. Cold start also applies if there have been changes in line characteristics or equipment, or both. A cold start shall always start from the RESET state.

2.2.1.7.4.2.5 Cold-Start-Only

Transceivers that do not meet start-up time requirements (see "Start-Up Time Requirements," Section 2.2.1.7.4.8) for the warm-start option are called cold-start-only transceivers.

2.2.1.7.4.2.6 Full Operational Status

Full operational status of the transceiver means that it has: (1) acquired bit timing (for NT), bit timing phase (for LT), and frame synchronization from the incoming signal from the other transceiver, (2) recognized the incoming superframe marker, and (3) fully converged both echo canceler and equalizer coefficients.

2.2.1.7.4.2.7 Total Deactivation

The phrase "total deactivation" is used in this specification to describe a process that includes the turn-off process as described here for this interface (see "Turn-Off," Section 2.2.1.7.4.2.8) and deactivation of the S/T interface as described in *ANSI* Standard T1.605-1991.

2.2.1.7.4.2.8 Turn-off

Turn-off is the process by which a pair of fully operational transceivers transition to the RESET state.

2.2.1.7.4.2.9 Transparency

The word transparency is used in this specification to mean that the B_1, B_2, or D-channel (2B+D) bits received by the transceiver on the interface are passed to the TE at the NT and to the network at the LT. Likewise, when a transceiver is transparent, 2B+D bits sent to the transceiver at the LT from within the network or at the NT from the TE are transmitted on the interface. Conversely, when a transceiver is not transparent, 2B+D bits received on the interface are not passed along to the TE at the NT or to the network at the LT. Likewise, when a transceiver is not transparent, 2B+D bits from within the network at the LT or from the TE at the NT are not transmitted on the interface. Transparency applies separately to each transceiver. Conditions for transparency are discussed in "Transparency," Section 2.2.1.7.4.7.6.

2.2.1.7.4.3 Reset

2.2.1.7.4.3.1 Introduction

The RESET state consists of two substates: the RECEIVE RESET and the FULL RESET states. In other sections of this section, the term RESET is used to refer to the FULL RESET state.

RESET has no implications about the state of convergence of the equalizer or echo canceler coefficients of the transceiver. The RESET states are applicable to cold-start-only as well as warm-start transceivers.

For specific transceiver implementations, RESET states (or substates) may mean different and possibly multiple internal states.

2.2.1.7.4.3.2 Full Reset

The FULL RESET state is one in which a transceiver has detected the loss of signal from the far-end and is not transmitting (sending signal to the loop).

The FULL RESET state shall also be entered following power-up.

Because the time for a cold start may be longer than desirable for normal operation (call origination), start-up shall be attempted upon NT power-up. After an unsuccessful start-up attempt, the NT DSL transmitter may re-enter FULL RESET.

While in FULL RESET, NTs shall initiate transmission if responding to a new power off/on cycle or to a new request for service from the customer terminal (TE). Under all other conditions, where the transceivers have been turned off (see "Turn-Off Procedure," Section 2.2.1.7.4.7.5), the NTs shall remain quiet, that is, NTs shall not start transmitting any signal until the NT has received the TL signal (start-up tone) from the network.

2.2.1.7.4.3.3 Receive Reset

The RECEIVE RESET state is a transient state in which an NT (or a network side transceiver) has detected the loss of signal from the far-end and is not transmitting (sending signal to the loop). In addition, the transceiver is not permitted to initiate the start-up sequence (send wake-up tone) but shall be capable of responding to the start-up sequence (detecting wake-up tone). An NT (or a network side transceiver) must remain in this state for at least 40 msec after detecting the loss of received signal, as specified in "Timers," Section 2.2.1.7.4.4, and "Turn-Off Procedure," Section 2.2.1.7.4.7.5, after which time the transceiver shall enter the FULL RESET state.

2.2.1.7.4.4 Timers

Timers shall be used to determine entry into the RESET states. Upon the occurrence of any of the following conditions:

- Failure to complete start-up within 15 seconds (warm or cold start)
- Loss of received signal for more than 480 msec.
- Loss of synchronization for more than 480 msec.

A transceiver shall cease transmission and, as specified in "Receive Reset," Section 2.2.1.7.4.3.3, enter the RECEIVE RESET state and remain for at least 40 msec (unless it responds to a wake-up tone), after which it shall enter the FULL RESET state. The manner of entering the RECEIVE RESET state is different for different conditions.

For conditions (1) or (3), it shall cease transmission and then, upon the subsequent detection of the loss of received signal, the transceiver shall enter the RECEIVE RESET state. Its response time to a loss of signal (after conditions (1) or (3) have been satisfied) shall be such that it shall enter the RECEIVE RESET state (and be capable of responding to the initiation of wake-up tone by the far-end transceiver) within 40 msec after the far end transceiver ceases transmission.

For condition (2), the transceiver shall immediately enter the RECEIVE RESET state.

For conditions (2) or (3), these requirements apply to transceivers after superframe synchronization is achieved (see T6 and T7 in Table 2.2.1-2 and Figure 2.2.1-17).

In addition, an NT shall enter the FULL RESET state if signal is not received within 480 msec after it ceases the transmission of TN (or SN1 if it is sent - see T2 to T3 in Table 2.2.1-2 and Figure 2.2.1-17).

An approach to the use of timers in DSL transceivers is found in "DSL Start-up and Activation," Section 2.2.3.5.

2.2.1.7.4.5 Signals During Start-Up

Table 2.2.1-2 defines the signals produced by the transceivers during start-up. These signals apply during both types of start-up (cold start and warm start). During start-up, all signals at the interface shall consist of sequences of symbols of the shape defined in "Pulses Originating at the NT," Section 2.2.1.6.3, and "Received Line Signal Characteristics," Section 2.2.1.6.4.

With the exception of the wake-up tones (TN and TL), the scrambler shall be used in the normal way in formulating the signals. For example, Table 2.2.1-2 shows binary ONEs for B- and D-channel bits and the overhead bits in the signal SN1. These binary ONEs are scrambled before coding, producing random pulses in these positions at the interface.

Except where noted otherwise in Table 2.2.1-2, all the pulse sequences are framed and superframed in accordance with the normal frame structure shown in Figures 2.2.1-3, 2.2.1-12, 2.2.1-13, and 2.2.1-14, and all pulses represent scrambled bits except those in the synchronization word. The signals TN and TL are 10-kHz tones generated by repeating the following unscrambled and unframed symbol pattern:

. . . +3 +3 +3 +3 −3 −3 −3 −3 . . .

2.2.1.7.4.6 Line Rate During Start-Up

During start-up, the network shall produce symbols at the nominal line rate within the tolerance specified in "Baud Rate, Timing, and Synchronization," Section 2.2.1.7.1.

The symbol rate from the NT shall be 80 kbaud ± 100 ppm.

2.2.1.7.4.7 Start-Up Sequence

Figure 2.2.1-17 shows the sequence of signals at the interface that are generated by the transceivers. The transition points in the sequence are also defined in Figure 2.2.1-17. "DSL Start-Up and Activation," Section 2.2.3.5, gives two examples in its discussion of how these start-up signals at the interface may relate to other activation events away from the interface. For further information on the events at the S- and T-reference points, the reader is referred to *ANSI* Standard T1.605-1991.

2.2.1.7.4.7.1 Wake-Up

When transceivers are in the RESET state, either transceiver may initiate start-up by sending a tone as defined in Table 2.2.1-2.

Table 2.2.1-2 — Definitions of Signals During Start-Up

SIGNAL	SYNCH SUPER-WORD (SW)	FRAME(ISW)	2B+D	M	START	TIME STOP	(FRAMES)
TN[a]	±3[g]	±3[g]	±3[g]	±3[g]	i	i	6
SN1[b]	Present[b]	Absent[d]	1	1	T1[c]	T2[c]	-
SN2[b]	Present[b]	Absent[d]	1	1	T5[c]	T6[c]	-
SN3[b]	Present[b]	Present[b]	Normal[+f]	Normal[e]	T6[c]	j	-
TL[a]	±3[g]	±3[g] g	±3[g] g	±3[g] g	i	i	2
SL1[b]	Present[b]	Absent[d]	1	1	T3[c]	T4[c]	-
SL2[b]	Present[b]	Present[b]	0	Normal[e]	T4[c]	T7[c]	-
SL3[b]	Present[b]	Present[b]	Normal[+f]	Normal[e]	T7[c]	j	-

Note(s):

a. TN,TL — Tones produced by NT or LT, respectively (see Section 2.2.1.7.4.5).

b. SNx, SLx — Pulse patterns produced by NT or LT, respectively.

c. Tx — Notation refers to transition instants defined in Figure 2.2.1-17.

d. Absent — Under Superframe this notation means that only SW is transmitted, not ISW.

e. Normal — Normal means that the M bits are transmitted onto the 2-wire line as required during normal operation; for example, valid crc bits, eoc bits, and indicator bits are transmitted.

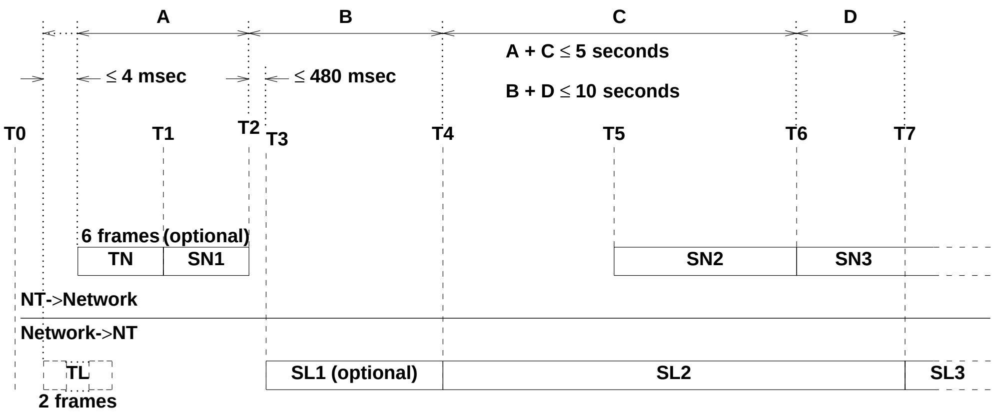
f. Normal+ — Except to perform a loopback, B- and D-channel bits shall remain in the previous state (that is, the B- and D-channel bits shall remain set to binary ONE in SN3 and set to binary Zero in SL3) until transparency is achieved as described in Section 2.2.1.7.4.7.6

g. Tones have alternating pattern of four +3s followed by four -3s, and no SW.

h. Tones have alternating pattern of four +3s followed by four -3s, and no SW.

i. See Figure 2.2.1-17 and text of Section 2.2.1.7.4.7 for start and/or stop time of this signal.

j. Signals SN3 and SL3 continue indefinitely (or until turn-off).



Time	Description of Event or State:
T0	RESET state.
T1	Network and NT are awake.
T2	NT discontinues transmission, indicating that the NT is ready to receive signal.
T3	Network responds to termination of signal and begins transmitting signal toward the NT.
T4	Network begins transmitting SL2 toward the NT, indicating network is ready to receive SN2.
T5	NT begins transmitting SN2 toward the network, indicating that NT has acquired SW frame and detected SL2.
T6	NT has acquired superframe marker, and is fully operational.
T7	Network has acquired superframe marker, and is fully operational.

Figure 2.2.1-17 — State Sequence for DSL Transceiver Start-Up

2.2.1.7.4.7.2 Start-Up from Customer Equipment

While the NT and network remain in the RESET state, a request for start-up from the customer terminal equipment shall result in the TN signal (tone) being sent from the NT toward the network. The network, on receiving TN shall remain silent until detection of cessation of signal from the NT. The rest of the sequence then follows as indicated in Table 2.2.1-2 and Figure 2.2.1-17. If the LT happens to try to start-up at the same time, it may send a TL tone during the TN tone without conflict.

While in the RESET state, NTs may initiate start-up only if responding to a new power off/on cycle or to a new request for service from the customer terminal equipment. Under all other conditions, where the transceivers have been turned off, the NTs shall remain quiet [that is, NTs shall not start transmitting any signal until the NT has received the TL signal (start-up tone) from the network].

2.2.1.7.4.7.3 Start-Up from the Network

While the NT and network remain in the RESET state, a request for start-up from the network shall result in the TL signal being sent from the network toward the NT. The NT, on receiving TL shall respond with TN within 4 msec from the beginning of TL. The rest of the sequence then follows as indicated in Table 2.2.1-2 and Figure 2.2.1-17.

Note: The dea bit from the network shall be set to binary ONE before start-up is initiated.

2.2.1.7.4.7.4 Progress Indicators

In the NT-to-network direction, the act bit remains set equal to 0 until the customer equipment is ready to transmit. The corresponding action at the T-reference point in the customer equipment is receipt of the signal INFO3. To communicate this progress indication, act from the NT is set equal to 1. Assuming INFO3 occurs before T6 and T7, this progress indication shall not affect overhead symbols at the interface until T6, when the NT overhead bits are allowed to be normal, and may not be detected by the network until T7.

After event T7 (Figure 2.2.1-17) and after act = 1 is received from the NT, the network sets the act bit equal to 1 to communicate readiness for Layer 2 communication (see "Frame Structure," Section 2.2.1.7.2, and "The act Bit," Section 2.2.3.1.2.2).

2.2.1.7.4.7.5 Turn-Off Procedure

All transceivers shall cease transmission following loss of received signal. There are different turn-off procedures for transceivers that have achieved full operational status than for transceivers that have not (see "Timers," Section 2.2.1.7.4.4).

The network may take advantage of the capabilities of warm-start NTs by announcing turn-off. In announcing turn-off, the network shall change dea from 1 to 0 and send dea = 0 in at least three consecutive superframes before ceasing transmission. It shall cease transmission before sending the dea bit in the superframe following the superframe in which dea = 0 is sent the last time. During the superframes with dea = 0 the NT has time to prepare for turn-off. Cold-start-only NTs may ignore the status of the dea bit.

After the warm-start NT has prepared itself for turn-off, it shall, upon the detection of loss of signal from the network, cease transmission and enter the RECEIVE RESET state within 40 msec of the occurrence of the transition to no signal at its interface. As specified in "Reset," Section 2.2.1.7.4.3, unless it responds to a TL signal from the network, it shall not initiate the transmission of wake-up tone for a period of at least 40 msec after it ceases transmission and then it shall enter the FULL RESET state.

The network (network-side transceiver), after announcing turn-off and ceasing transmission, shall enter the FULL RESET state upon detection of loss of received signal from the NT.

Although NTs are not permitted to initiate turn-off, the LT shall respond to loss of signal as previously stated. However, in this scenario, there is no stated means of taking advantage of warm-start capabilities.

2.2.1.7.4.7.6 Transparency

Transparency of the transmission in both directions by the NT shall be provided after the NT achieves full operational status (T6), and both act = 1 from the network and dea = 1. Full operational status of the NT means that the NT has: (1) acquired bit timing and frame synchronization from the incoming signal from the network, (2) recognized the superframe marker from the network, and (3) fully converged both its echo canceler and equalizer coefficients.

Transparency of the transmission in both directions within the network shall be provided when the network achieves full operational status (T7), detects the presence of the superframe marker from the NT, and receives act = 1 from the NT. Full operational status of the network means that the network has: (1) acquired bit timing phase of the incoming signal from the NT and frame synchronization, (2) recognized the superframe marker from the NT, and (3) fully converged both its echo canceler and equalizer coefficients.

At the LT, transparency of the B- and D-channels shall occur at any time during either the first LT-transmitted superframe with act = 1 or during the last LT-transmitted superframe with act = 0. Transparency occurs at the transition from all 0s to "normal" in the B- and D-channels in SL3. For example, referring to Figure 2.2.1-15, suppose superframe A is the last transmit superframe with act = 0, superframe B is the first transmit superframe with act = 1, and superframes C and D continue with act = 1. The transition to transparency may occur not later than the first bit of superframe C. This means that all B- and D-channel bits in superframes C and D shall be transmitted transparently, provided that conditions for transparency have been maintained.

At the LT, transparency of the B- and D-channels in the LT-to-network direction may occur at a different time than transparency in the LT-to-NT direction. However, in both directions the LT shall become transparent during the two transmit superframes A and B described in the example. The NT may not yet have achieved transparency during this interval.

After both the network and the NT achieve transparency in both directions, the act bits shall continue to reflect the state of readiness of the network and the terminal equipment for Layer 2 communication. The act bit in the network-to-NT direction shall reflect the status of the network side of the interface, except during 2B+D loopback toward the network. The act bit in the NT-to-network direction shall reflect the status of the NT side of the interface. Whenever either end, for any reason, loses its readiness to communicate at Layer 2 (for example, the terminal is unplugged), that end shall set its transmitted act bit to zero. A change of status of this bit shall be repeated in at least three consecutive transmitted superframes.

Transparency required to perform loopbacks is independent of the state of the act bit (see "Definition of Required eoc Functions," Section 2.2.3.1.3.4).

2.2.1.7.4.8 Start-Up Time Requirements

The network and the NT shall complete the start-up process, including synchronization and training of equalizers to the point of meeting performance criteria within the following lengths of time. Cold-start-only transceivers shall synchronize within 15 seconds. Warm-start transceivers shall synchronize within 300 msec on warm starts and within 15 seconds on cold starts. The 15-second cold-start time requirement is apportioned such that the NT is allowed 5 seconds and the network is allowed 10 seconds. For warm starts, the 300-msec start-up time requirement is apportioned equally between the NT and the network, 150 msec each. See Figure 2.2.1-17 for details.

Note: The 300-msec requirement applies to laboratory tests only. No 300-msec timer is involved in actual in-service loops. (See the definitions in "Warm Start," Section 2.2.1.7.4.2.3, and "Cold Start," Section 2.2.1.7.4.2.4 for warm- and cold-starts.)

As indicated in Figure 2.2.1-17, the start-up time requirements cover the time span from wake-up tone to T7, and do not include time for activation of customer terminal equipment. All start-up times apply only to the DSL, and do not apply to the entire customer access link where carrier systems may be involved (see Figure 2.2.4-1).

The following description of a laboratory test of start-up time is intended only to clarify the start-up time requirements. The test shall be started by a wake-up tone (either TN or TL) and time recorded from the beginning of TN until event T7 (see Figure 2.2.1-17). It is desirable to separately record the accumulation of time components A + C and B + D as defined in Figure 2.2.1-17.

The test shall be conducted on each of sixteen test loops (see "Definition of Telephone Plant," Section 2.2.1.6.4.1, and the figures in "Notes on the Class of Test Loops," Section 2.2.3.3.1). The test shall be conducted with an LT-NT pair on each test loop, first with the LT and NT as shown in the figures in "Notes on the Class of Test Loops," Section 2.2.3.3.1, and then with the NT and LT interchanged. Artificial crosstalk, power related metallic noise, and longitudinal noise as described in "Test Procedure," Section 2.2.1.6.4.4, shall be applied throughout the test. Furthermore:

a. It is desirable to apply the interference to both ends of the test loop.

b. It is desirable to conduct the test using clock sources with maximum frequency offsets.

c. It is desirable to repeat the test a number of times in order to determine the degree of repeatability.

For warm starts, the test shall begin from a RESET state that has been entered without loss of power following turn-off announcement as described in "Turn-Off Procedure," Section 2.2.1.7.4.7.5.

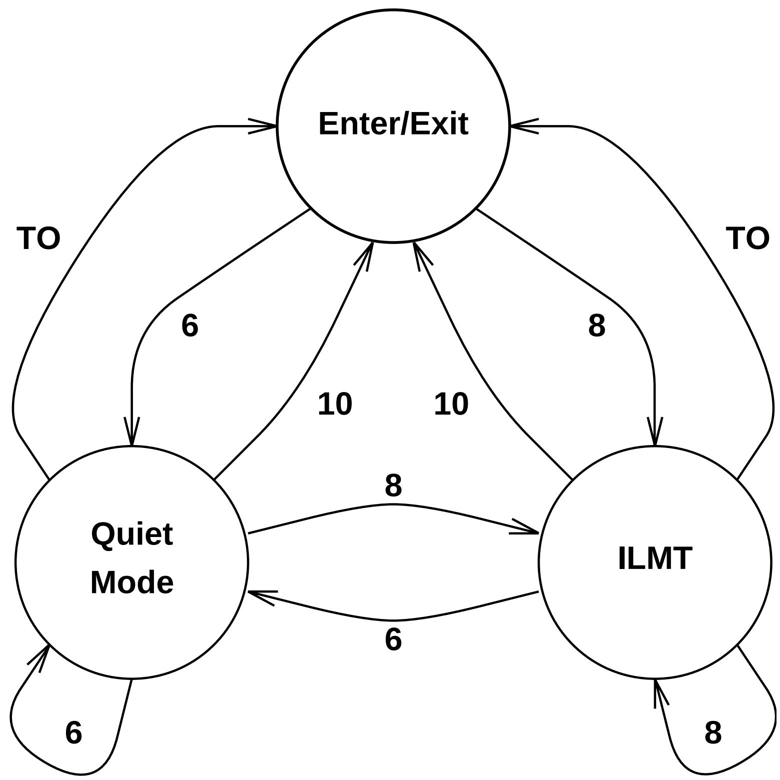
Start-up time on actual loops is beyond the scope of this standard.

2.2.1.7.5 NT Maintenance Modes

2.2.1.7.5.1 Overview of NT Maintenance Modes

The NT Quiet Mode (QM) functionality within an NT (or customer equipment containing the NT functionality) will assure that an NT will not attempt a start-up or will not initiate transmission during metallic loop tests conducted by the network. The Insertion Loss Measurement Test (ILMT) will cause a known test signal to be generated by an NT. This test will be used in network measurements of DSL transmission characteristics and may provide the ability to determine, from a single-ended test of the metallic loop, if the loop can support DSL transmission.

Figure 2.2.1-18, NT Loop Testing States, illustrates the various NT states associated with both the NT Quiet Mode and the Insertion Loss Measurement Test.



Note: ILMT = Insertion Loss Measurement Test.
Insertion Loss Signal = Scrambled, framed 2B1Q.
6,8,10 = Number of pulses within trigger signal.
Trigger Signal = DC or low-frequency AC pulses.
TO = Timeout = 75 seconds.

Figure 2.2.1-18 — NT Loop Testing States

As a result of a power off/on cycle, the NT exits the maintenance mode and attempts start-up as described in "Full Reset," Section 2.2.1.7.4.3.2. All knowledge of previous maintenance modes is lost.

2.2.1.7.5.2 NT Quiet Mode

The NT Quiet Mode implementation shall be as follows:

1. The NT shall unconditionally enter the Quiet Mode upon receipt of *six* consecutive pulses in the trigger signal (see "NT Quiet Mode and Insertion Loss Measurement Test Trigger Signal," Section 2.2.1.7.5.4, "DC Signaling Format," Section 2.2.1.7.5.5, and "Low Frequency AC Signaling Format," Section 2.2.1.7.5.6). Once triggered, the function shall latch until either timeout or turnoff.

2. While in Quiet Mode, the NT shall cease all transmission, and not attempt start-up.

3. The NT Quiet Mode duration shall be 75 seconds. If no trigger signal is received to change the NT state during the 75-second QM duration, the NT shall exit the maintenance mode. Upon exiting the maintenance mode, the NT and the

network shall be responsible for operation described in "Start-Up from Customer Equipment," Section 2.2.1.7.4.7.2, and "Start-Up from the Network," Section 2.2.1.7.4.7.3.

4. A receipt of *six* consecutive pulses in the trigger signal during Quiet Mode shall cause the NT to return to the start of the Quiet Mode state. (The Quiet Mode would then continue for another 75 seconds until either timeout or receipt of a new trigger signal that would alter the NT state.)

5. A receipt of *eight* consecutive pulses in the trigger signal during Quiet Mode shall cause the NT to enter the Insertion Loss Measurement Test state.

6. A receipt of *ten* consecutive pulses in the trigger signal during Quiet Mode shall cause the NT to exit the maintenance mode (see 3.).

7. If the NT receives 1, 2, 3, 4, 5, 7, 9, or greater than 10 consecutive pulses in the trigger signal then the state-change command is not valid and no action is taken by the NT.

2.2.1.7.5.3 Insertion Loss Measurement Test

The Insertion Loss Measurement Test implementation shall be as follows:

1. The receipt by the NT of eight consecutive pulses in the trigger signal (see "NT Quiet Mode and Insertion Loss Measurement Test Trigger Signal," Section 2.2.1.7.5.4, "DC Signaling Format," Section 2.2.1.7.5.5, and "Low Frequency AC Signaling Format," Section 2.2.1.7.5.6), shall unconditionally initiate the Insertion Loss Measurement Test. Once triggered, the function shall latch until either timeout or turnoff. The NT shall not attempt start-up during the Insertion Loss Measurement Test.

2. While in the Insertion Loss Measurement Test state, the NT shall generate a scrambled, framed, 2B1Q signal. SN1 and SN2 (see "Pulses Originating at the NT," Section 2.2.1.6.3) are examples of scrambled, framed, 2B1Q signals suitable for the Insertion Loss Measurement Test signal.

3. The Insertion Loss Measurement Test duration shall be 75 seconds. Upon exiting the maintenance mode, the NT and the network shall be responsible for operation as described in "Start-Up from Customer Equipment," Section 2.2.1.7.4.7.2, and "Start-Up from the Network," Section 2.2.1.7.4.7.3.

4. Receipt of *eight* consecutive pulses in the trigger signal during the Insertion Loss Measurement Test duration shall cause the NT to return to the start of the Insertion Loss Measurement Test. (The ILMT would then continue for 75 seconds until timeout or receipt of a new trigger signal to alter the NT state.)

5. A receipt of *six* consecutive pulses in the trigger signal during Insertion Loss Measurement Test shall cause the NT to enter the Quiet Mode state.

6. A receipt of *ten* consecutive pulses in the trigger signal during Insertion Loss Measurement Test shall cause the NT to exit the maintenance mode (see Item 3).

7. If the NT receives 1, 2, 3, 4, 5, 7, 9, or greater than 10 consecutive pulses in the trigger signal, then the state-change command is not valid and no action is taken by the NT.

2.2.1.7.5.4 NT Quiet Mode and Insertion Loss Measurement Test Trigger Signal

The NT shall be capable of detecting and responding to the following two types of signals:

- The DC signaling that begins with a steady current flow (start interval) followed by 6, 8, or 10 pulses sent as breaks in the current and ends with steady DC current flow (stop interval).
- The AC signaling that begins with no current flow (start interval, less than 200 μA DC) followed by 6, 8, or 10 half cycles of a 2- to 3-Hz sine wave, and ends with no current flow (stop interval). When receiving the AC signaling, the NT shall count each half cycle of the same wave as one pulse.

A valid test trigger signal shall consist of a valid start interval followed by either 6, 8, or 10 consecutive pulses followed by a valid stop interval. Unless an entire trigger sequence consisting of start interval, pulses, and stop interval is received, the NT shall take no action. A stop interval may be followed by a start interval without any intervening breaks. Signals on the loop before the start interval or after the stop interval shall not affect the NT trigger detection function. The start and stop intervals shall be ≥ 500 msec. The NT shall be capable of detecting and validating the trigger signal and entering into the desired state required by the number of pulses transmitted. A request for the same or a new state shall occur no sooner than one second after the beginning of the preceding stop interval. On receipt of a valid signal, the NT shall transition from one state to the requested state within 500 msec.

The pulse detector in the NT shall be implemented so that alias does not occur for pulse rates up to 64 pulses per second.

2.2.1.7.5.5 DC Signaling Format

The DC signal shall begin with a steady current flow with pulses sent as breaks in the current. These pulses shall:

- Be applied to the NT by test equipment in the network at a pulse speed of 4 to 8 pps
- Have a 40- to 60-percent break
- Have source voltage of 43.5 to 56 volts
- Have source resistance of 200 to 4,000 ohms (includes test system, test trunk, loop, and margin resistance).

2.2.1.7.5.6 Low Frequency AC Signaling Format

The AC signal shall consist of 6, 8, or 10 half cycles of a 2 to 3 Hz sine wave. Each half cycle of the sine wave is equivalent to one pulse described in "DC Signaling Format," Section 2.2.1.7.5.5. This sine wave shall:

- Be applied to the NT by test equipment in the network at a frequency between 2 and 3 Hz
- Have peak voltage between 60 and 62 volts
- Have a source resistance between 900 and 4,500 ohms (includes AC source, test system, test trunk, loop, and margin resistance).

2.2.2 ELECTRICAL CHARACTERISTICS

2.2.2.1 Impedance and Return Loss

The nominal driving point impedance at the interface looking toward the NT shall be 135 ohms. The return loss with respect to 135 ohms, over a frequency band from 1 kHz to 200 kHz, shall be as shown in Figure 2.2.2-1.

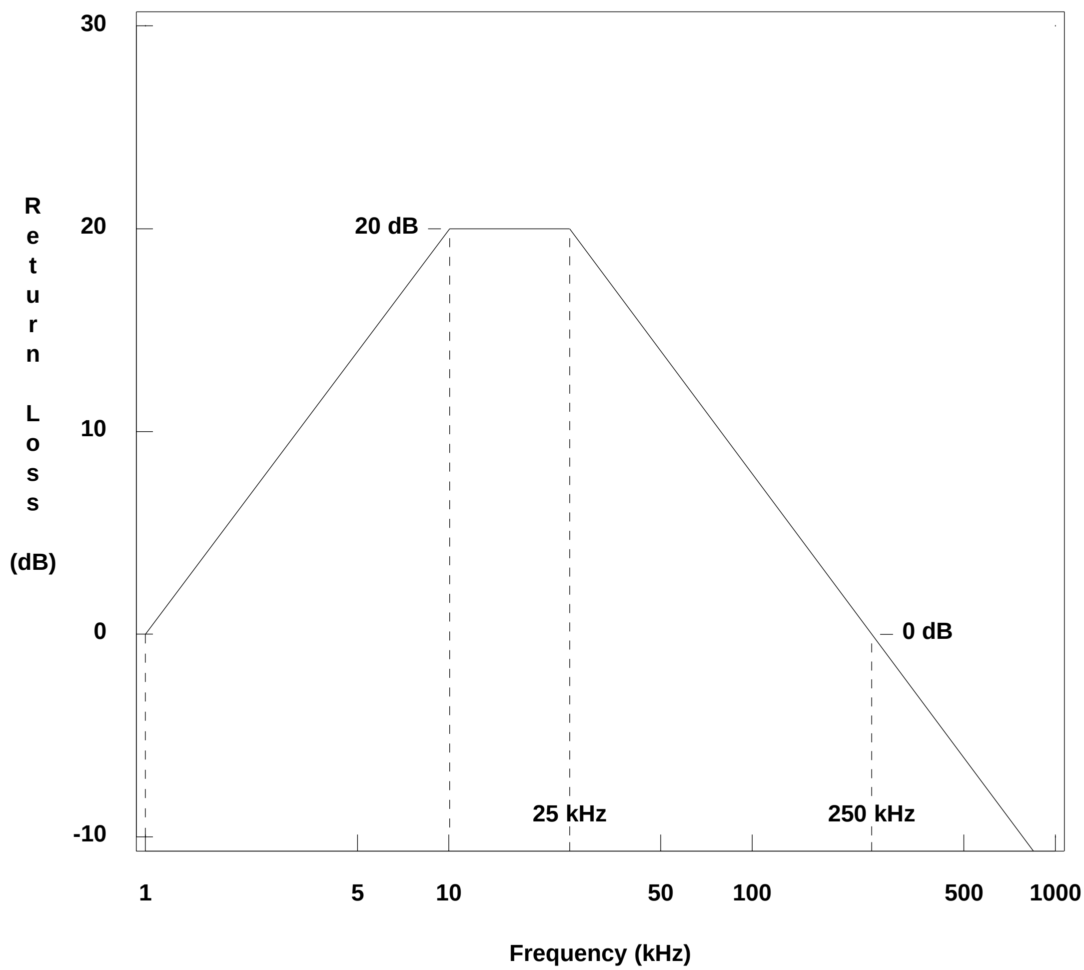


Figure 2.2.2-1 — Minimum Return Loss

2.2.2.2 Longitudinal Output Voltage

The NT shall present to the interface a longitudinal component whose rms voltage, in any 4-kHz bandwidth averaged in any 1-second period, is less than −50 dBV over the frequency range 100 Hz to 170 kHz, and less than −80 dBV over the range from 170 kHz to 270 kHz. Compliance with this limitation is required with a longitudinal termination having an impedance equal to or greater than a 100-ohm resistor in series with a 0.15-μF capacitor.

Figure 2.2.2-2 defines a measurement method for longitudinal output voltage. For direct use of this test configuration, the NT should be able to generate a signal in the absence of a signal from the network.

The ground reference for these measurements shall be the building or green-wire ground of the NT.

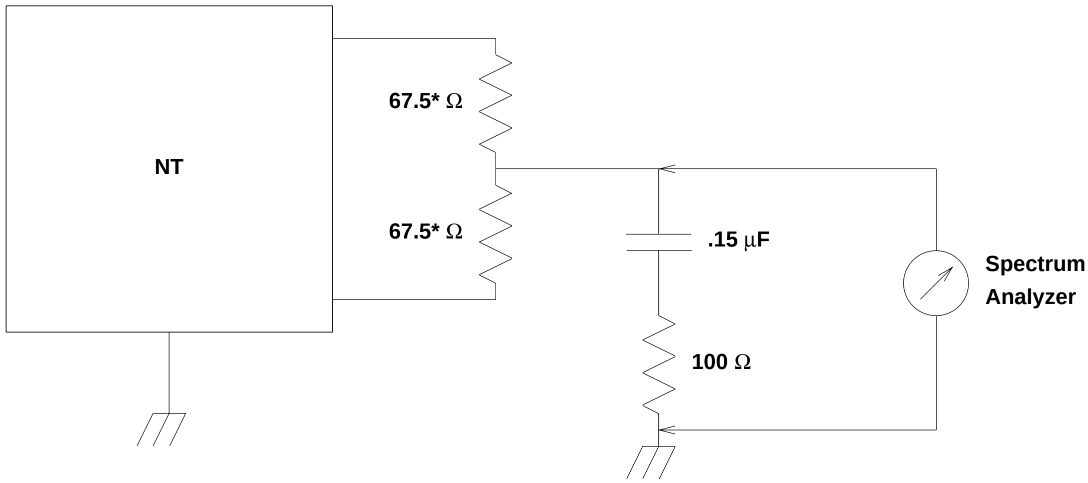


Figure 2.2.2-2 — Measurement Method for Longitudinal Output Voltage

2.2.2.3 Longitudinal Balance

The longitudinal balance (impedance to ground) is given in the following equation.

Exhibit 2.2.2-1 — Longitudinal Balance

$$LBal = 20\log\left|\frac{e_l}{e_m}\right| dB$$

where

e_l = the applied logitudinal voltage (referenced to the building or green-wire ground of the NT)

e_m = the resultant metallic voltage appearing across a 135-ohm termination

The balance shall be > 20 dB at frequencies up to 5 Hz. The minimum requirement increases above 5 Hz at 20 dB per decade to 55 dB at 281.2 Hz. The balance shall be > 55 dB between 281.2 Hz and 40 kHz. Above 40 kHz, the minimum requirement decreases at 20 dB per decade. See Figure 2.2.2-3.

Note: Longitudinal balance requirements given here apply to the NT. Longitudinal balance requirements for the network side are beyond the scope of this section.

Figure 2.2.2-4 defines a measurement method for longitudinal balance. For direct use of this test configuration, measurement should be performed with the NT powered up but inactive, driving zero volts.

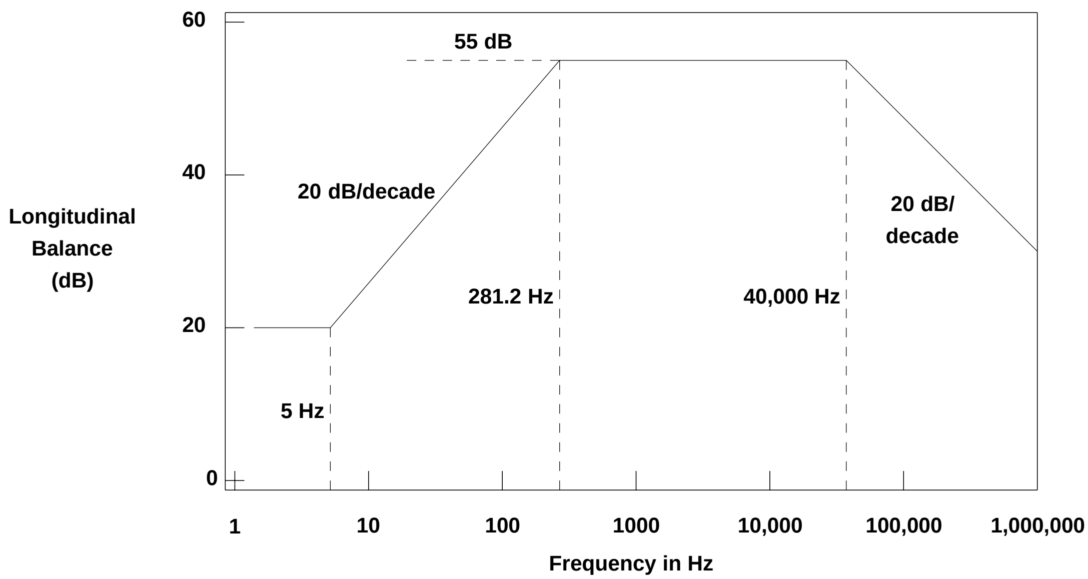
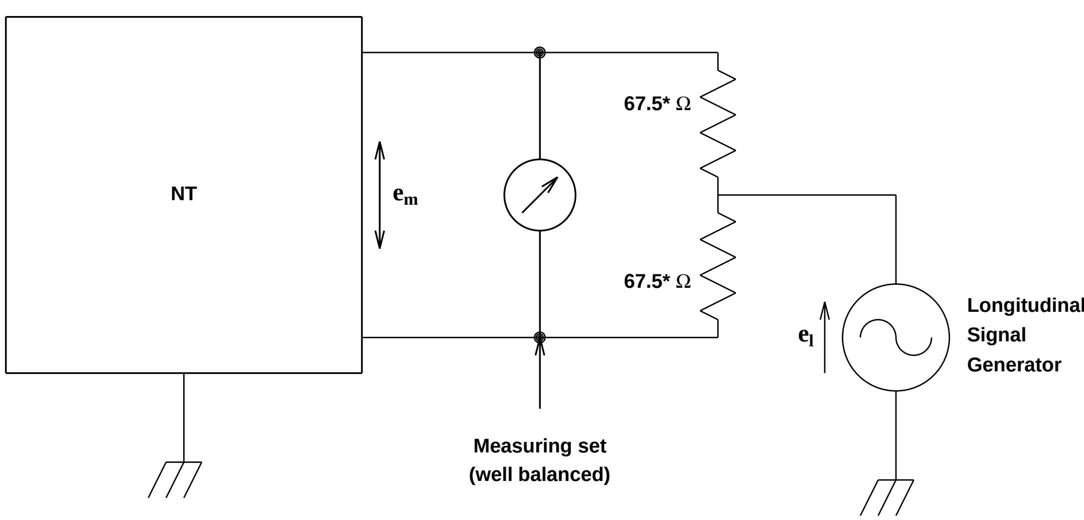


Figure 2.2.2-3 — Minimum Longitudinal Balance Requirement



* These resistors to be matched to better than 0.03 percent tolerance

Figure 2.2.2-4 — Measurement Method for Longitudinal Balance

2.2.2.4 Jitter

In this section, jitter is specified in terms of unit intervals (UI) of the nominal 80 kbaud signal (12.5 µsec).

2.2.2.4.1 NT Input Signal Jitter Tolerance

The NT shall meet the performance objectives specified in "Performance Test Requirement," Section 2.2.1.6.4.2, with wander/jitter at the maximum magnitude indicated in Figure 2.2.2-5, for single jitter frequencies in the range of 0.1 Hz to 20 kHz, superimposed on the test signal source with the received signal baud rate in the range of 80 kbauds ±5 ppm. The NT shall also meet the performance objectives with wander per day of up to 1.44 UI peak-to-peak where the maximum rate of change of phase is 0.06 UI/hour.

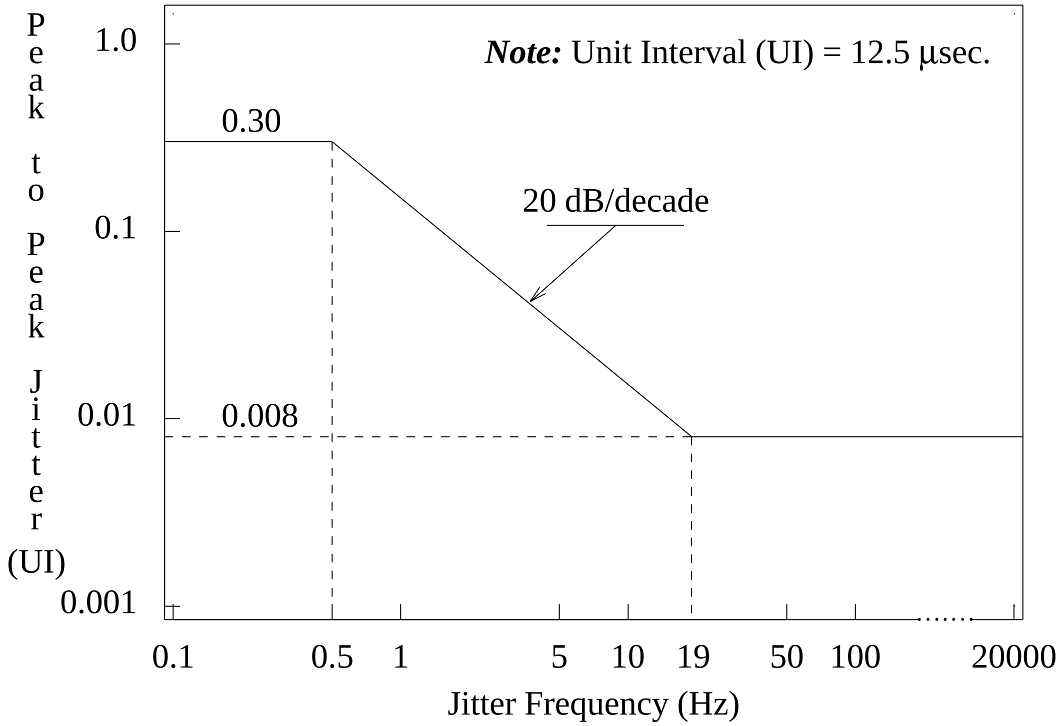


Figure 2.2.2-5 — Range of Permissible Sinusoidal Jitter, Signal Originating from Network

2.2.2.4.2 NT Output Jitter Limitations

With the wander/jitter as specified in "NT Input Signal Jitter Tolerance," Section 2.2.2.4.1, except as noted, superimposed on the NT input signal, the jitter on the transmitted signal of the NT toward the network shall conform to the following, with the received signal baud rate in the range of 80 kbaud ±5 ppm, as described in "Baud Rate, Timing, and Synchronization," Section 2.2.1.7.1.

a. The jitter shall be equal to or less than 0.04 UI peak-to-peak and less than 0.01 UI rms when measured with a high-pass filter having a 6-dB/octave roll-off below 80 Hz.

b. The jitter in the phase of the output signal (the signal transmitted toward the network) relative to the phase of the input signal (from the network) shall not exceed 0.05 UI peak-to-peak and 0.015 UI rms when measured with a band-pass filter having 6-dB/octave roll-offs above 40 Hz and below 1.0 Hz. (Note that the 1.0 Hz cut-off assures that the average difference in the phase of the input and output signals is subtracted.) This requirement applies with superimposed jitter in the phase of the input signal as specified in "NT Input Signal Jitter Tolerance," Section 2.2.2.4.1, for single frequencies up to 19 Hz.

c. The maximum (peak) departure of the phase of the output signal from its nominal difference (long-term average) from the phase of the input signal (from the network) shall not exceed 0.1 UI. This requirement applies during normal operation including following a "warm start." (Note that this means that, if deactivated and subsequently activated in conformance with the "warm start" requirements, the long-term average difference in phase of the output signal from the phase of the input signal shall be essentially unchanged.)

2.2.2.5 DC Characteristics

2.2.2.5.1 Sealing Current

Sealing current shall be provided by the network. The NT shall meet the requirements of this specification for currents of 0 mA and in the range of 1 mA to 20 mA and where the maximum rate of change of the current is no more that 20 mA per second (see "Metallic Termination," Section 2.2.2.5.2).

2.2.2.5.2 Metallic Termination

2.2.2.5.2.1 Overview of Metallic Termination at the NT

Table 2.2.2-1 and Figure 2.2.2-6 give characteristics that apply to the DC metallic termination at the NT.

The metallic termination provides a direct current path from tip to ring at the NT, providing a path for sealing current. By exercising the nonlinear functions of the metallic termination, a network-side test system may identify the presence of a conforming NT on the customer side of the interface. The characteristics of the metallic termination shall not be affected by whether the NT is powered in any state, or unpowered.

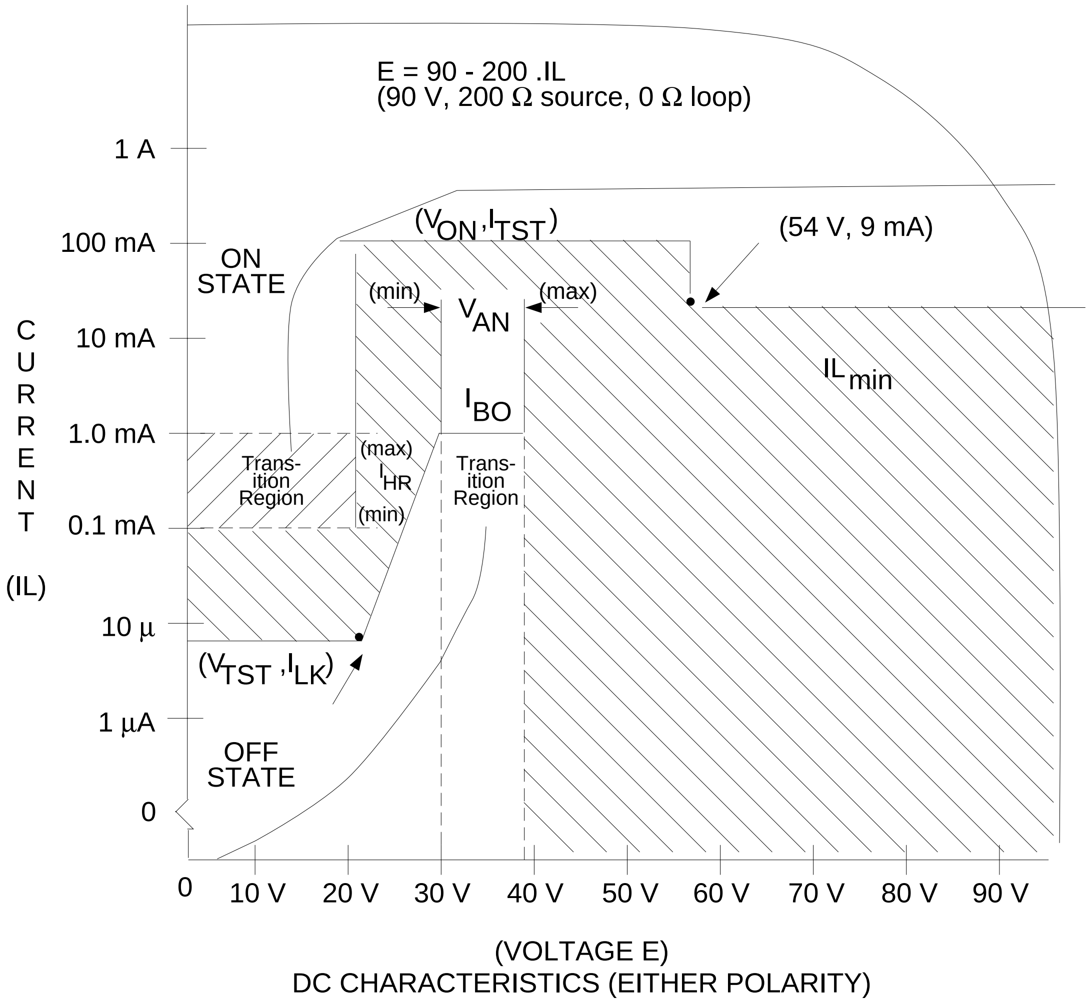
Table 2.2.2-1 — Characteristics of DC Metallic Termination at the NT

TYPE OF OPERATION	VALUES
	Normally OFF DC termination. Turned ON by application of metallic voltage. Held ON by loop current flow. Turned OFF by cessation of loop current flow.
Current in the ON state and at 15 V	≥ 20 mA
DC voltage drop (when ON) at −20 mA current	≤ 15 V
DC current with the application of 90 V through 4000 ohms for up to 2 seconds	min 9 mA, see [a] and Figure 2.2.2-6
DC leakage current (when OFF) at 20 V	≤ 5 µA
Activate/Nonactivate voltage	30.0 V DC ≤ V_{AN} ≤ 39.0 V DC
Activate (breakover) current at V_{AN}	1.0 mA
Activate time for voltage ≥ V_{AN}	3 msec to 50 msec
Hold/Release current	0.1 mA ≤ I_{HR} ≤ 1.0 mA
Release/Nonrelease time for current ≤ I_{HR}	3 msec to 100 msec
Maximum voltages and currents	See Section 2.2.3.4
Supporting information	See Section 2.2.4.2

Note(s):
a. This requirement is intended to ensure a termination consistent with test system operation.

There are two operational states of the DC metallic termination:

1. ON (conductive) state
2. OFF (nonconductive) state.



PARAMETER	MEANING	LIMIT	CONDITION	MEANING
I_{LK}	Leakage Current	$I_{LK} \leq 5\mu A$	V_{TST} = 20 V	Test Voltage
V_{AN}	Activate/Non-Activate Voltage	$30V \leq V_{AN} \leq 39$ V		
I_{BO}	Break Over Current	$I_{BO} \leq 1.0mA$		
I_{HR}	Hold/Release Current	$0.1mA \leq I_{HR} \leq 1.0mA$		
V_{ON}	ON Voltage	$V_{ON} \leq 15V$	I_{TST} = 20mA	Test Current
IL_{min}	Minimum ON Current	9mA	54V	

Figure 2.2.2-6 — Illustration of DC Characteristics of the NT1 (Bilateral Switch and Holding Current)

2.2.2.5.2.2 ON State

The application of a voltage across the metallic termination greater than the activate/nonactivate voltage, V_{AN}, for a duration greater than the activate time shall cause the termination to transition to the ON state. The activate/nonactivate voltage shall be in the range of 30.0 to 39.0 volts. The activate time shall be in the range of 3.0 to 50.0 msec. If a change of state is to occur, the transition shall be completed within 50 msec from the time in which the applied voltage across the termination first exceeds V_{AN}. Application of a voltage greater than V_{AN} for a duration less than 3.0 ms shall not cause the termination to transition to the ON state. See Table 2.2.2-1 and Figure 2.2.2-6.

While in the ON state, when the voltage across the termination is 15 volts, the current shall be greater than or equal to 20 mA. The metallic termination shall remain in the ON state as long as the current is greater than the threshold I_{HR} (see Table 2.2.2-1 and Figure 2.2.2-6), whose value shall be in the range of 0.1 to 1.0 mA. Application of 90.0 volts through 200 to 4000 ohms (for a maximum duration of 2 seconds) shall result in a current greater than 9.0 mA.

2.2.2.5.2.3 OFF State

The metallic termination shall transition to the OFF state if the current falls below the threshold I_{HR}, whose value shall be in the range of 0.1 to 1.0 mA for a duration greater than the "guaranteed release" time (100 msec) (see Table 2.2.2-1 and Figure 2.2.2-6). If a change of state is to occur, the transition shall be completed within 100 ms from the time in which the current first falls below I_{HR}. If the current falls below I_{HR} for a duration less than 3.0 msec, the termination shall not transition to the OFF state.

While in the OFF state, the current shall be less than 5.0 µA whenever the voltage is less than 20.0 volts. The current shall not exceed 1.0 mA while the voltage across the termination remains less than the activate voltage.

Descriptive material can be found in Table 2.2.2-1, Figure 2.2.2-6, and "Supporting Information Relating to DC Metallic Termination," Section 2.2.4.2.

2.2.2.5.2.4 NT Capacitance

While the metallic termination is OFF, the tip-to-ring capacitance of the NT when measured at a frequency of less than 100 Hz shall be 1.0 µF± 10 percent.

2.2.2.5.2.5 Behavior of the NT during Metallic Testing

During metallic testing, the NT shall behave as follows:

1. When a test voltage of up to 90 volts[1] is applied across the loop under test, the NT shall present its DC metallic termination as defined in "Metallic Termination," Section 2.2.2.5.2, Table 2.2.2-1, and Figure 2.2.2-6, and not trigger any protective device that will mask this signature. The series resistance (Test system + Test Trunk + Loop + Margin) can be from 200 to 4000 ohms (balanced between the two conductors).

2. The NT may optionally limit current in excess of 25 mA (20-mA maximum sealing current + 5-mA implementation margin).

2.2.2.5.3 NT Network-Side Resistance to Ground

The DC resistance between the NT tip conductor and earth ground and between the NT ring conductor and earth ground shall be greater than 5 megohms for all DC voltages up to and including 100 volts.

1. One test system in common use today applies to 70-volt DC plus 10-volt rms AC (84.4 volt peak) to one conductor of the loop while grounding the other conductor. The addition of a 5.8-volt margin yields the 90-volt requirement.

2.2.3 MAINTENANCE AND MEASUREMENTS

2.2.3.1 M-Channel Bit Functions

The M-channel bit functions specified in "Error Monitoring Function," Section 2.2.3.1.1, are based on the bit allocation for the DSL superframe defined in Figures 2.2.1-13 and 2.2.1-14.

2.2.3.1.1 Error Monitoring Function

2.2.3.1.1.1 Cyclic Redundancy Check (crc)

Twelve bits per superframe (1 kbps) shall be allocated to the cyclic redundancy check (crc) function. The crc bits are the M_5 and M_6 bits in frames 3 through 8 of the superframe (see Figures 2.2.1-13 and 2.2.1-14). The crc is an error detection code that shall be generated from the appropriate bits in the superframe and inserted into the bit stream by the transmitter. At the receiver, a crc calculated from the same bits shall be compared with the crc value transmitted in the bit stream. If the two crcs differ, there has been at least one error in the covered bits in the superframe.

2.2.3.1.1.2 crc Algorithms

The Cyclic Redundancy Check (crc) code shall be computed using the polynomial shown in Equation 2.2.3-1.

Exhibit 2.2.3-1 — Cyclic Redundancy Check Polynomial

$P(x) = x^{12} \oplus x^{11} \oplus x^{3} \oplus x^{2} \oplus x \oplus 1$
where $\oplus$ = modulo 2 summation.

One method of generating the crc code for a given superframe is illustrated in Figure 2.2.3-1. At the beginning of a superframe all register cells are cleared. The superframe bits to be crc'd are then clocked into the generator from the left. During bits that are not covered by the crc (SW, ISW, M_1, M_2 , M_3 , M_5 , M_6) the state of the crc generator is frozen and no change in state of any of the stages takes place. After the last superframe bit to be crc'd is clocked into REGISTER CELL 1, the twelve register cells contain the crc code of the next superframe. Between this point and the beginning of the next superframe, the register cell contents are stored for transmission in the crc field of the next superframe. Notice that superframe bit CRC1 resides in REGISTER CELL 12, CRC2 in REGISTER CELL 11, and so forth.

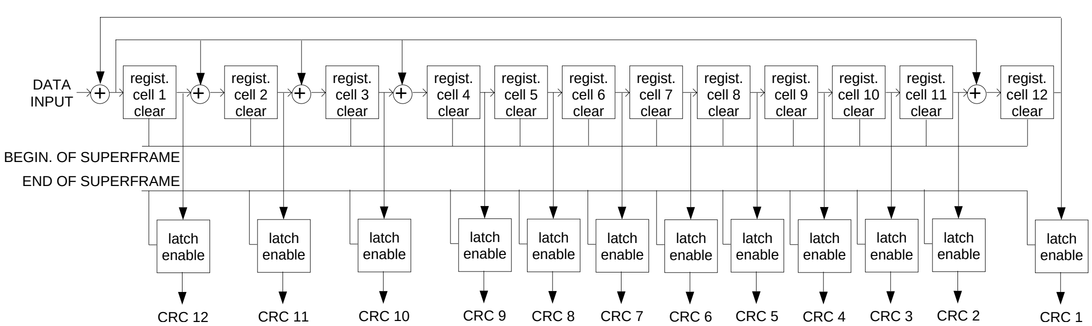


Figure 2.2.3-1 — CRC-12 Generator

Other viable methods for generating the crc bits exist. In the case that a method other than the one presented is used, the CRC1 shall correspond to the most significant bit of the crc remainder, the CRC2 to the next most significant bit, and so forth. The block diagram presented is intended to clarify the definition of the crc superframe bits. Other implementations are possible.

Note: The binary ONEs and ZEROs from the S/T interface, and corresponding bits from the network, must be treated as binary ONEs and ZEROs, respectively, for the computation of the crc.

2.2.3.1.1.3 Bits Covered by the crc

The crc bits shall be calculated from the bits in the D-channel, both B-channels, and the M_4 bits (see Figure 2.2.1-4).

2.2.3.1.2 Overhead Bit Functions

A number of transceiver operations and maintenance functions are handled by M_4, M_5, and M_6 bits in the superframe. These bits are defined in the following sections. To reflect a change in status, a new value for M_4 bits shall be repeated in at least three consecutive transmitted superframes.

2.2.3.1.2.1 Far-End Block Error (febe) Bit

The Far End Block Error (febe) bits are the M_4 bits in the second basic frame of superframes transmitted by either transceiver (see Figures 2.2.1-13 and 2.2.1-14). As crc errors are detected at the receiver, a febe bit shall be generated. The febe bit shall be set to binary ONE (1) if there are no errors in the superframe and to binary ZERO (0) if the superframe contains an error. The febe bit shall be placed in the next available outgoing superframe and transmitted back to the originator. The febe bits in each direction of transmission may be monitored to determine the performance of the far-end receiver.

2.2.3.1.2.2 The act Bit

The start-up (act) bit is the M_4 bit in the first basic frame of superframes transmitted by either transceiver (see Figures 2.2.1-13 and 2.2.1-14 and "Frame Structure," Section 2.2.1.7.2). The act bit is set to binary ONE (1) as a part of the start-up sequence to communicate readiness for Layer 2 communication (see "Progress Indicators," Section 2.2.1.7.4.7.4).

2.2.3.1.2.3 The dea Bit

The turn-off (dea) bit is the M_4 bit in the second basic frame of superframes transmitted by the network (see Figure 2.2.1-13 and "Frame Structure," Section 2.2.1.7.2). The dea bit is set to binary ZERO (0) by the network to communicate to the NT its intention to turn off (see "Turn-Off Procedure," Section 2.2.1.7.4.7.5).

2.2.3.1.2.4 NT Power Status (ps) Bits

The power status (ps_1 and ps_2) bits are the M_4 bits in the second and third basic frames of superframes transmitted by the NT (see Figure 2.2.1-14). The power status bits shall be used to indicate NT power status. Table 2.2.3-1 shows the power status bit assignments and the corresponding messages and definitions.

Table 2.2.3-1 — Power Status Bit Assignments and Messages

NT STATUS	ps_1 ps_2 BINARY VALUES	DEFINITION
All Power Normal	11	Primary and secondary power supplies are both normal.
Secondary Power Out	10	Primary power is normal, but the secondary power is marginal, unavailable, or not provided.
Primary Power Out	01	Primary power is marginal or unavailable, secondary power is normal.
Dying Gasp	00	Both primary and secondary power are marginal or unavailable. The NT may shortly cease normal operation.

These bits are set and held constant until the power status of the NT changes. It is expected that primary power will be provided by the normal AC mains. Secondary power (if provided) would normally be provided through a backup battery at the customer location.

The NT shall have sufficient energy storage to transmit the dying gasp indication for a minimum of three superframes.

2.2.3.1.2.5 NT Test Mode (ntm) Indicator Bit

The NT test mode indicator (ntm) bit is the M_4 bit in the fourth basic frame of superframes transmitted by the NT (see Figure 2.2.1-14). The ntm bit shall be used to indicate that the NT is in a customer-initiated test mode. The NT is considered to be in a test mode when the D-channel or either one of the B-channels is involved in a customer locally-initiated maintenance action. While in test mode, the NT may be unavailable for service or the NT may be unable to perform actions requested by eoc messages. The bit shall be a binary ONE (1) to indicate normal operation and binary ZERO (0) to indicate test mode. When indicating test mode [binary ZERO (0)], this bit is held constant until the test mode status of the NT changes. The return to binary ONE (ntm = 1) indicates the return of normal mode.

2.2.3.1.2.6 Cold-Start-Only (cso) Bit

The cso bit is the M_4 bit in the fifth basic frame of the superframe transmitted by an NT (see Figure 2.2.1-14). It shall be used to indicate the start-up capabilities of the NT transceiver. If the NT has a cold-start-only transceiver, as defined in "Definitions," Section 2.2.1.7.4.2, this bit is set to binary ONE (1). Otherwise, this bit shall be set to binary ZERO (0) in SN3.

2.2.3.1.2.7 U-Interface-Only-Activation (uoa) Bit

The uoa bit is the M_4 bit in the seventh basic frame of superframes transmitted by the network (see Figure 2.2.1-13). It shall be used to request the NT to activate or deactivate the S/T interface (if present). If the S/T interface is to be activated, this bit shall be set to binary ONE (1). Otherwise, this bit shall be set to binary ZERO (0).

2.2.3.1.2.8 S/T-Interface-Activity-Indicator (sai) Bit

The sai bit is the M_4 bit in the seventh basic frame of superframes transmitted by an NT (see Figure 2.2.1-14). It shall be used to indicate to the network when there is activity at the S/T reference point. If there is activity (INFO 1 or INFO 3) at the S/T reference point, this bit shall be set to binary ONE (1). Otherwise, this bit shall be set to binary ZERO (0).

2.2.3.1.2.9 Alarm Indication Bit (aib)

The aib bit is the M_4 bit in the eighth basic frame of superframes transmitted toward the NT (see Figure 2.2.1-13). When the transmission path for the D-, B_1-, and B_2-channels has been established all the way to the local exchange (see Figure 2.2.1-2), a binary ONE (aib = 1) shall be forwarded to the NT. Failure or interruption of an intermediate transmission system that transports the D-, B_1-, or B_2- channels shall result in forwarding binary ZERO (aib = 0) to the NT. Such failures may include loss of signal, loss of frame synchronization (carrier link or basic access DSL), and transmission terminal failure. Intermediate transmission interruptions may include loopbacks at intermediate points or the absence of provisioning of an intermediate transmission system.

2.2.3.1.2.10 Network Indicator Bit for Network Use

The M_4 bit in the eighth basic frame of superframes transmitted toward the network is reserved for network use. The NT shall always set this bit to binary ONE (1) toward the network.

2.2.3.1.2.11 Reserved Bits

All bits in M_4, M_5, and M_6 not otherwise assigned are reserved for future specification. Reserved bits shall be set to binary ONE (1) before scrambling.

2.2.3.1.3 Embedded Operations Channel (eoc) Functions

Twenty-four bits per superframe (2 kbps) are allocated to an embedded operations channel (eoc) that supports operations communications needs between the network and the NT.

2.2.3.1.3.1 eoc Frame

The eoc frame shall be composed of 12 bits synchronized to the superframe:

# of Bits	3	1	8
Function Provided	Address Field	Data/Msg Indicator	Info Field

The three-bit Address Field may be used to address up to seven locations. Only the specification of addresses of messages for the NT are within the scope of this section. However, addresses of intermediate network elements are discussed in "Discussion of eoc Addressing," Section 2.2.4.1.

The Data/Message Indicator bit shall be set to binary ONE (1) to indicate that the Information Field contains an operations message; it shall be set to binary ZERO (0) to indicate that the Information Field contains numerical data.[1] Up to 256 messages may be encoded in the Information Field.

1. At the present time there is no numerical data transfer required from or to the NT. Such data transfer is anticipated for only internal network applications.

Exactly two eoc frames shall be transmitted per superframe consisting of all M_1, M_2, and M_3 bits (see Figures 2.2.1-13 and 2.2.1-14).

2.2.3.1.3.2 Mode of Operation

The eoc protocol operates in a repetitive command/response mode. Three identical properly-addressed consecutive messages shall be received before an action is initiated. Only one message, under the control of the network, shall be outstanding (not yet acknowledged) on a complete Basic Access eoc at any one time.

The network shall continuously send an appropriately addressed message. In order to cause the desired action in the addressed element, the network shall continue to send the message until it receives three identical consecutive eoc frames from the addressed device that agree with the transmitted eoc frame. When the network is trying to activate an eoc function, autonomous messages from the NT will interfere with confirmation of receipt of a valid eoc message. The sending by the NT and receipt by the network of three identical consecutive properly addressed Unable-to-Comply messages constitutes notification to the network that the NT does not support the requested function, at which time the network may abandon its attempt.[2]

The addressed element shall initiate action when, and only when, three identical, consecutive, and properly addressed eoc frames, which contain a message recognized by the addressed element, have been received. [Any reply or echoed eoc frame shall be in the next available returning eoc frame, which allows a limited processing time of approximately 2.25 msec (see Figure 2.2.1-15). The NT shall respond to all received messages. The response shall be an echo of the received eoc frame toward the network with the following three exceptions.

1. If the NT does not recognize the message (Data/Message bit = 1) in a properly addressed eoc frame, rather than echo, on the third and all subsequent receipts of that same correctly addressed eoc frame, it shall return the Unable-to-Comply message in the next available eoc frame.

2. If the NT receives eoc frames with addresses other than its own address (000), or the broadcast address (111), it shall, in the next available eoc frame, return an eoc frame toward the network containing the Hold State message with its own address (the NT address, 000).

3. If an NT not implementing eoc data transfer functions receives a data byte (Data/Message bit = 0) in a properly addressed eoc frame, rather than echo, on the third and all subsequent receipts of that same correctly addressed eoc frame, it shall return the Unable-to-Comply.[3] message in the next available eoc frame.

The protocol specification has made no provision for autonomous messages from the NT.

All actions to be initiated at the NT shall be latching, permitting multiple eoc-initiated actions to be in effect simultaneously. A separate message shall be transmitted by the network to unlatch.

---

2. Failure by the network side to abandon the request for the unsupported function may interfere with further use of the eoc (for example, by contending operating systems within the network). The network has the responsibility to keep the eoc free for such use by timely substitution of "Hold State," "Return to Normal," or an alternate request after validation of the "Unable to Comply" response.

3. The requirement for an Unable-to-Comply response to a data byte addressed to an NT that does not implement a data reception feature applies to all implementations of eoc capabilities.

2.2.3.1.3.3 Addressing

An NT shall recognize either of two addresses, an NT address (000) and a broadcast address (111) to all nodes. An NT shall use the address 000 in sending the Unable-to-Comply message.

2.2.3.1.3.4 Definition of Required eoc Functions

The following are definitions of the required eoc functions:

a. ***Operate 2B+D Loopback:***[4] This function directs the NT to loopback the user-data (2B+D) bit stream toward the network.[5] This loopback may be transparent or nontransparent[6] but in either case will continue to provide sufficient signal to allow the TE to maintain synchronization to the NT.

b. ***Operate B_1-Channel (or B_2-Channel) Loopback:*** [7] This function directs the NT to loopback an individual B channel toward the network.[8] The individual B-channel loopback can provide per-channel maintenance capabilities without totally disrupting service to the customer. This loopback is transparent.[9]

c. ***Return to Normal:*** The purpose of this message is to release all outstanding eoc-controlled operations and to reset the eoc processor to its initial state.

d. ***Unable-to-Comply Acknowledgement:*** This will be the confirmation that the NT has validated the receipt of an eoc message, but that the eoc message is not in the menu of the NT.

e. ***Request Corrupt crc***: This message requests the sending of corrupt *crc*s toward the network, until canceled with Return to Normal

f. ***Notify of Corrupted crc***: This message notifies the NT that intentionally corrupted crcs will be sent from the network until cancellation is indicated by Return to Normal.

g. ***Hold State:*** This message is sent by the network to maintain the NT eoc processor and any active eoc-controlled operations in their present state. This message may also be sent by the NT toward the network to indicate that the NT has received an eoc frame with an address other than its own (000 or 111).

2.2.3.1.3.5 Codes for Required eoc Functions

Table 2.2.3-2 shows the codes for each of the eoc functions defined in "Definition of Required eoc Functions," Section 2.2.3.1.3.4.

---

4. Loopbacks may be performed after point T7 in the start-up sequence. The establishment of loopbacks is independent of the state of the act bit. Note, however, that the act bit from the NT must continue to reflect readiness to communicate at Layer 2 (presence of INFO 3) during B_1- and B_2- channel loopbacks.
5. This requirement is consistent with requirements found in ITU-TS Recommendation I.603.
6. "Transparent" is the ITU-TS term to indicate that the bits toward the loop are passed onward as well as looped back.
7. Loopbacks may be performed after point T7 in the start-up sequence. The establishment of loopbacks is independent of the state of the act bit. Note, however, that the act bit from the NT must continue to reflect readiness to communicate at Layer 2 (presence of INFO 3) during B_1- and B_2- channel loopbacks.
8. This requirement is consistent with requirements found in ITU-TS Recommendation I.603.
9. "Transparent" is the ITU-TS term to indicate that the bits toward the loop are passed onward as well as looped back.

Table 2.2.3-2 — Messages Required for Command/Response eoc Mode

MESSAGE	MSG CODE[a]	ORIGIN (o) & DEST. (d)	
		NETWORK	NT
Operate 2B+D Loopback	0101 0000	o	d
Operate B_1-Channel Loopback	0101 0001	o	d
Operate B_2-Channel Loopback	0101 0010	o	d
Request Corrupted *crc*	0101 0011	o	d
Notify of Corrupted *crc*	0101 0100	o	d
Return to Normal	1111 1111	o	d
Hold State	0000 0000	d/o	o/d
Unable-to-Comply Acknowledgment [b]	1010 1010	d	o

Note(s):

a. The leftmost bit of the Message Code is eoc_{i1} in Figures 2.2.1-13 and 2.2.1-14. It is also the most significant bit, and it is transmitted and received before the other seven bits of the Message code.

b. Affirmative Acknowledgment Implicit in eoc Protocol.

Sixty-four eoc message codes have been reserved for nonstandard applications[10] in the following four blocks of 16 codes each (x is 1 or 0): 0100 xxxx, 0011 xxxx, 0010 xxxx, 0001 xxxx. Another 64 eoc message codes have been reserved for internal network use[11] in the following four blocks of 16 codes each (x is 1 or 0): 0110 xxxx, 0111 xxxx, 1000 xxxx, 1001 xxxx. All remaining codes not defined in Table 2.2.3-2 and not reserved for nonstandard applications or for internal network use are reserved for future standardization. Thus, 120 codes associated with the NT (000) and broadcast (111) addresses, are available for future specification (that is, 256 total codes minus 8 defined codes from the table minus 64 codes for nonstandard applications minus 64 codes for internal network use).

When no functions are latched, and the network has no other messages to send, the network may send either the Hold State message or the Return to Normal message without changing the state of the NT. When one or more functions are latched, and the network has no other messages to send, the network shall send the Hold State message to keep the function(s) latched. However, the network may continue to send the message for one of the latched functions for some period during which the function is latched, with no change in NT state. The network shall send the Return to Normal message to unlatch any previously latched function(s). When the functions are unlatched, the network shall send the Hold State message, or continue to send the Return to Normal message until there is a need to send some other message.

The following list categorizes the M-channel eoc messages according to corresponding operations:

10. The reservation of codes for nonstandard applications does not in any way endorse their use. Any use of such messages shall not interfere with the eoc protocol. A transceiver that supports messages for nonstandard applications shall operate properly for standard functions with other transceivers that meet the requirements.

11. The reservation of codes for internal network applications does not in any way endorse their use. Any use of such messages shall not interfere with the eoc protocol. An NT is not expected to recognize these codes and should respond as discussed in "Mode of Operation," Section 2.2.3.1.3.2.

Request Diagnostic Data Function	Operate/Release Loopback Function
Notify of Corrupted *crc*	Operate 2B+D Loopback
Request Corrupted *crc*	Operate B_1-Channel Loopback
Return to Normal	Operate B_2-Channel Loopback
Unable to Comply	Return to Normal
Hold State	Unable to Comply
	Hold State

2.2.3.2 Environmental Conditions

2.2.3.2.1 Protection

Material referring to protection may be found in "Overvoltage, Surge Protection, and EMC," Section 2.2.3.4.

2.2.3.2.2 Electromagnetic Compatibility

Material referring to electromagnetic compatibility may be found in "Overvoltage, Surge Protection, and EMC," Section 2.2.3.4.

2.2.3.3 Test Loops and Performance Measurements

This section is not part of the specification — for information only.

2.2.3.3.1 Notes on the Class of Test Loops

This section is not part of the specification — for information only.

For the purpose of this section, the telephone loop plant is defined as a set of 16 loops, 1 being a null (zero length) loop, with crosstalk and other impairments as specified in "Received Line Signal Characteristics," Section 2.2.1.6.4. The makeups of the 15 nonnull loops are presented in Figures 2.2.3-3, 2.2.3-4, and 2.2.3-5.

The characteristics of the loops in Figures 2.2.3-3, 2.2.3-4, and 2.2.3-5 are precisely defined over a broad frequency range by means of the primary constants listed in the tables in "Primary Constants of Typical Telephone Cable," Section 2.2.4.3. The tables give values of resistance per mile (R), inductance per mile (L), conductance per mile (G), and capacitance per mile (C) based on a commonly used model of polyethylene insulated cable (PIC) at approximately room temperature (70° F). Obviously, actual cable deviates from the precise model, depending on such factors as temperature, insulation type, manufacturer, and detailed manufacturing conditions. Further information on the characteristics of cable is given in "Primary Constants of Typical Telephone Cable," Section 2.2.4.3.

The cable makeups of 15 loops to be used in the measurement of BER were chosen with the help of loop configurations from a survey of customer loops taken in 1983. However, the actual loop makeups, as found in the survey, have been somewhat simplified to make it easier to simulate these loops in a laboratory. Thus, the sections of different gauge are relatively long, and in multiples of a convenient length in kilofeet. The units, kilofeet and gauge, are used to conform to records for most existing North American telephone plants. Further information about the characteristics of the test loops is found in "Primary Constants of Typical Telephone Cable," Section 2.2.4.3.

2.2.3.3.2 Notes on Test Procedure for Measuring BER

The filter needed to simulate the crosstalk interference from 49 disturbers can be conceptually divided into three sections: one that is shaped like the power spectral density (PSD) of an assumed interferer; one representing a model for near-end crosstalk (NEXT) characteristics for 49 disturbers; and one that bandlimits the simulated crosstalk at four times the baud rate of the 2B1Q system (320 kHz). The design of the filter is not considered here. Requirements to assure sufficient accuracy of the resulting simulated NEXT are given in the main text of this section.

Figure 2.2.3-2 shows the PSD of the assumed interferers, the basis of the first conceptual section, and is also expressed as P in the following equation.

Exhibit 2.2.3-2 — Single-Sided PSD Equation

$$P = K \times \frac{1}{f_o} \times \frac{[sin(\frac{\pi f}{f_o})]^2}{(\frac{\pi f}{f_o})^2} + K \times \frac{2}{2f_o} \times \frac{[sin(\frac{\pi f}{2f_o})]^2}{(\frac{\pi f}{2f_o})^2}$$

where:

f = frequency in Hz

f_o = 80,000 Hz

K = 5/9 x V_p^2/R

V_p = 2.33 Volts

R = 135 Ohms.

The equation and the figure are single-sided PSDs, meaning that the integral of P, with respect to f, from 0 to infinity, gives the power in Watts.

The first term in the equation for P is *half* of the PSD of an 80-kbaud 2B1Q signal with random equiprobable levels, full-baud square-topped pulses and no filtering (10.5 dBm). The second term is the PSD of a similar signal of twice the baud rate (13.5 dBm).

To complete our understanding of the assumed interferer, consider P_1 , also given in Figure 2.2.3-3 and in the following equation.

Exhibit 2.2.3-3 — Full PSD Equation

$$P = K \times \frac{2}{fo} \times \frac{[sin(\frac{\pi f}{fo})]^2}{(\frac{\pi f}{fo})^2}$$

where:

f = frequency in Hz
fo = 80,000 Hz
K = 5/9 x V_p^2/R
V_p = 2.33 Volts
R = 135 Ohms.

The P_1 is the *full* PSD of an 80-kbaud 2B1Q signal with random equiprobable levels, full-baud square-topped pulses, and no filtering (13.5 dBm). P_1 has the property that it is essentially identical to the PSD of most 2B1Q systems at frequencies below 50 kHz, but because there is no pulse shaping (filtering) it is greater than the PSD of most 2B1Q systems at frequencies above 50 kHz, and in fact it violates the upper bound for PSD (Figure 2.2.1-9).

At frequencies below 50 kHZ, P is nearly identical to P_1 but the second term causes the null in P_1 at 80 kHz to be filled in. Selection of P to represent the interferers is a deliberate attempt to force designers to sharply reduce the sensitivity of their receivers to interference components above 50 kHz. Because P has essentially the same value below 50 kHz as a transceiver meeting the Specification, the margin should be the same as is achieved using the transceiver's own PSD as the basis for producing simulated crosstalk, as long as the receiver is properly filtered.

The second conceptual section, the simplified NEXT model, is a transfer function with loss decreasing at 15 dB per decade of frequency and having 57-dB loss at 80 kHz.

This transfer function results in the $f^{3/2}$ factor in P_{NEXT} (see "Simulated Crosstalk," Section 2.2.1.6.4.4.1). This transfer function can not be realized as a separate filter because it exhibits a singularity at infinity. The transfer function is an approximation to the average NEXT loss for the worst 1 percent of pair combinations in a binder group in the population of all binder groups.

The problem of a singularity at infinity is moot because the complete filter includes a third conceptual section to bandlimit the simulated NEXT at four times the baud rate (320 kHz).

The electronic components that produce the artificial NEXT must permit the Gaussian signal to have unclipped peaks to at least six times its root mean squared value.

The NEXT source defined in "Simulated Crosstalk," Section 2.2.1.6.4.4.1, is used by connecting it in parallel with the connection of the loop to the transceiver. See point I in Figure 2.2.1-8.

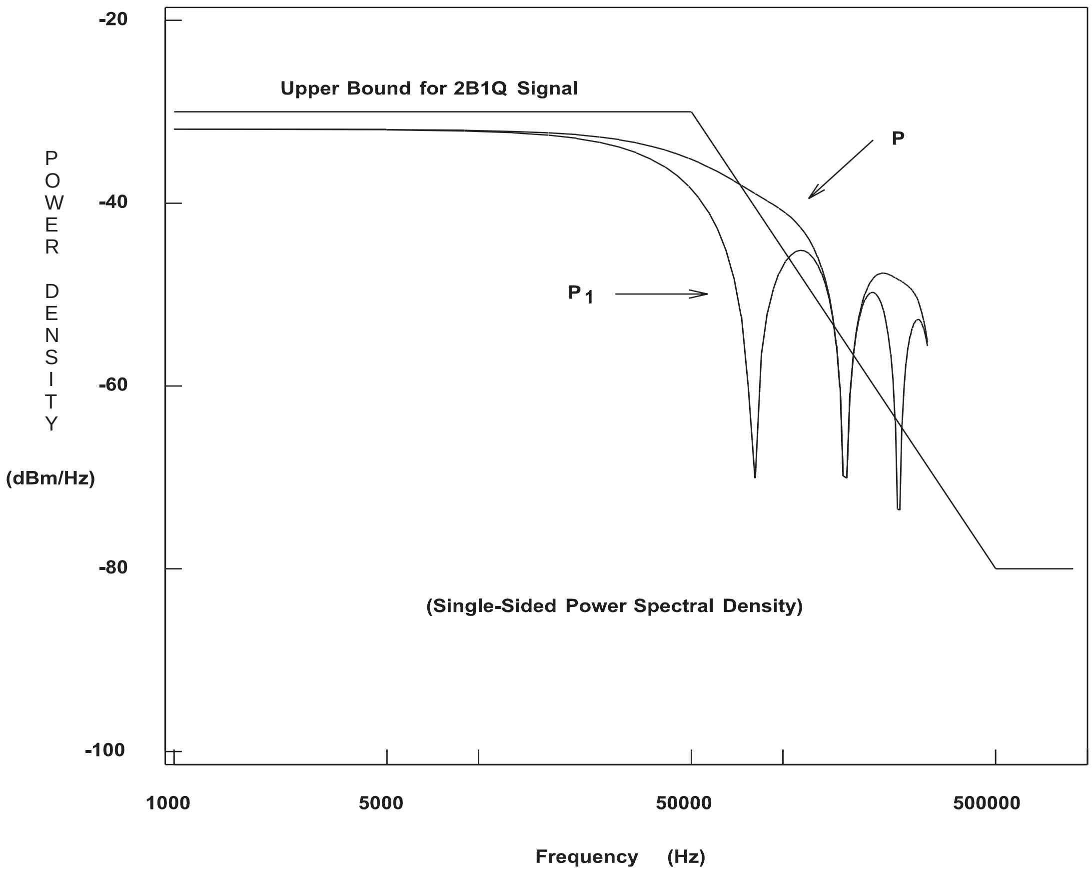
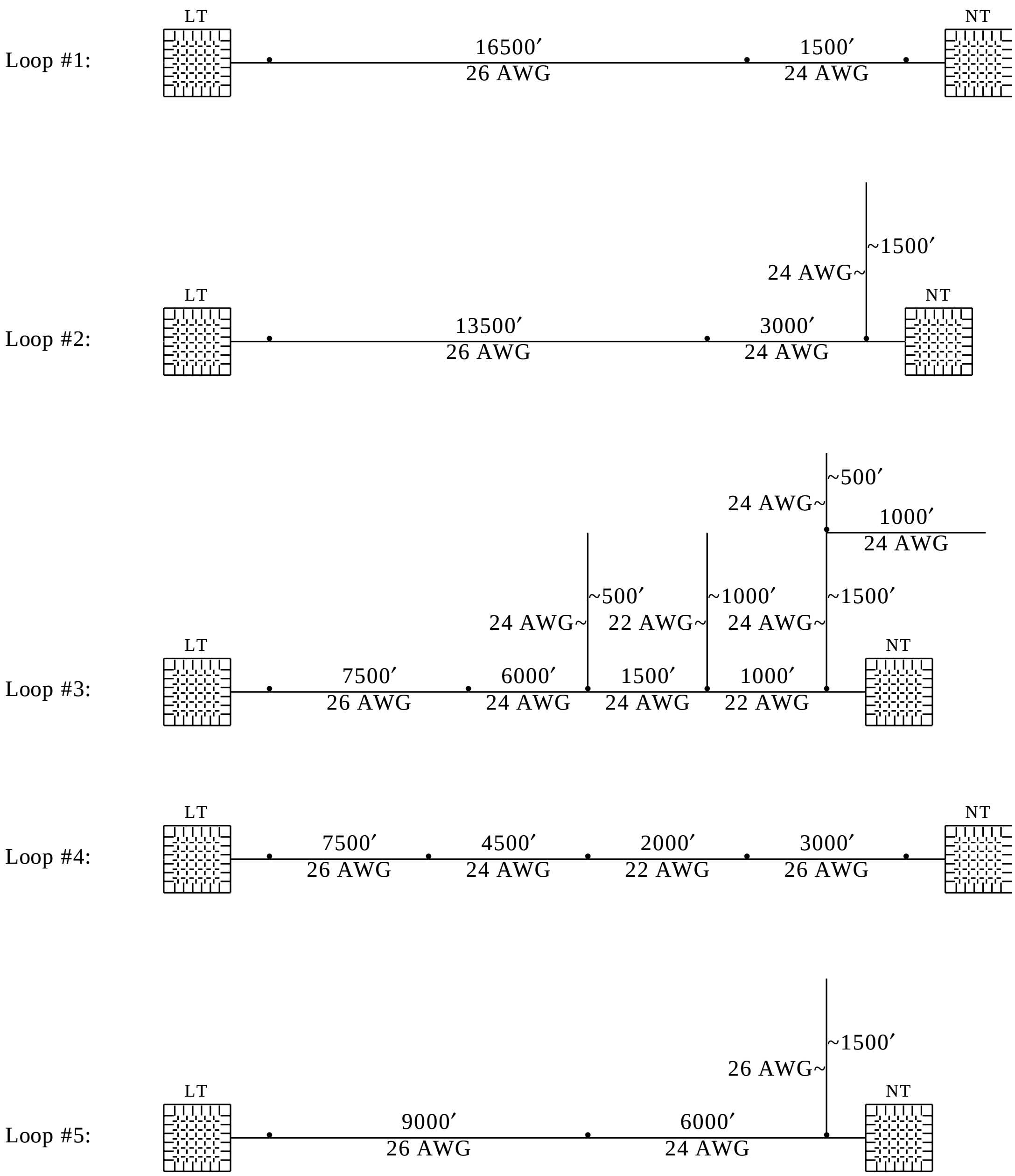
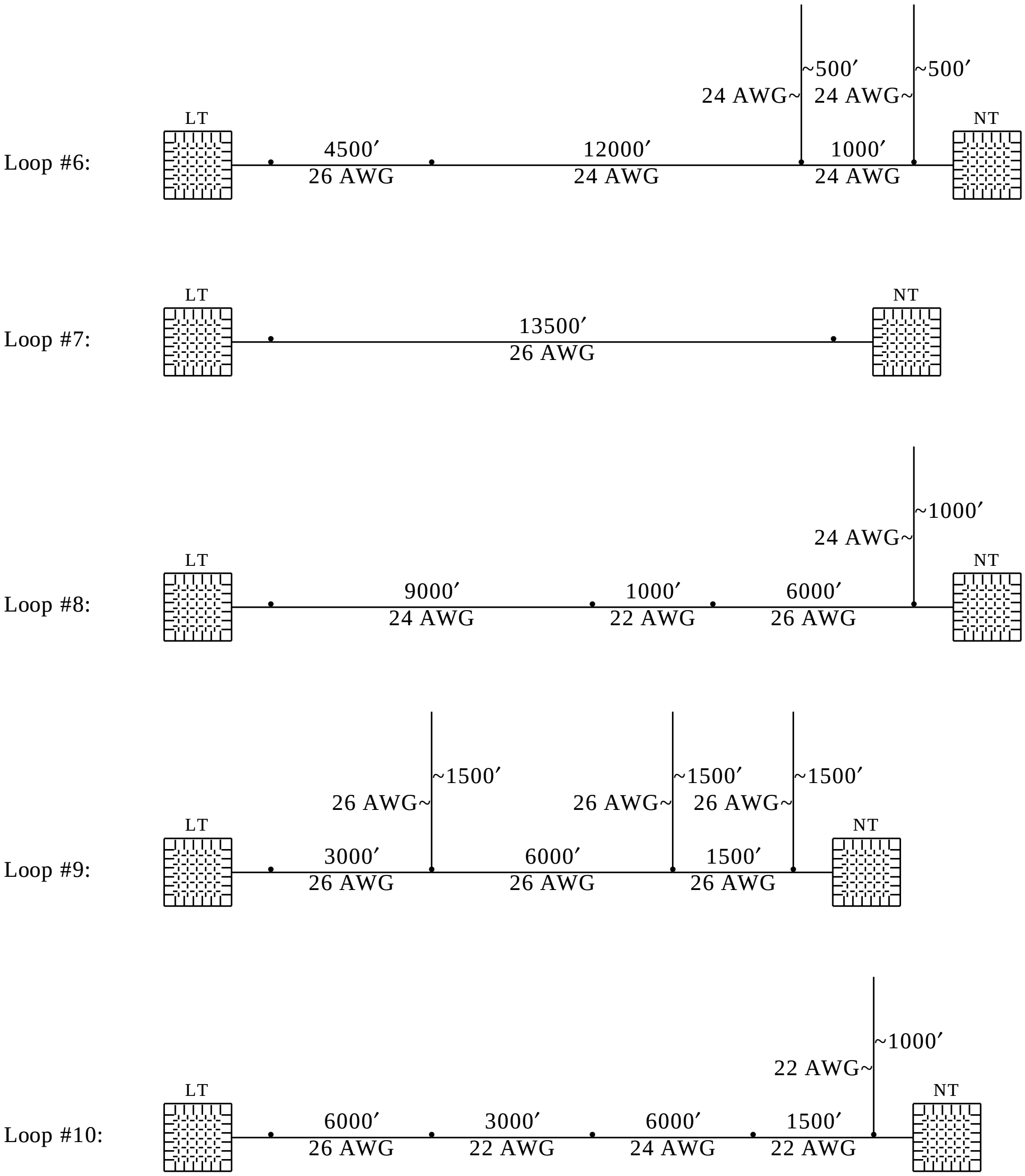


Figure 2.2.3-2 — Power Spectral Density (PSD) of Assumed Interferers



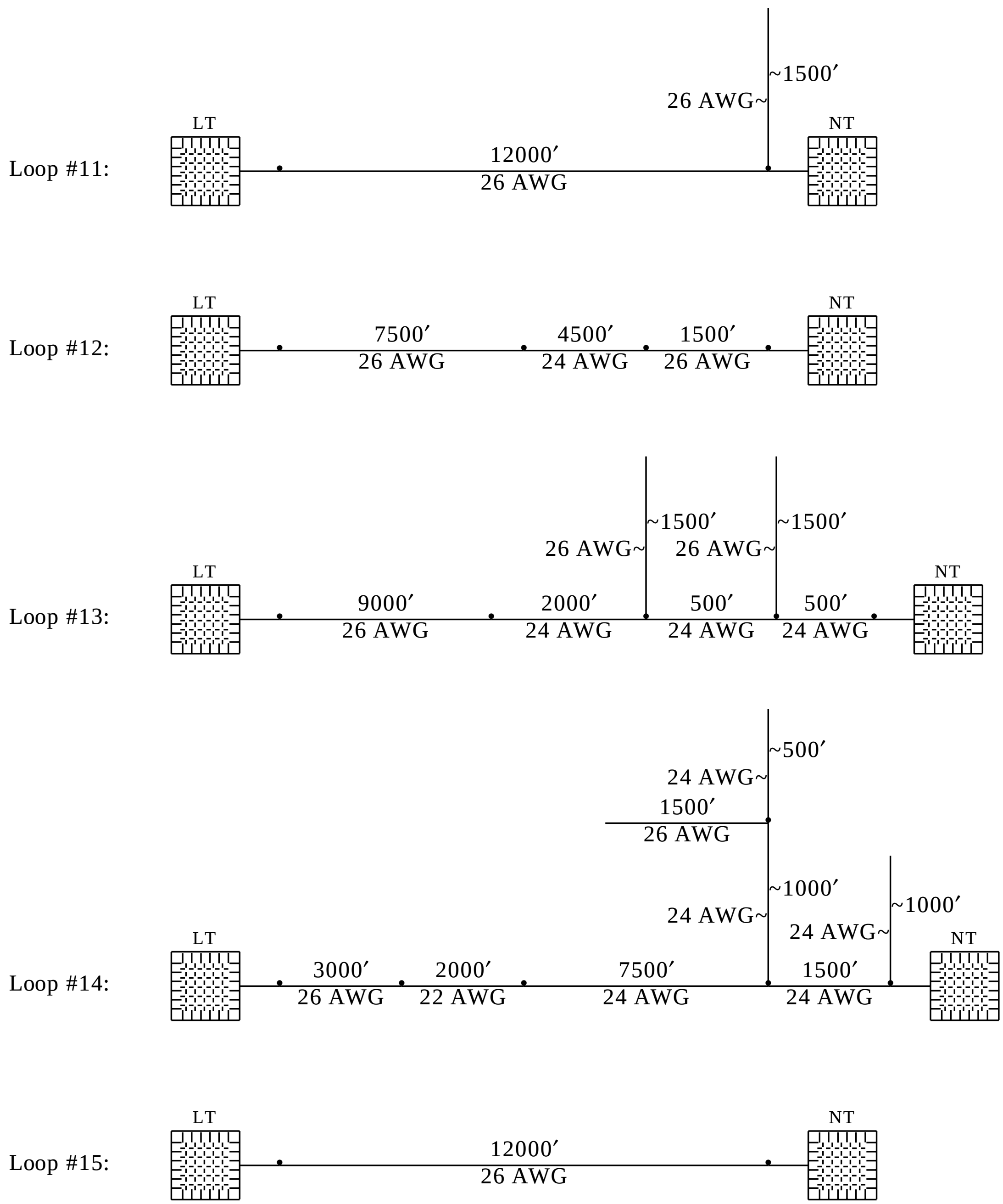
Note: 1) AWG means American Wire Gauge
2) Distances are in feet (′): 1000′ = .3048 km

Figure 2.2.3-3 — Loops for Testing Received Signal Performance: #1 - #5



Note: 1) AWG means American Wire Gauge
2) Distances are in feet (′): 1000′ = .3048 km

Figure 2.2.3-4 — Loops for Testing Received Signal Performance: #6 - #10



Note: 1) AWG means American Wire Gauge
2) Distances are in feet (′): 1000′ = .3048 km

Figure 2.2.3-5 — Loops for Testing Received Signal Performance: #11 - #15

2.2.3.4 Overvoltage, Surge Protection, and EMC

This section is not part of the specification — for information only.

The purpose of this section of the interface specification is to present the electrical characteristics of the ISDN Basic Access signals appearing at the network side of the NT, and to describe the physical interface between the network and the NT. Such phenomena as lighting and overvoltages due to inductive interference or power crosses lie beyond the scope of this section. However, these topics are discussed in other readily-available documents as follows:

On the subjects of lightning and 60-Hz overvoltages:

- Technical Report TR-EOP-000001, Issue 2, "Lightning, Radio Frequency and 60 Hz Disturbances at the Bell Operating Company Network Interface," Piscataway, N.J.; Bellcore; 1987, June.
- *ANSI*[12]/IEEE C62.42-1986, "Guide for the Application of Gas Tube Arrester Low-Voltage Surge-Protective Devices."

Both documents contain useful information on the application of surge arresters and the loop electrical environment.

The following standards documents are also available:

- *UL*[13] 1459, "Standard for Telephone Equipment," Underwriters Laboratories, Inc. This standard deals with safety considerations for telephone equipment.
- *ANSI*/EIA/TIA-571, "Environmental Considerations for Telephone Terminals." This standard discusses the normal operating environment of telephone terminal equipment, fire hazards, and protection.

The reader may also wish to consult the following:

- D. W. Bodle and P. A. Gresh, "Lightning Surges in Paired Telephone Cable Facilities," Bell System Technical Journal, Vol. 40, (March 1961).
- P. A. Gresh, "Physical and Transmission Characteristics of Customer Loop Plant," Bell System Technical Journal, Vol. 48, (December, 1969).
- Donald N. Heirman, "Time Variations and Harmonic Content of Inductive Interference in Urban/Suburban and Residential/Rural Telephone Plants," IEEE, 1976 Annals No. 512C0010.
- R. L. Carroll and P. S. Miller, "Loop Transients at the Customer Station," Bell System Technical Journal, Vol. 59, No. 9, (November 1980).
- R. L. Carroll, "Loop Transient Measurements in Cleveland, South Carolina," Bell System Technical Journal, Vol. 59, No. 9 (November 1980).
- "Measurement of Transients at the Subscriber Termination of a Telephone Loop," ITU-TS, COM V-No. 53 (November 1983).
- D. V. Batorsky and M. E. Burke, "1980 Bell System Noise Survey of the Loop Plant," AT&T Bell Laboratories Technical Journal, Vol. 63, No. 5 (May––June 1984).
- Hiroaki Koga and Tamio Motomitsu, "Lightning-Induced Surges in Paired Telephone Subscriber Cable in Japan," IEEE Transactions on Electromagnetic Compatibility, Vol. EMC-27, August 1985.
- Gord Clarke and Mike Coleman, "Study Sheds Light on Overvoltage Protection," Telephony, November 24, 1986.

---

12. Registered trademark of American National Standard Institute.
13. Registered trademark of Underwriter Laboratories, Inc.

The power emitted by the DSL is limited by the masks presented in Figures 2.2.1-7 and 2.2.1-9.

Notwithstanding any information contained or implied in these figures, it is assumed that the DSL will comply with applicable FCC requirements on emission of electromagnetic energy. These requirements may be found in the Title 47, Code of Federal Regulations, Sections 15 and 68, and other FCC documents.

In the design of the NT, consideration should be given to the handling of the following additional environmental conditions:

a. ***Maximum Continuous (Sealing Current) Voltage:*** The maximum DC voltage that can be applied from a sealing current source is -72 volts (limited by safety considerations).

b. ***Maximum Short-Term DC Test Voltages:*** Metallic testing systems can apply voltages as high as +135 V. This voltage in combination with the -52 V office battery could result in voltages as high as 190 volts across the NT. Source impedances in this case could be as low as 200 ohms. Test voltages such as this are applied for less than 1 sec with repeated applications occurring with no greater than 25 percent duty cycle.

c. ***Maximum Accidental Ringing Voltages:*** Ringing voltages can be accidentally applied to the NT. The largest ringing voltage that is applied to a loop from present-day switching systems is 105 volts RMS, 20 Hz superimposed on -52 V DC (-200.5 V peak) with a minimum source impedance of 200 ohms. Ringing cadences typically have a 33 percent duty cycle over a 6-second period.

2.2.3.5 DSL Start-Up and Activation

This section is not part of the specification — for information only.

2.2.3.5.1 Overview of Start-up and Activation

The requirements for start-up of digital subscriber line transceivers at the interface on the network side of the NT are given in "Start-Up and Control," Section 2.2.1.7.4. This section covers both the case in which the transmission system remains active essentially all the time as well as the optional case in which the transceivers are turned-on only when needed for transmission. Total activation is a term used to include both DSL start-up and activation of the S/T interface. Operation involving the U-only activation feature [see "Superframes," Section 2.2.1.7.2.6, "U-Interface-Only-Activation (uoa) Bit," Section 2.2.3.1.2.7, and "S/T-Interface-Activity-Indicator (sai) Bit," Section 2.2.3.1.2.8] is also described. The total-activation process is controlled from points away from the interface, and therefore the context of the requirements given in "Start-Up and Control," Section 2.2.1.7.4, is much more than the interface requirements given there.

The purpose of this section is to discuss examples of how the start-up sequence described in "Start-Up and Control," Section 2.2.1.7.4, may relate to other activation events away from the interface. It is not the intention of this section to specify requirements on how the NT relates events at its two interfaces. For a complete discussion of the activation requirements at the S and T reference points, see *ANSI* T1.605-1991 and ITU-TS Recommendation I.430.

Figure 2.2.3-6 shows the Layer 1 customer access, including the ISDN system, the LT, the NT, and the TE. Signals that cross each boundary are listed below it, with arrows indicating direction. For instance, the signals TL, SL0, SL1, SL2, and SL3, as discussed in "Start-Up and Control," Section 2.2.1.7.4, are shown going from the LT to the NT. As indicated in Figure 2.2.3-6, ITU-TS Recommendation G.960 discusses signals crossing all the boundaries. The signals crossing the NT-TE boundary are discussed in greater detail in both *ANSI* T1.605-1991 and ITU-TS Recommendation I.430. The signals on the interface between the NT and LT are discussed in greater detail in the ITU-TS Recommendation G.961. Not all signals shown crossing the "Boundary" between the ISDN system and the LT may actually cross that boundary. For instance, either the status of DSL synchronization, or the presence of DSL signal could be used entirely within the LT with only the primitives (AI, DI) indicating DSL status to the ISDN system. Furthermore, the indication primitives or the status indicators may simply be deliverable on request, as opposed to actively transmitted across the boundary. This depends on the architecture of the ISDN system and on where one draws the boundary between the LT and the rest of the ISDN system.

The purpose in detailing the activation process in this section is to understand the context for the requirements found in "Start-Up and Control," Section 2.2.1.7.4. Therefore, only those functions found in Figure 2.2.3-6 that relate to start-up or turn-off will be discussed further.

Figures 2.2.3-7 and 2.2.3-8 illustrate the total activation process: Figure 2.2.3-7 when initiated by the exchange, and Figure 2.2.3-8 when initiated by the terminal equipment. The boxes in Figure 2.2.3-6 represent the start-up process; time moves toward the right; events at the network end of the system are represented across the bottom; and events at the TE end of the system are represented across the top. Signals above the box are at the T-reference point. Signals below the box are inside the exchange. Signals inside the box are at the network side of the NT.

Other forms of illustration are also given in Figures 2.2.3-9, 2.2.3-10, 2.2.3-11, 2.2.3-12, 2.2.3-13, 2.2.3-14, and 2.2.3-15. In Figures 2.2.3-9, 2.2.3-10, 2.2.3-11, 2.2.3-12, 2.2.3-13, 2.2.3-14, and 2.2.3-15., time moves down, and additional detail about signals exchanged by the LT and NT is shown. Deactivation and DSL-only turn-on is also illustrated.

The most complex form of illustration is found in the finite-state matrices, Tables 2.2.3-3, 2.2.3-5, 2.2.3-7, and 2.2.3-9. See "Discussion of eoc Addressing," Section 2.2.4.1, and "Activation Finite State Matrices," Section 2.2.3.5.6.

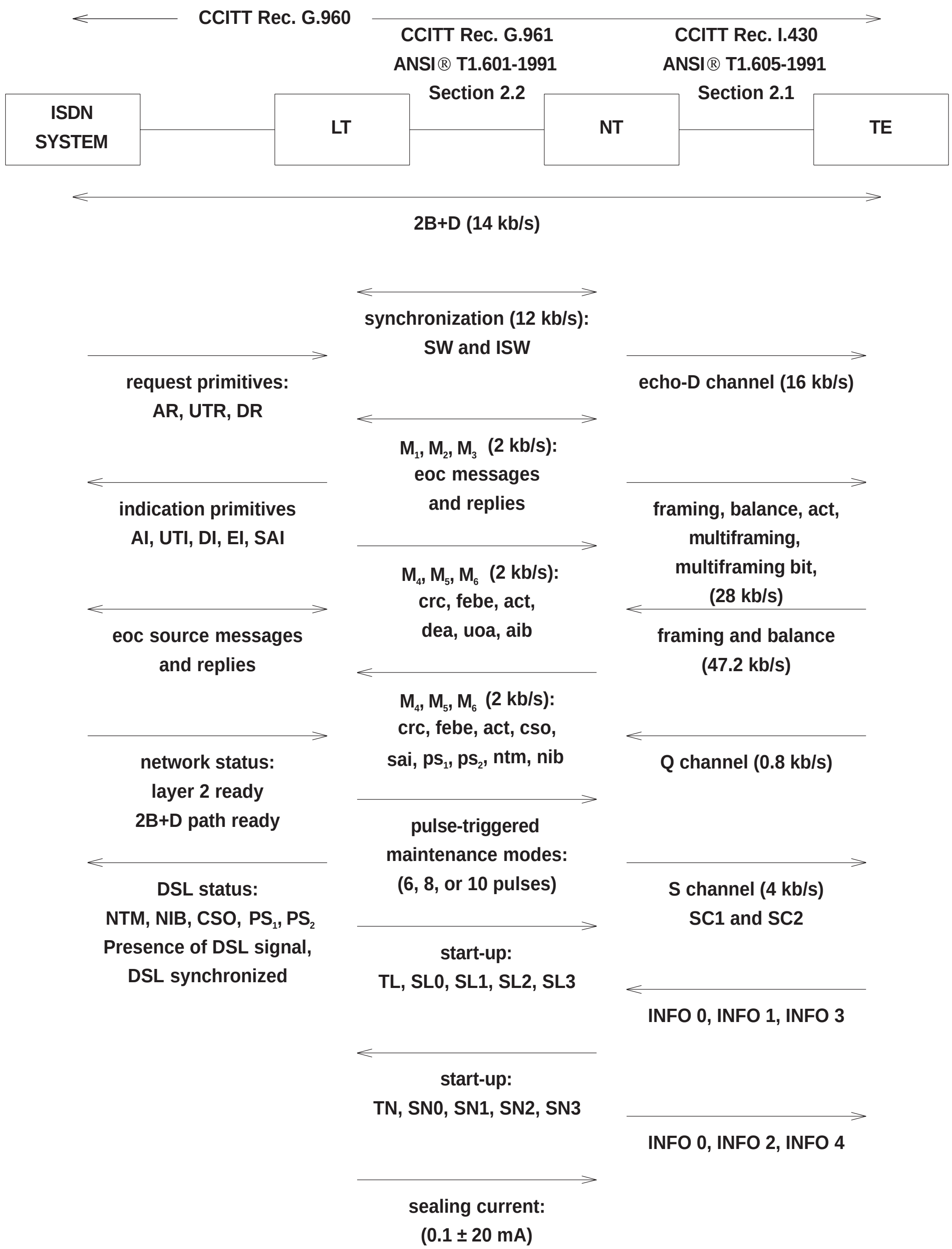


Figure 2.2.3-6 — ISDN Basic Access Signals

2.2.3.5.2 Symbols, Abbreviations, and Notes

This section contains symbols, abbreviations, and notes for Figures 2.2.3-9, 2.2.3-10, 2.2.3-11, 2.2.3-12, 2.2.3-13, 2.2.3-14, and 2.2.3-15.

Symbols and Abbreviations

"—"	No change, no action
"- -"	No change, no action
"/"	Impossible or prohibited situation under normal circumstances
"AI"	Primitive - Activation Indication (Note 1)
"AR"	Primitive - Activation Request (Note 1)
"DI"	Primitive - Deactivation Indication (Note 1)
"DR"	Primitive - Deactivation Request (Note 1)
"EI"	Primitive - Error Indication (Note 1)
"Hn"	Go to state "Hn"
"Jn"	Go to state "Jn"
"ST.Mn"	Start timer Mn
"STP.Mn"	Stop timer Mn
"SLn,SNn"	Pulse patterns produced by NT or LT, respectively SL0, SN0 = no signal)
"Tn"	Notation refers to transition instants defined in Figure 2.2.1-17
"UTI"	Primitive - U-only Turn-on Indication
"UTR"	Primitive - U-only Turn-on Request

Note 1: Primitives are the subject of continuing study and are significant only in combined NT1/TE or LT/ET implementations.

Note 2: These events are initiated at the T reference point (See T1.605-1991, Table 4).

Note 3: This condition represents an "Activation Request" event.

Note 4: This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

Note 5: This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

Note 6: This event takes priority over received act = 0 for warm-start NTs. This event could be ignored for cold-start-only NTs.

Note 7: S/T INFO signals are shown as transmit signals in Tables 2.2.3-3 and 2.2.3-7, which do not directly control these signals. They are included for information only.

Note 8: The signals output in this state remain unchanged from signals output during the preceding state. (For example, act = 0 if States H6 or H11 preceded, or act = 1 if States H7 or H8 preceded.)

Note 9: This event will cause turn-off of the NT independent of whether the transmitter is cold-start-only or warm-start.

Note 10: This event must occur after transmitting at least three superframes with dea=0. See "Turn-Off Procedure," Section 2.2.1.7.4.7.5.

Note 11: When in State H4, absence of signal > 480 ms causes transition to State H1.

Note 12: When INFO 1 remains continuous after the NT fails to bring up the network side and returns to State H1, the NT does not again go to State H2, unless a new transition from INFO 0 to INFO 1 is received. See "Reset," Section 2.2.1.7.4.3, and "Supporting Information Relating to DC Metallic Termination," Section 2.2.4.2.

Note 13: The transceiver should return to the state from which it entered State H9, unless the uoa or act bit(s) have changed.

Note 14: The response "H1, EI, DI" applies only during the first 480 ms after ceasing transmission (TN or SN1). Otherwise, "no action" is appropriate. See "Timers," Section 2.2.1.7.4.4.

Note 15: The network is permitted to choose "no action" rather than sending AR and transferring to State J7. For example, when the access link is undergoing maintenance, "no action" is an appropriate response.

Note 16: When in State J3, absence of signal >480 ms causes transition to State J1.

2.2.3.5.3 Total Activation Initiated by the Exchange

Total activation is defined in "Total Activation," Section 2.2.1.7.4.2.1.

Figure 2.2.3-7 illustrates the total activation process initiated by the exchange.

The PH Activate Request (AR) is a switching system primitive impinging on the DSL from the network. The effect of this request is to start the process leading to total activation as described in "Start-Up and Control," Section 2.2.1.7.4, and Figure 2.2.1-16, in which the network sends a tone toward the NT.

The PH Activate Request also causes the overhead dea bit to be set equal to 1 in the network. At first, this action has no effect because there is no communication between network and the NT: no framing or synchronization, no convergence of the equalizer and echo canceler coefficients. Once the NT has acquired the superframe marker (at T6 of Figure 2.2.1-16), the NT is in a position to begin to interpret overhead bits. After the NT has acquired the superframe marker (T6), and verifies uoa=1, it sends INFO 2 toward the TE. In time, the TE replies to INFO 2 with INFO 3. This event is signaled to the network by setting the overhead act bit in the NT-to-network direction equal to 1.

Again, setting act = 1 has no effect initially, because until T7 the network receiver cannot detect overhead bits from the NT.

At the NT, full operational status means that the NT has: (1) acquired bit timing and frame synchronization, (2) recognized the superframe marker, and (3) fully converged both its echo canceler and equalizer coefficients. This point is labeled T6 in Figure 2.2.1-16. At this point, the NT introduces the superframe marker into its signal toward the network as an indication that the NT is fully operational. The presence of act = 1 in the signal SN3 from the NT conveys the presence of INFO 3 at the T-reference point. As long as the conditions for T6 hold, and if the presence of dea = 1 indicates a continuing request for activation from the exchange, if INFO 3 remains present at the T-reference point, and if act = 1 is received from the network, then the NT opens transparent transmission in the B- and D-channels in both directions.

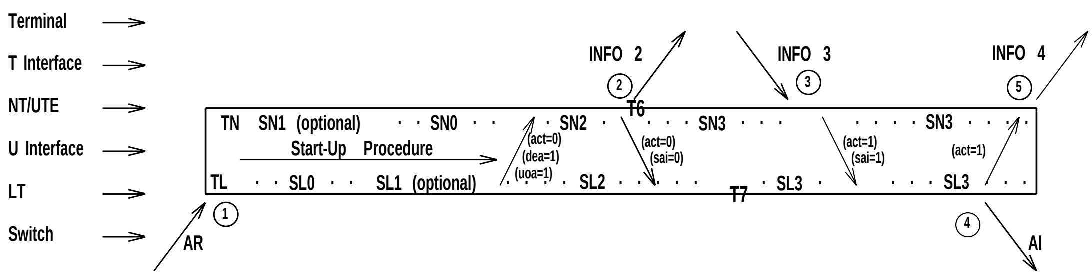
At the network, full operational status of the DSL (beginning at point T7 in Figure 2.2.1-16) means that the network has: (1) acquired bit timing phase of the signal from the NT, and frame synchronization, (2) fully converged its echo canceler and equalizer coefficients, and (3) recognized the superframe marker from the NT. After detecting act = 1 from the NT, the network sets act = 1 in the signal toward the NT. This last event is a signal to the NT that the network is ready for Layer 2 communication. As long as full operational status is maintained, if the total-activate request from the exchange continues, and if the network continues to receive act = 1 from the NT, then the network begins transparent transmission in B- and D-channels in both directions.

Only after transceivers in the NT and LT have attained transmission transparency can the customer initiate or receive calls on the B- and D-channels.

The time scale in Figures 2.2.3-7 and 2.2.3-8 is not meant to be representative of the relative amounts of time spent on different parts of the processes.

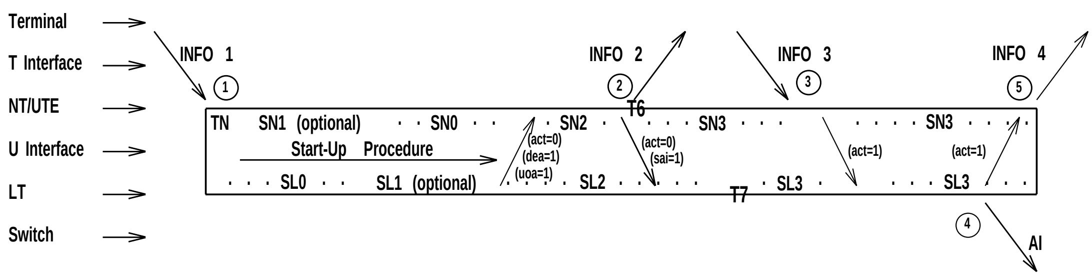
The reader is referred to *ANSI* T1.605-1991 and ITU-TS Recommendation I.430 for more information on the activation process at the S/T reference point, the interface between the NT and the customer terminal equipment.

Figures 2.2.3-9 and 2.2.3-10 is an alternative illustration of total activation initiated by the network. The diagonal arrows show the direction of signal flow, whereas the horizontal arrows show the direction of information flow.



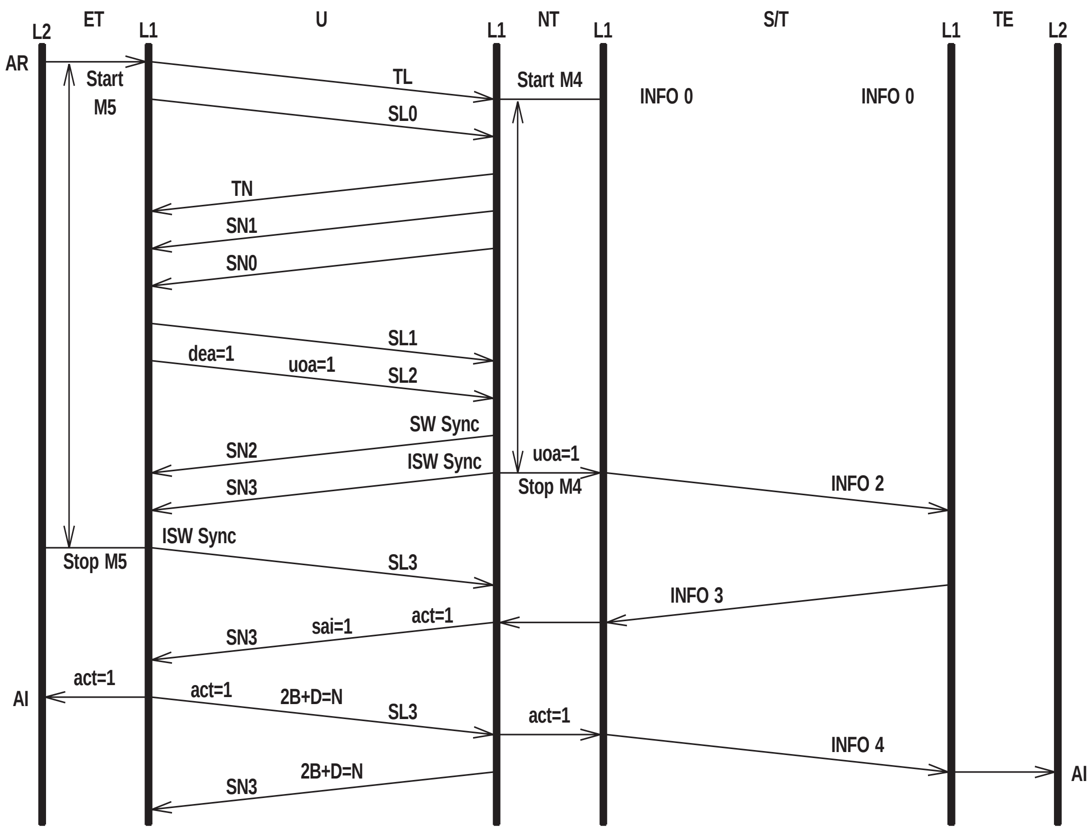
1. Exchange requests activation (AR). (Set dea = 1.)
2. NT has detected superframe marker and is fully operational (T6).
3. TE replies to INFO 2 with INFO3, and NT sends act = 1.
4. LT has recognized superframe marker from the NT and has detected act = 1 from NT. LT sends active indication (AI) to layer 2 and opens channels to normal signals.
5. NT has detected act = 1. NT opens channels to normal signals.

Figure 2.2.3-7 — Outline of Total Activation Process - Total Activation Initiated by the Exchange



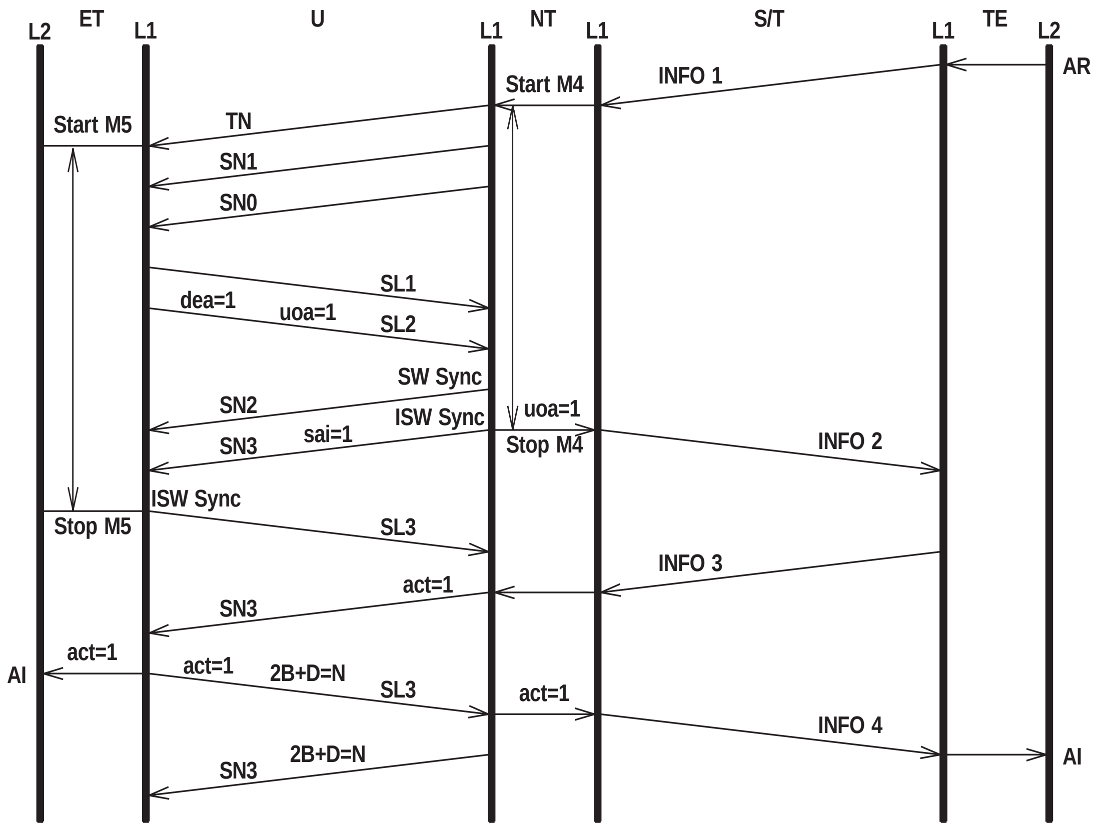
1. TE requests activation (INFO 1).
2. NT has acquired superframe marker and is receiving INFO 1 (T6).
3. TE replies to INFO 2 with INFO 3, and NT sends act = 1.
4. LT has recognized superframe marker from the NT and has detected act = 1 from NT. LT sends active indication (AI) to layer 2 and opens channels to normal signals.
5. NT has detected act = 1. NT opens channels to normal signals.

Figure 2.2.3-8 — Outline of Total Activation Process - Total Activation Initiated by Terminal Equipment



NOTES:
1. L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-3, 2.2.3-4, 2.2.3-7, and 2.2.3-8.
2. Receipt of INFO 3 and SL3 at the NT can theoretically occur in either order.
3. Reading of the uoa bit is necessary only when the option “DSL-only turn-on” is implemented.

Figure 2.2.3-9 — Total Activation Process - Total Activation Initiated by the Exchange



NOTES:
1. L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-3, 2.2.3-4, 2.2.3-7, and 2.2.3-8.
2. Receipt of INFO 3 and SL3 at the NT can theoretically occur in either order.
3. Reading of the uoa bit is necessary only when the option “DSL-only turn-on” is implemented.

Figure 2.2.3-10 — Total Activation Process - Total Activation Initiated by Terminal Equipment (INFO 1)

2.2.3.5.4 Total Activation Initiated by the Terminal Equipment

Total activation is defined in "Total Activation," Section 2.2.1.7.4.2.1.

Figure 2.2.3-8 illustrates the total activation process initiated by the terminal equipment. It is essentially similar to Figure 2.2.3-7, except that INFO 1 from the TE begins the process. In this case, the NT starts the process described in "Start-Up and Control," Section 2.2.1.7.4, and Figure 2.2.1-16 by sending a tone toward the network. Once the NT has acquired the superframe marker (at T6 in Figure 2.2.1-16) it sends the INFO 2 signal. The rest of the process is identical to Figure 2.2.3-7.

Although a process setting dea = 1 is not shown in Figure 2.2.3-8, the bit must be set equal to 1 by the network transceiver at some time before instant T4 of the start-up procedure (see Figure 2.2.1-16). This is to ensure that the NT does not receive an inadvertent turn-off announcement after having achieved superframe synchronization.

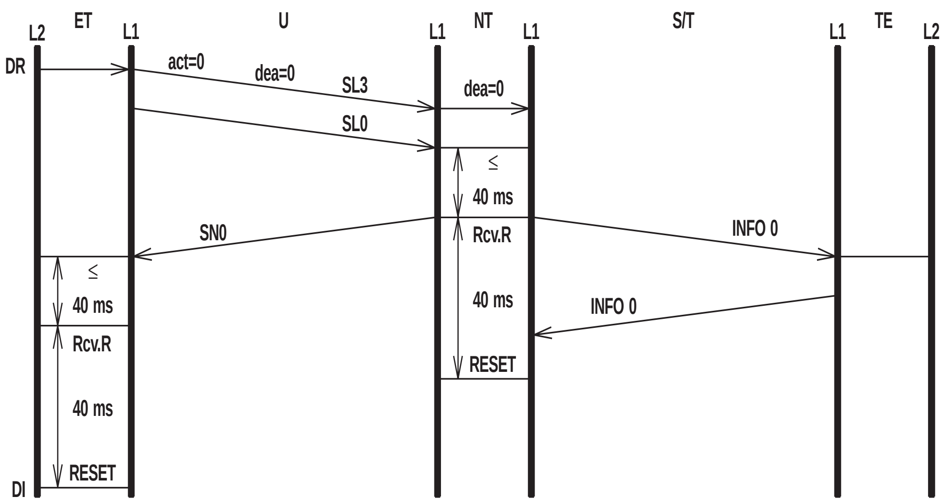
Figure 2.2.3-10 is an alternative illustration of total activation initiated by the terminal equipment. The diagonal arrows show the direction of signal flow, whereas the horizontal arrows show the direction of information flow.

2.2.3.5.5 Total Deactivation

Total deactivation is defined in "Total Deactivation," Section 2.2.1.7.4.2.7.

The PH Deactivate Request (DR) is a switching system primitive that starts the turn-off process described in "Turn-Off Procedure," Section 2.2.1.7.4.7.5. After detecting dea=0, the NT deactivates the S/T interface by sending INFO 0.

Figure 2.2.3-11 illustrates a method of showing total deactivation (a process that starts from total activation and is always initiated by the exchange).



NOTE:
L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-3, 2.2.3-4, 2.2.3-7, and 2.2.3-8.

Figure 2.2.3-11 — Total Deactivation Process (DR)

2.2.3.5.6 Activation Finite State Matrices

The total activation/deactivation procedures for NTs and LTs (both warm-start and cold-start-only) are shown in the form of finite state matrices, Tables 2.2.3-3 and 2.2.3-5, respectively. The finite state matrices reflect the requirements necessary to assure proper interfacing of LTs with NTs and vice versa. The primitives at the Layer 1 boundary are also described.

2.2.3.5.7 S/T-Only Activation

If the NT does not acquire the superframe marker within the maximum permitted time (15 seconds), the NT may send the INFO 2 signal synchronized to an internal free-running clock. Once the NT receives the INFO 3 signal from a TE in response to this INFO 2 signal, it may send the INFO 4 signal. This procedure is required to permit the S/T interface to activate for maintenance reasons when the network interface cannot activate.

Table 2.2.3-3 — Activation/Deactivation: NT (H) Finite State Matrix (An Example) (1 of 2)

ab EVENT ↓	STATE NAME:	POWER-OFF	FULL RESET	ALERTING	EC TRAINING (OPTIONAL)	EC CNVRG'D	SW SYNC	ISW SYNC
	STATE CODE EVENT:[c]	H0	H1 (T0)	H2	H3 (T1)	H4 (T2)	H5 (T5)	H6 (T6)
	SIGNAL -> LT:	SN0	SN0	TN	SN1	SN0	SN2	SN3 act=0
	SIGNAL -> TE:[d]	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 2 act=0
Power ON		ST.M4 H2	-	-	-	-	-	-
Loss of power		-	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI
Received new INFO 1 signal [f g]		/	H2 [h]	-	-	-	-	-
Received INFO 3 signal (act=0,dea=1) [f g]		/	/	/	/	/	/	/
Received INFO 0 or S/T Loss of Sync [f j]		/	-	-	-	-	-	-
End of Tone TN (9 ms)		/	/	H3 or H4	/	/	/	/
Received tone TL		/	ST.M4 H2	-	/	/	/	/
Echo canceler converged		/	-	-	H4	-	-	-
SW sync and detect SL2		/	/	/	/	H5	-	-
ISW sync (SL2)		/	/	/	/	/	STP.M4 H6	-
Received dea=0 (SL2 or SL3) [k]		/	/	/	/	/	/	H9
Received (SL2 or SL3) act=0 and dea=1		/	/	/	/	/	/	-
Received (SL3) act=1 and dea=1		/	/	/	/	/	/	-
Loss of synchronization (> 480 ms)		/	/	/	/	/	/	H10 EI
Loss of signal (> 480 ms) [m]		/	/	/	/	STP.M4 H1 EI, DI [n]	-	ST.M6 H12 EI
Expiry of timer M4 (15 seconds)		/	/	/	H10 EI	H10 EI	H10 EI	/
Loss of Signal < 40 ms		/	/	/	/	-	-	-
Expiry of timer M6 (40 ms)			/	/	/	/	/	/

Note(s):

a. Symbols and Abbreviations:
- - = No change, no action
- / = Impossible or prohibited situation under normal circumstances
- AI = Primitive - Activation Indication
- AR = Primitive - Activation Request
- DI = Primitive - Deactivation Indication
- DR = Primitive - Deactivation Request
- EI = Primitive - Error Indication
- Hn = Go to state "Hn"
- Jn = Go to state "Jn"
- ST.Mn = Start timer Mn
- STP.Mn = Stop timer Mn
- SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
- Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
- UTI = Primitive - U-only Turn-on Indication
- UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant only in combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. S/T INFO signals are shown as transmit signals in Tables 2.2.3-3 and 2.2.3-7, which do not directly control these signals. They are included for information only.

Table 2.2.3-3 — Activation/Deactivation: NT (H) Finite State Matrix (An Example) (1 of 2) (Contd)

Note(s): (Contd)

e. The signals output in this state remain unchanged from signals output during the preceding state. (For example, act = 0 if States H6 or H11 preceded, or act = 1 if States H7 or H8 preceded.)

f. These events are initiated at the T reference point (See T1.605-1991, Table 4).

g. This condition represents an "Activation Request" event.

h. When INFO 1 remains continuous after the NT fails to bring up the network side and returns to State H1, the NT does not again go to State H2, unless a new transition from INFO 0 to INFO 1 is received. See Sections 2.2.1.7.4.3 and 2.2.4.2.

i. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

j. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

k. This event takes priority over received act = 0 for warm-start NTs. This event could be ignored for cold-start-only NTs.

l. The transceiver should return to the state from which it entered State H9, unless the uoa or act bit(s) have changed.

m. When in State H4, absence of signal > 480 ms causes transition to State H1.

n. The response "H1, EI, DI" applies only during the first 480 ms after ceasing transmission (TN or SN1). Otherwise, "no action" is appropriate. See Section 2.2.1.7.4.4.

Table 2.2.3-4 — Activation/Deactivation: NT (H) Finite State Matrix (An Example) (2 of 2)

ab	STATE NAME:	PENDING ACTIVE	ACTIVE	PENDING DEACT'N	TEAR DOWN	TE INACTIVE	RCV RESET
	STATE CODE EVENT:[c]	H7	H8	H9	H10	H11	H12
EVENT ↓	SIGNAL -> LT: SIGNAL -> TE:[d]	SN3 act=1 INFO 2 act=1	SN3 act=1 INFO 4 act=1	SN3 e	SN0 INFO 0	SN3 act=0 INFO 2 act=0	SN0 INFO 0
Power ON		-	-	-	-	-	-
Loss of power		H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI
Received new INFO 1 signal [f g]		/	/	-	-	/	-
Received INFO 3 signal (act=0,dea=1) [f g]		H7	-	-	-	-	H7
Received INFO 0 or S/T Loss of Sync [f j]		H11	H11	-	-	-	-
End of Tone TN (9 ms)		/	/	/	/	/	/
Received tone TL		/	/	/	/	/	ST.M4 STP.M6 H2
Echo canceler converged		-	-	-	-	-	-
SW sync and detect SL2		-	-	-	-	-	/
ISW sync (SL2)		-	-	-	-	-	/
Received dea=0 (SL2 or SL3) [k]		H9	H9	-	-	H9	/
Received (SL2 or SL3) act=0 and dea=1		-	H7	H6, H7or H11 [l]	-	-	/
Received (SL3) act=1 and dea=1		H8 AI	-	H8 [l]	-	-	/
Loss of synchronization (> 480 ms)		H10 EI	H10 EI	H10 EI	-	H10 EI	-
Loss of signal (> 480 ms) [m]		ST.M6 H12 EI	ST.M6 H12 EI	/	/	ST.M6 H12 EI	-
Expiry of timer M4 (15 seconds)		/	/	/	/	/	-
Loss of Signal < 40 ms		-	-	ST.M6 H12	ST.M6 H12	-	/
Expiry of timer M6 (40 ms)		/	/	/	/	/	H1

Note(s):

a. Symbols and Abbreviations:
- = No change, no action
/ = Impossible or prohibited situation under normal circumstances
AI = Primitive - Activation Indication
AR = Primitive - Activation Request
DI = Primitive - Deactivation Indication
DR = Primitive - Deactivation Request
EI = Primitive - Error Indication
Hn = Go to state "Hn"
Jn = Go to state "Jn"
ST.Mn = Start timer Mn
STP.Mn = Stop timer Mn
SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
UTI = Primitive - U-only Turn-on Indication
UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. S/T INFO signals are shown as transmit signals in Tables 2.2.3-3 and 2.2.3-7, which do not directly control these signals. They are included for information only.

Table 2.2.3-4 — Activation/Deactivation: NT (H) Finite State Matrix (An Example) (2 of 2) (Contd)

Note(s): (Contd)

e. The signals output in this state remain unchanged from signals output during the preceding state. (For example, act = 0 if States H6 or H11 preceded, or act = 1 if States H7 or H8 preceded.)

f. These events are initiated at the T reference point (See T1.605-1991, Table 4).

g. This condition represents an "Activation Request" event.

h. When INFO 1 remains continuous after the NT fails to bring up the network side and returns to State H1, the NT does not again go to State H2, unless a new transition from INFO 0 to INFO 1 is received. See Sections 2.2.1.7.4.3 and 2.2.4.2.

i. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

j. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

k. This event takes priority over received act = 0 for warm-start NTs. This event could be ignored for cold-start-only NTs.

l. The transceiver should return to the state from which it entered State H9, unless the uoa or act bit(s) have changed.

m. When in State H4, absence of signal > 480 ms causes transition to State H1.

n. The response "H1, EI, DI" applies only during the first 480 ms after ceasing transmission (TN or SN1). Otherwise, "no action" is appropriate. See Section 2.2.1.7.4.4.

Table 2.2.3-5 — Activation/Deactivation: LT (J) Finite State Matrix (An Example) (1 of 2)

a b	STATE NAME:	POWER OFF	FULL RESET	ALERTING	AWAKE	EC TRAINING	EC CNVRG'D	SW SYNC
	STATE CODE EVENT:[c]	J0	J1 (T0)	J2	J3 (T1)	J4 (T3) OPTIONAL	J5 (T4)	J6
EVENT ↓	SIGNAL -> NT:	SL0	SL0	TL	SL0	SL1	SL2 dea=1	SL2 dea=1
Power ON		J1	-	-	-	-	-	-
Loss of power		-	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI
Activation Request (AR)		-	ST.M5 J2	-	-	-	-	-
Deactivation Request (DR) [d]		-	-	-	-	-	-	-
End of Tone TL (3 ms)		/	/	J3	/	/	/	/
Received tone TN		/	ST.M5 J3	-	-	/	/	/
Loss of signal energy (TN or SN1)		/	/	-	J4 or J5	-	/	/
Echo canceler converged		/	-	-	-	J5	-	-
SW sync (SN2 or SN3)		/	/	/	/	/	J6	-
ISW sync (SN3)		/	/	/	/	/	/	STP.M5 J7
Received act=0 (SN3)		/	/	/	/	/	/	/
Received act=1 (SN3)		/	/	/	/	/	/	/
Loss of synchronization (>480 ms)		/	/	/	/	/	/	/
Loss of signal (>480 ms)		/	/	/	T1 [e]	/	-	-
End of last super frame with dea=0 [f]		/	/	/	/	/	/	/
Expiry of timer M5 (15 seconds)		/	/	/	J10 EI	J10 EI	J10 EI	J10 EI
Absence of signal <40 ms		/	-	/	/	/	-	-
Expiry of timer M7 (40 ms)		/	/	/	/	/	/	/

Note(s):

a. Symbols and Abbreviations:
- = No change, no action
/ = Impossible or prohibited situation under normal circumstances
AI = Primitive - Activation Indication
AR = Primitive - Activation Request
DI = Primitive - Deactivation Indication
DR = Primitive - Deactivation Request
EI = Primitive - Error Indication
Hn = Go to state "Hn"
Jn = Go to state "Jn"
ST.Mn = Start timer Mn
STP.Mn = Stop timer Mn
SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
UTI = Primitive - U-only Turn-on Indication
UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. This event will cause turn-off of the NT independent of whether the transmitter is cold-start-only or warm-start.

e. When in State J3, absence of signal >480 ms causes transition to State J1.

f. This event must occur after transmitting at least three superframes with dea=0. See Section 2.2.1.7.4.7.5.

Table 2.2.3-6 — Activation/Deactivation: LT (J) Finite State Matrix (An Example) (2 of 2)

a b	STATE NAME:	ISW SYNC	ACTIVE	DEACT'N ALERT'N	TEAR DOWN	PENDING DEACT'N	RCV RESET
	STATE CODE EVENT:[c]	J7 (T7)	J8	J9	J10	J11	J12
EVENT ↓	SIGNAL -> NT:	SL3 dea=1	SL3 dea=1	SL3 dea=0	SL0	SL0	SL0
Power ON		-	-	-	-	-	-
Loss of power		J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI
Activation Request (AR)		-	-	-	-	-	-
Deactivation Request (DR) [d]		J9	J9	-	-	-	-
End of Tone TL (3 ms)		/	/	/	/	/	/
Received tone TN		/	/	/	/	/	ST.M5 STP.M7 J3
Loss of signal energy (TN or SN1)		/	/	/	/	/	/
Echo canceler converged		-	-	-	-	-	-
SW sync (SN2 or SN3)		-	-	-	-	-	/
ISW sync (SN3)		-	-	-	-	-	/
Received act=0 (SN3)		-	J7	-	-	-	/
Received act=1 (SN3)		J8 AI	-	-	-	-	/
Loss of synchronization (>480 ms)		J10 EI	J10 EI	J10 EI	-	-	-
Loss of signal (>480 ms)		ST.M7 J12 EI	ST.M7 J12 EI	ST.M7 J12 EI	-	-	-
End of last super frame with dea=0 [f]		/	/	J11	/	/	/
Expiry of timer M5 (15 seconds)		/	/	/	/	/	/
Absence of signal <40 ms		-	-	-	ST.M7J1	J1 DI	-
Expiry of timer M7 (40 ms)		/	/	/	/	/	J1 DI

Note(s):

a. Symbols and Abbreviations:
- = No change, no action
/ = Impossible or prohibited situation under normal circumstances
AI = Primitive - Activation Indication
AR = Primitive - Activation Request
DI = Primitive - Deactivation Indication
DR = Primitive - Deactivation Request
EI = Primitive - Error Indication
Hn = Go to state "Hn"
Jn = Go to state "Jn"
ST.Mn = Start timer Mn
STP.Mn = Stop timer Mn
SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
UTI = Primitive - U-only Turn-on Indication
UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. This event will cause turn-off of the NT independent of whether the transmitter is cold-start-only or warm-start.

e. When in State J3, absence of signal >480 ms causes transition to State J1.

f. This event must occur after transmitting at least three superframes with dea=0. See Section 2.2.1.7.4.7.5.

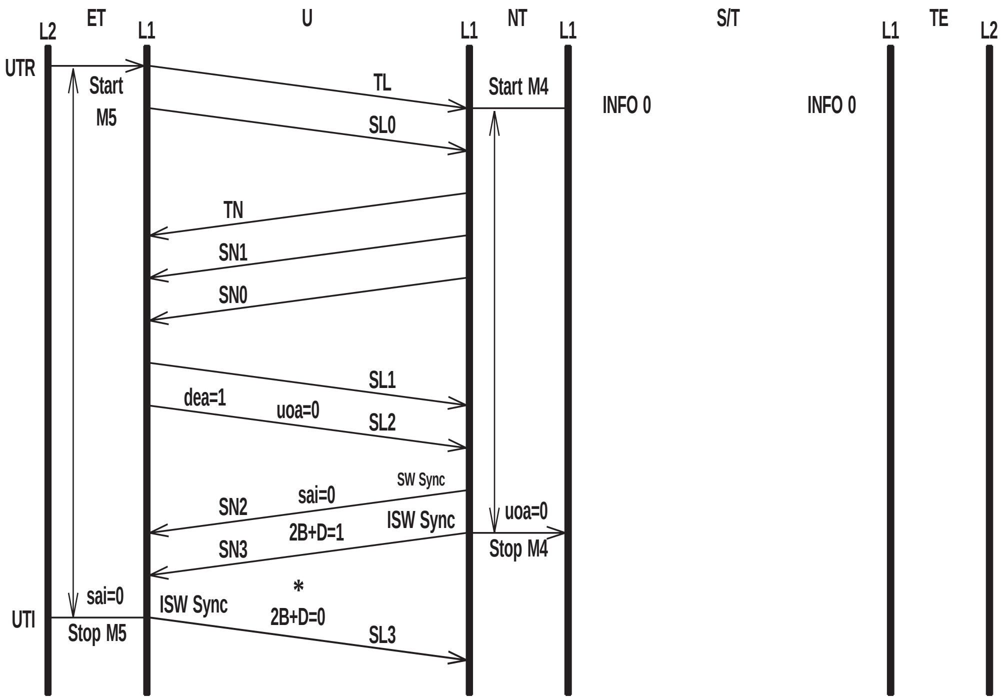
2.2.3.5.8 DSL-Only Turn-On

2.2.3.5.8.1 UTR Initiated by the Exchange from Reset

The DSL-only turn-on request (UTR) is an optional switching system primitive. The effect of this request is to start the process described in "Start-Up and Control," Section 2.2.1.7.4, and in Figure 2.2.1-16 in which the network sends the tone toward the NT. The PH DSL-only Turn-on Request also sets dea=1 and uoa=0 toward the NT.

After the NT has acquired the superframe marker (at T6 in Figure 2.2.1-16) and detected uoa bit = 0, it does not activate the S/T interface.

After the network has acquired the superframe marker (at T7 in Figure 2.2.1-16), the DSL is fully operational. Figure 2.2.3-12 illustrates DSL-only turn-on (a process that starts from RESET and is initiated by only the exchange).



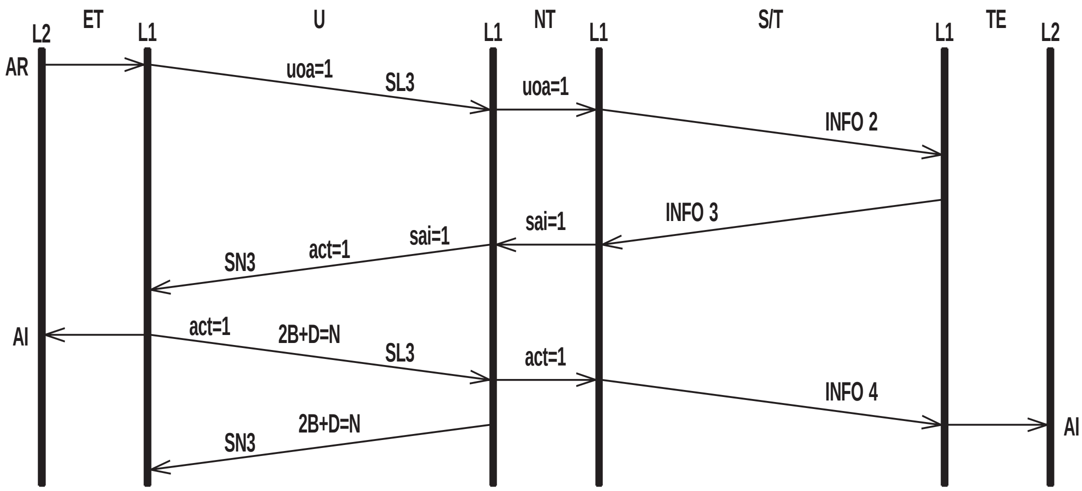
NOTES:
* Except to perform a loopback, 2B+D bits remain in the previous state (SN2 or SL2) until both act bits indicate full transparency of B- and D-channels. Refer to Table 2.2.3-2 for information on messages required.
L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-7 and 2.2.3-8.

Figure 2.2.3-12 — DSL-Only Turn-on Process Initiated by the Exchange from Reset (UTR)

2.2.3.5.8.2 Total Activation Initiated by the Exchange when DSL-Only Is Turned-On

This process is initiated when the PH-Activate Request (AR) replaces the UTR request. The network sets uoa=1 toward the NT.

After detecting uoa=1, the NT allows S/T interface activation as described in "Total Activation Initiated by the Exchange," Section 2.2.3.5.3. Figure 2.2.3-13 illustrates this process.

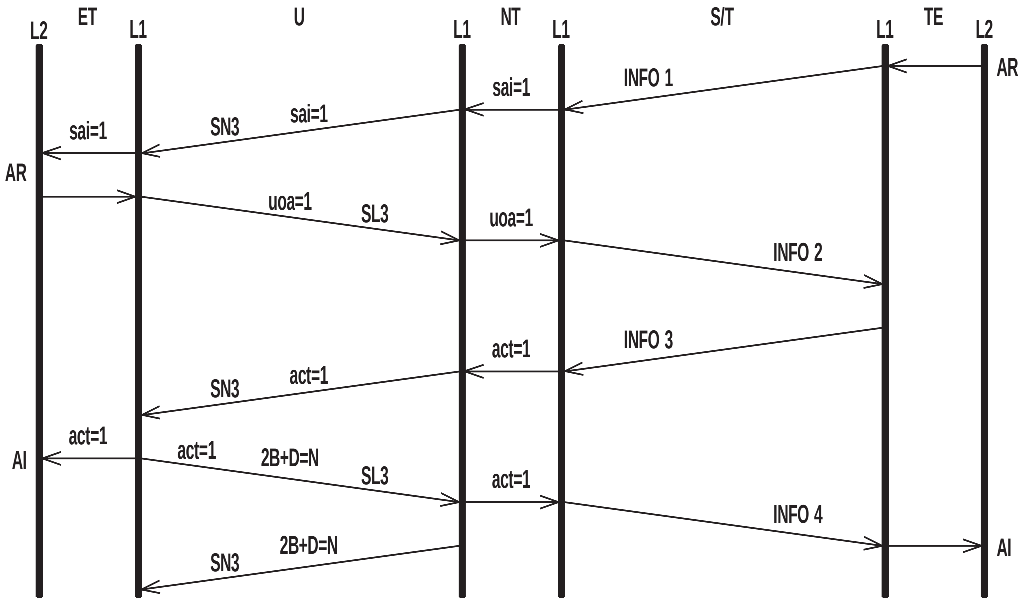


NOTES:
1. L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-7 and 2.2.3-8.
2. Receipt of INFO 3 and SL3 at the NT can theoretically occur in either order.

Figure 2.2.3-13 — Change from DSL-Only to Total Activation Initiated by the Exchange (AR)

2.2.3.5.8.3 Total Activation Initiated by the Terminal Equipment when DSL-Only Is Turned-On

This process is initiated after receiving INFO 1 from the TE while the DSL-only feature is turned-on. The NT sends the sai bit = 1 toward the network. After detecting the sai bit = 1, the exchange may send back the PH-Activate Request (AR). The network may refuse to send AR, for instance when the access link is undergoing maintenance. Then the process continues as described in "Total Activation Initiated by the Exchange when DSL-Only Is Turned-On," Section 2.2.3.5.8.2. Figure 2.2.3-14 illustrates this process.



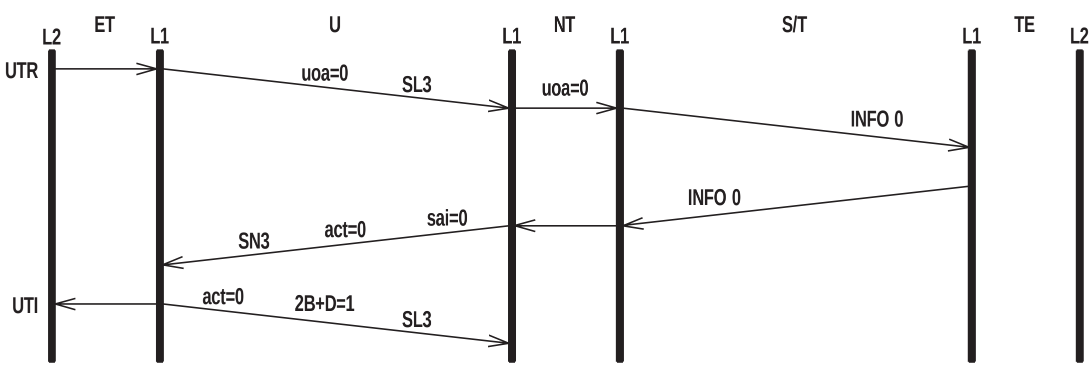
NOTES:
1. L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-7 and 2.2.3-8.
2. Receipt of INFO 3 and SL3 at the NT can theoretically occur in either order.

Figure 2.2.3-14 — Change from DSL-Only to Total Activation Initiated by Terminal Equipment (INFO 1)

2.2.3.5.8.4 S/T-Interface-Only Deactivation

This process is initiated by the PH DSL-only Turn-on Request (UTR) and starts from total activation. The network sends uoa=0 toward the NT.

After detecting uoa=0, the NT shall deactivate the S/T interface by sending INFO 0. Then the NT sets sai=0 toward the network. Figure 2.2.3-15 illustrates this process.



NOTE:
L1 = Layer 1; L2 = Layer 2. Other symbols and abbreviations are defined in Tables 2.2.3-7 and 2.2.3-8.

Figure 2.2.3-15 — Change to DSL-Only from Total Activation Initiated by Exchange (UTR)

2.2.3.5.9 Activation Finite State Matrices when DSL-Only Turn-On Option Is Implemented

The activation/deactivation procedures for NTs and LTs, including the DSL-only turn-on processes, are shown in the form of finite-state matrices in Tables 2.2.3-7 and 2.2.3-9.

Table 2.2.3-7 — Activation/Deactivation: NT (H) Finite State Matrix (DSL-Only Turn-on Option) An Example (1 of 2)

a b	STATE NAME:	POWER OFF	FULL RESET	ALERTING	EC TRAINING (OPTIONAL)	EC CNVRG'D	SW SYNC	ISW SYNC	ISW SYNC CALL	PENDING ACTIVE
	STATE CODE EVENT:[c]	H0	H1 (T0)	H2	H3 (T1)	H4 (T2)	H5 (T5)	H6(a)(T6)	H6 (T6)	H7
EVENT ↓	SIGNAL -> LT:	SN0	SN0	TN	SN1	SN0	SN2	SN3 act=0 sai=1or0	SN3 ct=0 sai=1or0	SN3 act=1 sai=1
	SIGNAL -> TE:[d]	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 2	INFO 2
Power On		ST.M4 H2	–	–	–	–	–	–	–	–
Loss of power		—	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI
Received new S/T INFO 1 signal [f g] /		/	ST.M4 H2 [h]	—	—	—	—	—	—	/
Received INFO 3 signal [f i] (uoa=1,act=0,dea=1) /		/	/	/	/	/	/	H7	—	—
Received INFO 0 or S/T Loss of Sync [f j]		/	—	—	—	—	—	—	—	H11
End of tone TN (9 ms)		/	/	H3 or H4	/	/	/	/	/	/
Received tone TL		/	ST.M4 H2	—	/	/	/	/	/	/
Echo canceler converged		/	—	—	H4	—	—	—	—	—
SW sync and detect SL2		/	/	/	/	H5	—	—	—	—
ISW sync (SL2)		/	/	/	/	/	STP.M4 H6(a)	—	—	—
Received (SL2 or SL3) dea=0 [k] /		/	/	/	/	/	/	H9	H9	H9
Received (SL2 or SL3) uoa=0 and dea=1		/	/	/	/	/	/	H8(a) or H8(c)	H8(a) or H8(c)	H8(b)
Received (SL2 or SL3) uoa=1, act=0 and dea=1		/	/	/	/	/	/	H6	—	—
Received (SL3) uoa=1, act=1, and dea=1		/	/	/	/	/	/	—	—	H8 AI
Loss of synchronization (> 480 ms)		/	/	/	/	/	/	H10 EI	H10 EI	H10 EI
Loss of signal (> 480 ms) [m]		/	/	/	/	STP.M4 H1 EI, DI [n]	—	ST.M6 H12 EI	ST.M6 H12 EI	ST.M6 H12 EI

See note(s) at end of table.

Table 2.2.3-7 — Activation/Deactivation: NT (H) Finite State Matrix (DSL-Only Turn-on Option) An Example (1 of 2) (Contd)

a b	STATE NAME:	POWER OFF	FULL RESET	ALERTING	EC TRAINING (OPTIONAL)	EC CNVRG'D	SW SYNC	ISW SYNC	ISW SYNC CALL	PENDING ACTIVE
	STATE CODE EVENT:[c]	H0	H1 (T0)	H2	H3 (T1)	H4 (T2)	H5 (T5)	H6(a)(T6)	H6 (T6)	H7
EVENT ↓	SIGNAL -> LT:	SN0	SN0	TN	SN1	SN0	SN2	SN3 act=0 sai=1or0	SN3 ct=0 sai=1or0	SN3 act=1 sai=1
	SIGNAL -> TE:[d]	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 0	INFO 2	INFO 2
Expiry of timer M4 (15 seconds)		/	/	/	H10 EI	H10 EI	H10 EI	/	/	/
Loss of Signal < 40 ms		/	/	/	/	—	—	—	—	—
Expiry of timer M6 (40 ms)		/	/	/	/	/	/	/	/	/

Note(s):

a. Symbols and Abbreviations:
–– = No change, no action
/ = Impossible or prohibited situation under normal circumstances
AI = Primitive - Activation Indication
AR = Primitive - Activation Request
DI = Primitive - Deactivation Indication
DR = Primitive - Deactivation Request
EI = Primitive - Error Indication
Hn = Go to state "Hn"
Jn = Go to state "Jn"
ST.Mn = Start timer Mn
STP.Mn = Stop timer Mn
SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
UTI = Primitive - U-only Turn-on Indication
UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. S/T INFO signals are shown as transmit signals in Tables 2.2.3-3 and 2.2.3-7, which do not directly control these signals. They are included for information only.

e. The signals output in this state remain unchanged from signals output during the preceding state. (For example, act = 0 if States H6 or H11 preceded, or act = 1 if States H7 or H8 preceded.)

f. These events are initiated at the T reference point (See T1.605-1991, Table 4).

g. This condition represents an "Activation Request" event.

h. When INFO 1 remains continuous after the NT fails to bring up the network side and returns to State H1, the NT does not again go to State H2, unless a new transition 2.2.1.7.4.3 and 2.2.4.2.

i. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

j. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

k. This event takes priority over received act = 0 for warm-start NTs. This event could be ignored for cold-start-only NTs.

l. The transceiver should return to the state from which it entered State H9, unless the uoa or act bit(s) have changed.

m. When in State H4, absence of signal > 480 ms causes transition to State H1.

n. The response "H1, EI, DI" applies only during the first 480 ms after ceasing transmission (TN or SN1). Otherwise, "no action" is appropriate. See Section 2.2.1.7.4.4.

Table 2.2.3-8 — Activation/Deactivation: NT (H) Finite State Matrix (DSL-Only Turn-on Option) An Example (2 of 2)

a b	STATE NAME:	ACTIVE	UOA	S/T DEACT.	UOA & TE CALL	PENDING DEACT'N	TEAR DOWN	TE INACTIVE	RCV RESET
	STATE CODE EVENT:[c]	H8	H8(a)	H8(b)	H8(c)	H9	H10	H11	H12
EVENT ↓	SIGNAL -> LT:	SN3 act=1 sai=1	SN3 act=0 sai=0	SN3 act=0 sai=0	SN3 act=0 sai=1	SN3	SN0	SN3 act=0 sai=0	SN0
	SIGNAL[d] -> TE:	INFO 4	INFO 0	INFO 0	INFO 0	e	INFO 0	INFO 2	INFO 2
Power On		–	–	–	–	–	–	–	–
Loss of power		H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI	H0 EI
Received new S/T INFO 1 signal [f] [g] /		/	H8(c)	H8(c)	—	—	—	/	—
Received INFO 3 signal [f] [i] (uoa=1,act=0,dea=1) /		/	—	/	—	—	H7	H7	—
Received INFO 0 or S/T Loss of Sync [f] [j]		H11	/	H8(a)	/	—	—	—	—
End of tone TN (9 ms)		/	/	/	/	/	/	/	/
Received tone TL		/	/	/	/	/	/	/	STP.M4 STP.M6 H2
Echo canceler converged		—	—	—	—	—	—	—	—
SW sync and detect SL2		—	—	—	—	—	—	—	/
ISW sync (SL2)		—	—	—	—	—	—	—	/
Received (SL2 or SL3) dea=0 [k] /		H9	H9	H9	H9	—	—	H9	/
Received (SL2 or SL3) uoa=0 and dea=1		H8(b)	—	—	—	Prev. State [l]	—	H8(a)	/
Received (SL2 or SL3) uoa=1, act=0 and dea=1		H7	H6	—	H6	Prev. State [l]	—	—	/
Received (SL3) uoa=1, act=1, and dea=1		—	—	—	—	Prev. State [l]	—	—	/
Loss of synchronization (> 480 ms)		H10 EI	H10 EI	H10 EI	H10 EI	H10 EI	—	H10 EI	—
Loss of signal (> 480 ms) [m]		ST.M6 H12 EI	ST.M6 H12 EI	ST.M6 H12 EI	ST.M6 H12 EI	/	/	ST.M6 H12 EI	—
Expiry of timer M4 (15 seconds)		/	/	/	/	/	/	/	—
Loss of Signal < 40 ms		—	—	—	—	ST.M6 H12	ST.M6 H12	—	/
Expiry of timer M6 (40 ms)		/	/	/	/	/	/	/	H1 D1

See note(s) at end of table.

Table 2.2.3-8 — Activation/Deactivation: NT (H) Finite State Matrix (DSL-Only Turn-on Option) An Example (2 of 2) (Contd)

Note(s):

a. Symbols and Abbreviations:
   –– = No change, no action
   / = Impossible or prohibited situation under normal circumstances
   AI = Primitive - Activation Indication
   AR = Primitive - Activation Request
   DI = Primitive - Deactivation Indication
   DR = Primitive - Deactivation Request
   EI = Primitive - Error Indication
   Hn = Go to state "Hn"
   Jn = Go to state "Jn"
   ST.Mn = Start timer Mn
   STP.Mn = Stop timer Mn
   SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
   Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
   UTI = Primitive - U-only Turn-on Indication
   UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. S/T INFO signals are shown as transmit signals in Tables 2.2.3-3 and 2.2.3-7, which do not directly control these signals. They are included for information only.

e. The signals output in this state remain unchanged from signals output during the preceding state. (For example, act = 0 if States H6 or H11 preceded, or act = 1 if States H7 or H8 preceded.)

f. These events are initiated at the T reference point (See T1.605-1991, Table 4).

g. This condition represents an "Activation Request" event.

h. When INFO 1 remains continuous after the NT fails to bring up the network side and returns to State H1, the NT does not again go to State H2, unless a new transition 2.2.1.7.4.3 and 2.2.4.2.

i. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is transparent to user data.

j. This condition indicates that the user data path (2B+D channels) in the TE-to-NT direction is not transparent to user data.

k. This event takes priority over received act = 0 for warm-start NTs. This event could be ignored for cold-start-only NTs.

l. The transceiver should return to the state from which it entered State H9, unless the uoa or act bit(s) have changed.

m. When in State H4, absence of signal > 480 ms causes transition to State H1.

n. The response "H1, EI, DI" applies only during the first 480 ms after ceasing transmission (TN or SN1). Otherwise, "no action" is appropriate. See Section 2.2.1.7.4.4.

Table 2.2.3-9 — Activation/Deactivation: LT (J) Finite State Matrix (DSL-Only Turn-on Option) An Example (1 of 2)

a b	STATE NAME:	POWER OFF	FULL RESET	ALERTING	AWAKE	EC TRAINING	EC CNVRG'D CALL	SW SYNC CALL	ISW SYNC CALL	ACTIVE
EVENT ↓	STATE CODE EVENT:[c]	J0	J1 (T0)	J2	J3 (T1)	J4 (T3) OPTIONAL	J5 (T4)	J6	J7 (T7)	J8
	SIGNAL→NT:	SL0	SL0	TL	SL0	SL1	SL2 dea=1 act=0 uoa=1	SL2 dea=1 act=0 uoa=1	SL3 dea=1 act=0 uoa=1	SL3 dea=1 act=1 uoa=1
Power ON		J1	-	-	-	-	-	-	-	-
Loss of power		-	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI
Activation Request (AR)		-	ST.M5 J2	-	-	-	-	-	-	-
U-only Turn-onRequest (UTR)		-	ST.M5 J2	-	-	-	J5(a)	J6(a)	J7(a)	J7(a)
Deactivation Request (DR) [d]		-	-	-	-	-	-	-	J9	J9
End of tone TL (3 ms)		/	/	J3	/	/	/	/	/	/
Received tone TN		/	ST.M5 J3	-	-	/	/	/	/	/
Loss of signal energy (TN or SN1)		/	-	-	J4,J5 or J5(a)	-	/	/	/	/
Echo canceler converged and UTR		/	-	-	-	J5(a)	-	-	-	-
Echo canceler converged and AR		/	-	-	-	J5	-	-	-	-
SW sync (SN2 or SN3)		/	/	/	/	/	J6	-	-	-
Received (SN3) act=0		/	/	/	/	/	/	/	-	J7 EI
Received (SN3) act=1		/	/	/	/	/	/	/	J8 A1	-
Received (SN3) sai=1		/	/	/	/	/	/	/	-	-
Loss of synchronization (> 480 ms)		/	/	/	/	/	/	/	J10 EI	J10 EI
Los of signal (> 480 ms)		/	/	/	J1 [f]	/	-	-	ST.M7 J12 EI	ST.M7 J12 EI
End of last super frame with dea=0 [g]		/	/	/	/	/	/	/	/	/
Expiry of timer M5 (15 seconds)		/	/	/	J10 EI	J10 EI	J10 EI	J10 EI	/	/
Absence of signal < 40 ms		/	-/	/	/	/	-	-	-	-
Expiry of timer M7 (40 ms)		/	/	/	/	/	/	/	/	/
ISW sync (SN3)		/	/	/	/	/	/	STP.M5 J7	-	-

See note(s) at end of table.

Table 2.2.3-9 — Activation/Deactivation: LT (J) Finite State Matrix (DSL-Only Turn-on Option) An Example (1 of 2) (Contd)

Note(s):

a. Symbols and Abbreviations:
–– = No change, no action
/ = Impossible or prohibited situation under normal circumstances
AI = Primitive - Activation Indication
AR = Primitive - Activation Request
DI = Primitive - Deactivation Indication
DR = Primitive - Deactivation Request
EI = Primitive - Error Indication
Hn = Go to state "Hn"
Jn = Go to state "Jn"
ST.Mn = Start timer Mn
STP.Mn = Stop timer Mn
SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
UTI = Primitive - U-only Turn-on Indication
UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. This event will cause turn-off of the NT independent of whether the transmitter is cold-start-only or warm-start.

e. The network is permitted to choose "no action" rather than sending AR and transferring to State J7. For example, when the access link is undergoing maintenance, "no action" is an appropriate response.

f. When in State J3, absence of signal >480 ms causes transition to State J1.

g. This event must occur after transmitting at least three superframes with dea=0. See Section 2.2.1.7.4.7.5.

Table 2.2.3-10 — Activation/Deactivation: LT (”J”) Finite State Matrix (DSL-Only Turn-on Option) An Example (2 of 2)

a b / EVENT ↓ — STATE NAME:	EC CONVRG’D UOA	SW SYNC CALL	U ACTIVE	DEACT’N S/T	DEACT’N ALERT’N	TEAR DOWN	PENDING DEACT’N	RCV RESET
STATE CODE EVENT:[c]	J5(a) (T4)	J6(a)	J8(a)	J7(a)	J9	J10	J11	J12
SIGNAL→NT:	SL2 dea=1 act-0 uoa=0	SL2 dea=1 act=0 uoa=0	SL3 dea=1 act=0 uoa=0	SL3 dea=1 act=0 uoa=0	SL3 dea=0 act=0	SL0	SL0	SL0
Power ON	-	-	-	-	-	-	-	-
Loss of power	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI	J0 EI
Activation Request (AR)	J5	J6	J7	J7	-	-	-	-
U-only Turn-onRequest (UTR)	-	-	-	-	-	-	-	-
Deactivation Request (DR) [d]	-	-	J9	J9-	-	-	-	-
End of tone TL (3 ms)	/	/	/	/	/	/	/	/
Received tone TN	/	/	/	/	/	/	/	ST.M5 STP.M7 J3
Loss of signal energy (TN or SN1)	/	/	/	/	/	/	/	/
Echo canceler converged and UTR	-	-	-	-	-	-	-	-
Echo canceler converged and AR	-	-	-	-	-	-	-	-
SW sync (SN2 or SN3)	J8(a)	-	-	-	-	-	-	-
Received (SN3) act=0	/	/	-	J8(a) UT1	-	-	-	-
Received (SN3) act=1	/	/	/	-	-	-	-	-
Received (SN3) sai=1	/	/	J7 AR [e]	-	-	-	-	-
Loss of synchronization (> 480 ms)	/	/	J10 EI	J10 EI	J10 EI	-	-	-
Los of signal (> 480 ms)	-	—	ST.M7 J12 EI	ST.M7 J12 EI	ST.M7 J12 EI	-	-	-
End of last super frame with dea=0 [g]	/	/	/	/	J11	/	/	/
Expiry of timer M5 (15 seconds)	J10 EI	J10 EI	/	/	/	/	/	/
Absence of signal < 40 ms	-	-	-	-	-	ST.M7 J12	J1 D1	-
Expiry of timer M7 (40 ms)	/	/	/	/	/	/	/	J1 D1
ISW sync (SN3)	/	STP.M5 J8(a) UT1	-	-	-	-	-	-

See note(s) at end of table.

Table 2.2.3-10 — Activation/Deactivation: LT (”J”) Finite State Matrix (DSL-Only Turn-on Option) An Example (2 of 2) (Contd)

Note(s):

a. Symbols and Abbreviations:
–– = No change, no action
/ = Impossible or prohibited situation under normal circumstances
AI = Primitive - Activation Indication
AR = Primitive - Activation Request
DI = Primitive - Deactivation Indication
DR = Primitive - Deactivation Request
EI = Primitive - Error Indication
Hn = Go to state "Hn"
Jn = Go to state "Jn"
ST.Mn = Start timer Mn
STP.Mn = Stop timer Mn
SLn,SNn = Pulse patterns produced by NT or LT, respectively (SL0, SN0 = no signal)
Tn = Notation refers to transition instants defined in Figure 2.2.1-17.
UTI = Primitive - U-only Turn-on Indication
UTR = Primitive - U-only Turn-on Request

b. Primitives are the subject of continuing study and are significant in only combined NT1/TE or LT/ET implementations.

c. See Figure 2.2.1-17.

d. This event will cause turn-off of the NT independent of whether the transmitter is cold-start-only or warm-start.

e. The network is permitted to choose "no action" rather than sending AR and transferring to State J7. For example, when the access link is undergoing maintenance, "no action" is an appropriate response.

f. When in State J3, absence of signal >480 ms causes transition to State J1.

g. This event must occur after transmitting at least three superframes with dea=0. See Section 2.2.1.7.4.7.5.

2.2.3.6 Linearity Measurement

This section is not part of the specification — for information only.

With the transceiver (network or NT) terminated in a 135-ohm resistance through a zero-length loop, and driven by an arbitrary binary sequence, the voltage appearing across the resistance is filtered (anti-alias), sampled and converted to digital form (V_{out}) with a precision of no less than 12 bits (see Figure 2.2.3-16). These samples are compared with the output of an adjustable, linear filter, the input of which is the scrambled, framed, and linearly encoded transmitter input. The signals at the subtractor may both be in digital form, or they may both be in analog form.

The linear digital filter input ("Quaternary Input Data" in Figure 2.2.3-16) can be considered a linearity standard. It may be produced from the transmitter output by an errorless receiver (with no de-scrambler), or from the scrambled transmitter input data if it is available. If the samples input to the adjustable filter are available in digital form, no additional A/D converter is required. Whether analog or digital, these samples are required to be in the ratio 3:1:-1:-3, to an accuracy of at least 12 bits.

The sampling rate of the samplers and filters may be higher than the baud rate, and generally will be several times the baud rate for good accuracy. Alternatively, the sample rate may be at the baud rate, but the rms values are obtained by averaging over all sample phases relative to the transmitter signal.

Because the anti-alias filter, sampler, and A/D converter operating on the transmitter output may introduce a loss or gain, proper calibration requires determining $<V_{out}^2>$ at the filter output, as shown in Figure 2.2.3-16, rather than the mean-squared value of the transmitter output itself.

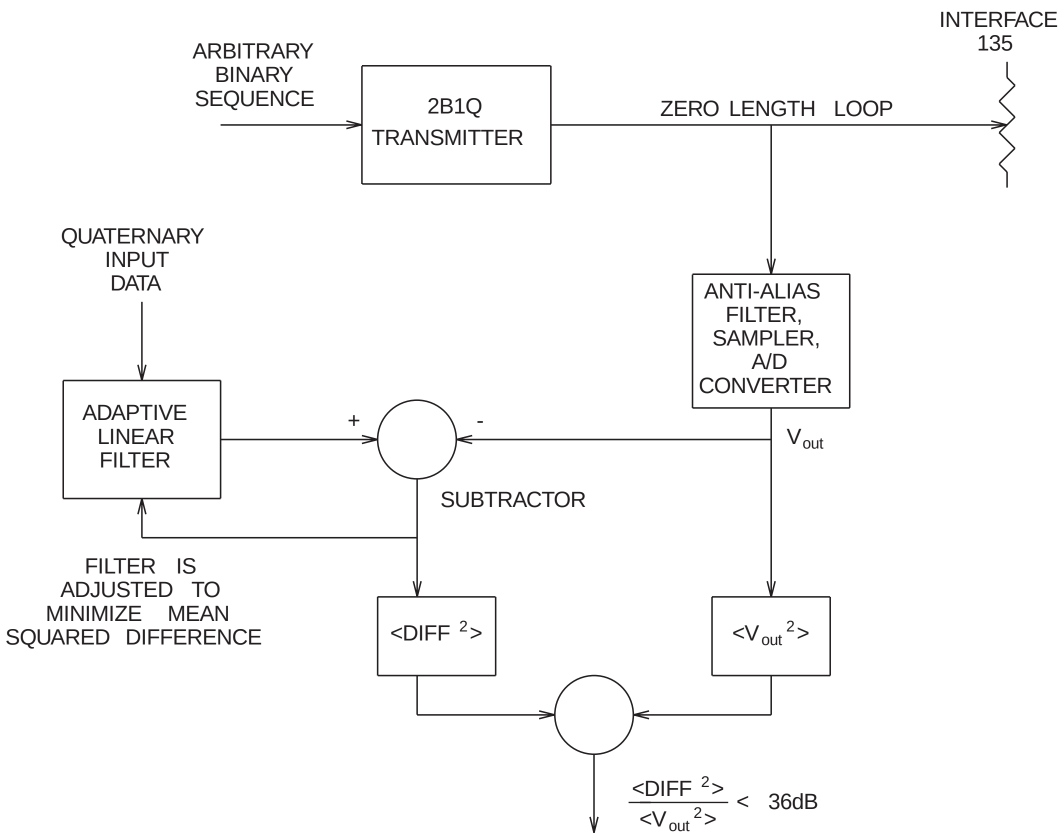


Figure 2.2.3-16 — Measurement of DSL Transmitter Linearity

2.2.4 SUPPORTING INFORMATION

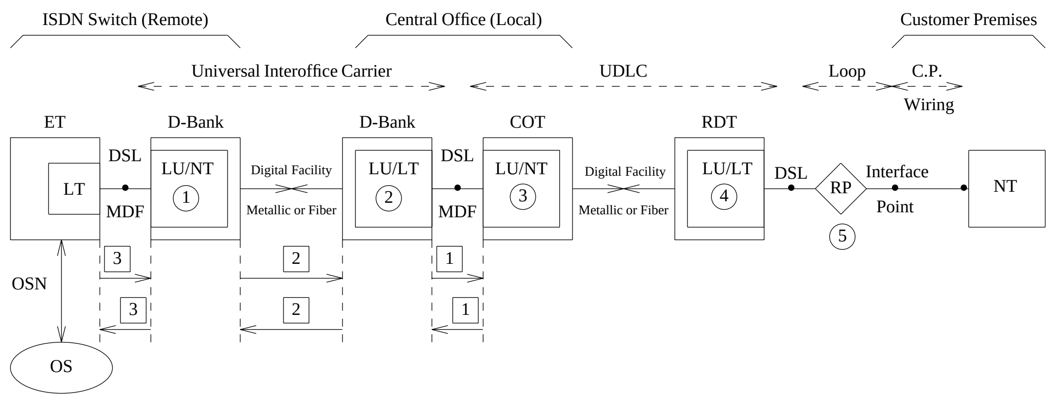
2.2.4.1 Discussion of eoc Addressing

This section is not part of the specification — for information only.

2.2.4.1.1 Assignment of eoc Addresses

Figure 2.2.4-1 shows a possible worst case architecture for supporting ISDN basic access. In such extended configurations, the digital subscriber line (DSL) provided by the switch connects to intermediate transmission equipment instead of connecting directly to an NT. There may be additional transmission elements at more distant points in the configuration before eventually terminating at the NT.

Each transmission element indicated by ❍ in Figure 2.2.4-1, with n equal to 1 through 5, may need to be given an eoc address. This allows the switch to send Layer 1 maintenance commands to each of these elements. The address for such transmission elements shall be assigned in a relative fashion with respect to the switch such that the first element from the switch is treated by the network as eoc Address 1, the next as eoc Address 2, and so on until the interface on the network side of the NT is reached. The first element on the customer side of the interface is assumed to be the NT and is always addressed as 0.



Symbols & Abbreviations

COT - Central Office Terminal	LU/LT - Line Unit/"LT"	OSN - Operations System Network (Packet)
DSL - Digital Subscriber Line	LU/NT - Line Unit/"NT"	OS - Operations System
Interface Point - Interface on the	MDF - Main Distributing Frame	RDT - Remote Digital Terminal
Network Side of NT	NT - Network Termination	RP - Loop Repeater, Network
LT - Line Termination	❐ - Message with Address x	UDLC - Universal Digital Loop Carrier
❍ - nth Transmission Element		

Figure 2.2.4-1 — Worst Case ISDN Basic Access Configuration

2.2.4.1.2 Addresses 1 through 6 (Intermediate Elements)

For the previously mentioned addressing scheme, the intermediate transmission elements have eoc addresses in the range of 1 to 6. Intermediate transmission elements will react to Addresses 1 through 6 as follows:

- ***Direction toward CPE (Network to NT):***
  - — If address in range of 2 to 6, decrement address and pass message on.

— If address equals 1, comply (see "Mode of Operation," Section 2.2.3.1.3.2) with received message and send proper eoc response (see "Mode of Operation," Section 2.2.3.1.3.2) frame back toward the network. The response frame will be written over the response frame from the NT. Pass the eoc frame on with the broadcast address and the message changed to Hold State.

- ***Direction Toward Network (NT to Network):***

— If address in range 1 to 5, increment address and pass message on.

Note: For the addressing mechanism described in this section, the order of the address bits in the eoc address field is important. In Figure 2.2.1-12, the m_1, M_2, and M_3 bits in the first frame of the superframe are the eoc address, eoc_{a1}, eoc_{a2}, abd eoc_{a3}, respectively. In this address field, eoc_{a1} is the most significant bit and eoc_{a3} is the least significant bit.

2.2.4.1.3 Action of Intermediate Elements

The intermediate transmission elements will react to eoc Addresses 0 and 7 (NT address and broadcast address, respectively) as follows:

- In either direction, if Address 0, address not changed and message passed on.
- If Address 7,

— Downstream - comply with received message, address not changed, and message passed on

— Upstream - address not changed, and message passed on.

Thus, all downstream units would comply with a message with a broadcast address; however, only the NT would respond with an acknowledgment. Intermediate units would relay the NT's acknowledgment to the network.

When eoc messages for internal ISDN network use activate operations functions identical to operations functions standardized at the NT, then the message codes for those messages should be identical as well.

2.2.4.1.4 Action of NT

The NT will comply with messages to only Addresses 0 and 7. When messages are received at the NT with Addresses 1 through 6, the NT sends back an eoc frame with the Hold State message and Address 0. The proper action for the NT in every case is fully defined in "Mode of Operation," Section 2.2.3.1.3.2.

2.2.4.1.5 Summary

The previously mentioned addressing scheme for assigning eoc addresses to intermediate transmission elements of extended configurations allows maintenance functions to be performed at each element, simplifying circuit provisioning and minimizing network reconfiguration costs.

Figure 2.2.4-1 shows an example of a loopback request for Element 3 and the value of the address field at different links in the circuit.

In using this addressing scheme, it is important for the network to be aware of the exact configuration. Otherwise, the network may fail to address elements that are present, or may attempt to address elements that are not present. In any case, by not having correct information about the configuration, the network may send and receive data or issue commands that have entirely different meaning and/or results than expected.

The network will become aware of the fact that it is addressing an intermediate element beyond the last intermediate element in the configuration, because the NT will reply with the 0 address and the Hold State message. However, if the actual configuration has more elements than assumed by the network, none of the messages sent by the network to intermediate addresses will result in a reply with a 0 address.

The NT response to messages it receives that are not addressed to it provides a means of determining the correct configuration at any time. The determination is possible because the network receives eoc frames with the Address 0 and the Hold State message when it addresses a nonexistent element. For example, the correct eoc configuration may be determined at any time by the network sending the Hold State message with eoc address first set to 1, and then set to successively higher addresses until Address 0 is returned in three consecutive identical eoc frames. This procedure can eliminate confusion and assure accurate communication on the eoc channel in those cases when record errors would have led to confusion. If record errors are a problem, or changes of configuration are frequent, this procedure could be repeated often enough to assure valid results of eoc transactions.

2.2.4.2 Supporting Information Relating to DC Metallic Termination

This section is not part of the specification — for information only.

This information is in addition to the requirements given in Table 2.2.2-1 and "Metallic Termination," Section 2.2.2.5.2. Table 2.2.4-1 gives the AC characteristics of an example DC metallic termination in the ON and OFF states, measured with the transceiver disconnected.

Figure 2.2.4-2 provides a definition of activate and release time tests. Figure 2.2.4-2 (a) is to be used to test the nonactivate response time of the termination against spurious noise signals. Laboratory test equipment shall source the test waveform shown in the figure. The termination shall not respond to any test waveform that has a duration t_a less than 3.0 ms.

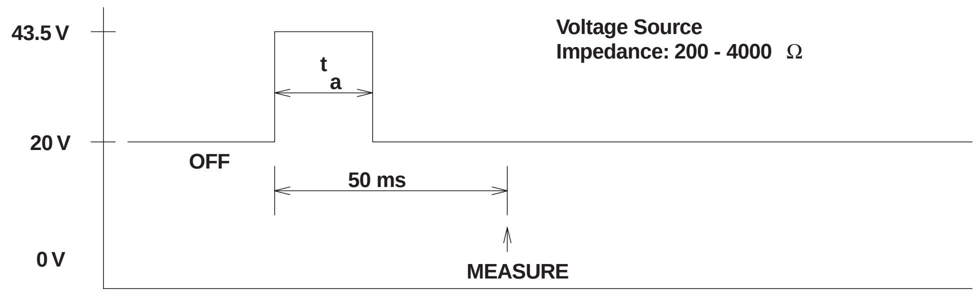
Figure 2.2.4-2 (b) is to be used to test the activate time of the termination with the minimum office battery voltage of 43.5 volts. Laboratory test equipment shall source the test waveform shown in the figure. The test waveform shall have a duration of less than 2 seconds so that measurements will not be interfered with by protection circuitry. The termination shall not respond to any test voltage that has a duration t_b less than 3.0 ms, and shall respond to a test voltage of duration greater than or equal to 50.0 ms. Metallic termination turn-ON shall be complete within 50 ms of application of the test voltage. After the transition, the fact that current exceeds the curve for 11_{-min} in Figure 2.2.2-6 is an indication that the termination is ON.

Figure 2.2.4-2 (c) is to be used to test the release time of the termination when operating at greater than or equal to 1.0 mA. Laboratory test equipment shall source the test waveform shown in the figure. Transition to the OFF state shall not occur if t_c is less than 3.0 ms. Change of state shall be complete if the current remains below the release current for more than 100 ms. The termination shall be considered OFF if the current measured is less than or equal to 0.1 mA when the current source is reapplied at t_c greater than or equal to 100.0 ms and the voltage across the termination is less than the minimum activate voltage of 30 volts.

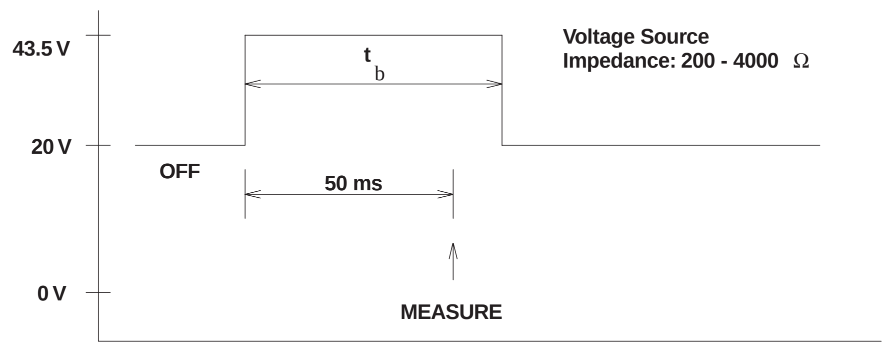
Figure 2.2.3-10 is an illustration of the DC characteristics of the NT.

Table 2.2.4-1 — AC Characteristics of the Metallic Termination

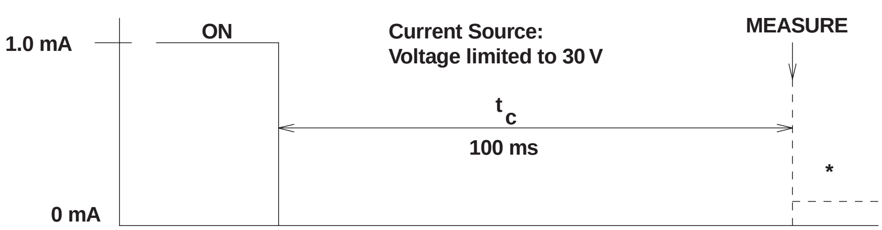
CHARACTERISTICS	VALUES
AC Impedance 200 Hz – 40 kHz	≥ 10 kohm
Nonlinearity (at 7 VPP) when terminated with 67.5-ohm resistor (2000 Hz – 40 kHz)	≤ -70 dB
Reference to High Voltage	Section 2.2.3.4



(a) Nonactivate Time Test Waveform



(b) Activate Time Test Waveform



(c) Release Time Test Waveform

* When the termination turns OFF, the test system will not be able to source 1 mA through the termination since the voltage is limited to 30 V.

Figure 2.2.4-2 — Definitions of Termination's Activate and Release Times

2.2.4.3 Primary Constants of Typical Telephone Cable

Tables 2.2.4-2, 2.2.4-3, 2.2.4-4, 2.2.4-5, 2.2.4-6, 2.2.4-7, 2.2.4-8, 2.2.4-9, 2.2.4-10, 2.2.4-11, 2.2.4-12, 2.2.4-13, 2.2.4-14, 2.2.4-15, 2.2.4-16, 2.2.4-17, 2.2.4-18, and 2.2.4-19 give primary constants for both polyethylene insulated cable (PIC) and PULP insulated cable from 1 Hz to 5 MHz at 0° F, 70° F, and 120° F.

Table 2.2.4-2 — 26 Gauge PIC Cable at 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	488.83	0.9935	0.000	0.08300
5.	488.83	0.9935	0.001	0.08300
10.	488.83	0.9935	0.002	0.08300
15.	488.83	0.9935	0.003	0.08300
20.	488.83	0.9935	0.004	0.08300
30.	488.83	0.9935	0.005	0.08300
50.	488.83	0.9935	0.008	0.08300
70.	488.83	0.9935	0.011	0.08300
100.	488.83	0.9935	0.016	0.08300
150.	488.83	0.9935	0.022	0.08300
200.	488.83	0.9934	0.028	0.08300
300.	488.84	0.9934	0.040	0.08300
500.	488.84	0.9933	0.063	0.08300
700.	488.85	0.9933	0.084	0.08300
1,000.	488.86	0.9932	0.115	0.08300
1,500.	488.89	0.9930	0.164	0.08300
2,000.	488.91	0.9928	0.210	0.08300
3,000.	488.97	0.9924	0.299	0.08300
5,000.	489.11	0.9917	0.466	0.08300
7,000.	489.26	0.9910	0.625	0.08300
10,000.	489.53	0.9899	0.853	0.08300
15,000.	490.07	0.9881	1.213	0.08300
20,000.	490.71	0.9863	1.558	0.08300
30,000.	492.30	0.9826	2.217	0.08300
50,000.	496.65	0.9733	3.458	0.08300
70,000.	502.51	0.9617	4.634	0.08300
100,000.	513.93	0.9502	6.320	0.08300
150,000.	536.26	0.9375	8.993	0.08300
200,000.	561.79	0.9281	11.550	0.08300
300,000.	622.63	0.9139	16.436	0.08300
500,000.	746.31	0.8910	25.633	0.08300
700,000.	862.21	0.8717	34.351	0.08300
1,000,000.	1013.99	0.8495	46.849	0.08300
1,500,000.	1222.70	0.8271	66.665	0.08300
2,000,000.	1398.54	0.8133	85.624	0.08300
3,000,000.	1693.35	0.7965	121.841	0.08300
5,000,000.	2160.47	0.7794	190.021	0.08300

Table 2.2.4-3 — 26 Gauge Pulp Cable at 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	488.83	0.9691	0.560	0.08300
5.	488.83	0.9691	0.566	0.08300
10.	488.83	0.9691	0.574	0.08300
15.	488.83	0.9691	0.582	0.08300
20.	488.83	0.9691	0.590	0.08300
30.	488.83	0.9691	0.606	0.08300
50.	488.83	0.9691	0.639	0.08300
70.	488.83	0.9691	0.672	0.08300
100.	488.83	0.9691	0.722	0.08300
150.	488.83	0.9690	0.808	0.08300
200.	488.83	0.9690	0.895	0.08300
300.	488.84	0.9690	1.076	0.08300
500.	488.85	0.9689	0.456	0.08300
700.	488.86	0.9688	0.860	0.08300
1,000.	488.87	0.9687	2.502	0.08300
1,500.	488.90	0.9684	3.655	0.08300
2,000.	488.93	0.9682	4.893	0.08300
3,000.	488.00	0.9678	7.575	0.08300
5,000.	489.15	0.9669	13.580	0.80300
7,000.	489.33	0.9660	20.237	0.08300
10,000.	489.63	0.9646	31.164	0.08300
15,000.	490.23	0.9624	51.321	0.08300
20,000.	490.94	0.9601	73.387	0.08300
30,000.	492.67	0.9556	121.941	0.08300
50,000.	497.33	0.9450	232.178	0.80300
70,000.	503.52	0.9336	355.449	0.80300
100,000.	515.44	0.9221	558.820	0.08300
150,000.	538.53	0.9092	935.452	0.08300
200,000.	564.72	0.8996	1348.793	0.08300
300,000.	626.65	0.8851	2259.977	0.08300
500,000.	752.12	0.8615	4332.104	0.08300
700,000.	869.26	0.8418	6651.430	0.08300
1,000,000.	1022.62	0.8190	10480.000	0.08300
1,500,000.	1233.50	0.7959	16181.359	0.08300
2,000,000.	1411.18	0.7817	22011.598	0.08300
3,000,000.	1709.05	0.7643	33940.115	0.08300
5,000,000.	2181.04	0.7463	58504.338	0.08300

Table 2.2.4-4 — 26 Gauge PIC Cable at 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	440.75	0.9861	0.000	0.08300
5.	440.75	0.9861	0.001	0.08300
10.	440.75	0.9861	0.002	0.08300
15.	440.76	0.9861	0.003	0.08300
20.	440.76	0.9861	0.004	0.08300
30.	440.76	0.9861	0.005	0.08300
50.	440.76	0.9861	0.008	0.08300
70.	440.76	0.9861	0.011	0.08300
100.	440.76	0.9861	0.016	0.08300
150.	440.76	0.9861	0.022	0.08300
200.	440.76	0.9860	0.028	0.08300
300.	440.76	0.9660	0.040	0.08300
500.	440.77	0.9859	0.063	0.08300
700.	440.78	0.9859	0.084	0.08300
1,000.	440.79	0.9858	0.115	0.08300
1,500.	440.81	0.9856	0.164	0.08300
2,000.	440.83	0.9854	0.210	0.08300
3,000.	440.88	0.9850	0.299	0.08300
5,000.	441.01	0.9843	0.466	0.08300
7,000.	441.15	0.9836	0.625	0.08300
10,000.	441.39	0.9825	0.853	0.08300
15,000.	441.87	0.9807	1.213	0.08300
20,000.	442.88	0.9789	1.558	0.08300
30,000.	443.88	0.9753	2.217	0.08300
50,000.	447.81	0.9660	3.458	0.08300
70,000.	453.09	0.9546	4.634	0.08300
100,000.	463.39	0.9432	6.320	0.08300
150,000.	485.80	0.9306	8.993	0.08300
200,000.	513.04	0.9212	11.550	0.08300
300,000.	575.17	0.9062	16.436	0.08300
500,000.	699.61	0.8816	25.633	0.08300
700,000.	812.95	0.8614	34.351	0.08300
1,000,000.	956.65	0.8381	46.849	0.08300
1,500,000.	1154.38	0.8146	66.665	0.08300
2,000,000.	1321.07	0.8001	85.624	0.08300
3,000,000.	1600.68	0.7823	121.841	0.08300
5,000,000.	2044.07	0.7638	190.021	0.08300

Table 2.2.4-5 — 26 Gauge Pulp Cable at 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	440.75	0.9619	0.560	0.08190
5.	440.75	0.9619	0.566	0.08185
10.	440.76	0.9619	0.574	0.08183
15.	440.76	0.9619	0.582	0.08181
20.	440.76	0.9619	0.590	0.08180
30.	440.76	0.9619	0.606	0.08178
50.	440.76	0.9619	0.639	0.08175
70.	440.76	0.9619	0.672	0.08173
100.	440.76	0.9619	0.722	0.08171
150.	440.76	0.9618	0.808	0.08168
200.	440.76	0.9618	0.895	0.08166
300.	440.76	0.9618	1.076	0.08162
500.	440.77	0.9617	1.456	0.08157
700.	440.78	0.9616	1.860	0.08154
1,000.	440.79	0.9615	2.502	0.08150
1,500.	440.82	0.9612	3.655	0.08145
2,000.	440.85	0.9610	4.893	0.08141
3,000.	440.91	0.9606	7.575	0.08135
5,000.	441.05	0.9597	13.580	0.08127
7,000.	441.21	0.9588	20.237	0.08121
10,000.	441.48	0.9574	31.164	0.08114
15,000.	441.02	0.9552	51.321	0.08106
20,000.	442.66	0.9530	73.387	0.08099
30,000.	443.22	0.9485	121.941	0.08089
50,000.	447.42	0.9380	232.178	0.08075
70,000.	454.00	0.9266	355.449	0.08065
100,000.	464.75	0.9153	358.820	0.08053
150,000.	487.85	0.9025	935.452	0.08038
200,000.	515.72	0.8930	1348.793	0.08027
300,000.	578.88	0.8776	2259.977	0.08010
500,000.	705.05	0.8524	4332.104	0.07986
700,000.	819.59	0.8318	6651.430	0.07986
1,000,000.	964.79	0.8080	10480.000	0.07986
1,500,000.	1164.58	0.7840	16181.359	0.07986
2,000,000.	1333.00	0.7690	22011.598	0.07986
3,000,000.	1615.52	0.7506	33940.115	0.07986
5,000,000.	2063.53	0.7314	58504.338	0.07986

Table 2.2.4-6 — 26 Gauge PIC Cable at 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	373.45	0.9758	0.000	0.08300
5.	373.45	0.9758	0.001	0.08300
10.	373.45	0.9758	0.002	0.08300
15.	373.45	0.9758	0.003	0.08300
20.	373.45	0.9758	0.004	0.08300
30.	373.45	0.9758	0.005	0.08300
50.	373.45	0.8756	0.008	0.08300
70.	373.45	0.9755	0.011	0.08300
100.	373.45	0.9754	0.016	0.08300
150.	373.45	0.9752	0.022	0.08300
200.	373.46	0.9751	0.028	0.08300
300.	373.46	0.9747	0.040	0.08300
500.	373.46	0.9740	0.063	0.08300
700.	373.47	0.9733	0.084	0.08300
1,000.	373.48	0.9722	0.115	0.08300
1,500.	373.50	0.9704	0.164	0.08300
2,000.	373.52	0.9687	0.210	0.08300
3,000.	373.56	0.9651	0.299	0.08300
5,000.	373.67	0.9559	0.466	0.08300
7,000.	373.78	0.9446	0.625	0.08300
10,000.	373.99	0.9333	0.853	0.08300
15,000.	374.40	0.9208	1.213	0.08300
20,000.	374.89	0.9115	1.558	0.08300
30,000.	376.10	0.8955	2.217	0.08300
50,000.	379.43	0.8685	3.458	0.08300
70,000.	383.91	0.8468	4.634	0.08300
100,000.	392.63	0.9333	6.320	0.08300
150,000.	415.15	0.9208	8.993	0.08300
200,000.	444.79	0.9115	11.550	0.08300
300,000.	508.72	0.8955	16.436	0.08300
500,000.	634.23	0.8685	25.633	0.08300
700,000.	743.98	0.8468	34.351	0.08300
1,000,000.	876.38	0.8222	46.849	0.08300
1,500,000.	1058.74	0.7972	66.665	0.08300
2,000,000.	1212.60	0.7816	85.624	0.08300
3,000,000.	1470.94	0.7624	121.841	0.08300
5,000,000.	1881.11	0.7420	190.021	0.08300

Table 2.2.4-7 — 26 Gauge Pulp Cable at 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	373.45	0.9518	0.560	0.08190
5.	373.45	0.9618	0.566	0.08185
10.	373.45	0.9518	0.574	0.08183
15.	373.45	0.9518	0.582	0.08181
20.	373.45	0.9518	0.590	0.08180
30.	373.45	0.9518	0.606	0.08178
50.	373.45	0.9518	0.639	0.08175
70.	373.45	0.9518	0.672	0.08173
100.	373.45	0.9518	0.722	0.08171
150.	373.46	0.9517	0.808	0.08168
200.	373.46	0.9517	0.895	0.08166
300.	373.46	0.9517	1.076	0.08162
500.	373.47	0.9516	1.456	0.08157
700.	363.47	0.9515	1.860	0.08154
1,000.	373.49	0.9514	2.502	0.08150
1,500.	373.51	0.9511	3.655	0.08145
2,000.	373.53	0.9509	4.893	0.08141
3,000.	373.58	0.9505	7.575	0.08135
5,000.	373.70	0.9496	13.580	0.08127
7,000.	373.84	0.9487	20.237	0.08121
10,000.	374.07	0.9474	31.164	0.08114
15,000.	374.53	0.9452	51.321	0.08106
20,000.	375.07	0.9430	73.387	0.08099
30,000.	376.39	0.9385	121.941	0.08089
50,000.	379.95	0.9281	232.178	0.08075
70,000.	384.68	0.9169	355.449	0.08065
100,000.	393.78	0.9056	558.820	0.08053
150,000.	416.90	0.8930	935.452	0.08038
200,000.	447.11	0.8336	1348.793	0.08027
300,000.	512.01	0.8672	2259.977	0.08010
500,000.	639.17	0.8397	4332.104	0.07986
700,000.	750.06	0.8177	6651.430	0.07986
1,000,000.	883.84	0.7927	10480.000	0.07986
1,500,000.	1068.09	0.7672	16181.359	0.07986
2,000,000.	1223.55	0.7512	22011.598	0.07986
3,000,000.	1484.58	0.7315	33940.115	0.07986
5,000,000.	1899.02	0.7105	58504.338	0.07986

Table 2.2.4-8 — 24 Gauge PIC Cable at 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	307.43	0.9935	0.000	0.08300
5.	307.43	0.9935	0.001	0.08300
10.	307.43	0.9935	0.002	0.08300
15.	307.43	0.9935	0.003	0.08300
20.	307.43	0.9935	0.004	0.08300
30.	307.43	0.9935	0.005	0.08300
50.	307.43	0.9935	0.008	0.08300
70.	307.43	0.9935	0.011	0.08300
100.	307.43	0.9935	0.016	0.08300
150.	307.43	0.9934	0.022	0.08300
200.	307.43	0.9934	0.028	0.08300
300.	307.43	0.9934	0.040	0.08300
500.	307.44	0.9933	0.063	0.08300
700.	307.45	0.9932	0.084	0.08300
1,000.	307.47	0.9931	0.115	0.08300
1,500.	307.49	0.9928	0.164	0.08300
2,000.	307.52	0.9926	0.210	0.08300
3,000.	307.59	0.9921	0.299	0.08300
5,000.	307.75	0.9912	0.466	0.08300
7,000.	307.94	0.9903	0.625	0.08300
10,000.	308.27	0.9889	0.853	0.08300
15,000.	308.97	0.9866	1.213	0.08300
20,000.	309.82	0.9843	1.558	0.08300
30,000.	311.98	0.9796	2.217	0.08300
50,000.	318.10	0.9649	3.458	0.08300
70,000.	326.39	0.9535	4.634	0.08300
100,000.	339.90	0.9417	6.320	0.08300
150,000.	367.43	0.9273	8.993	0.08300
200,000.	398.81	0.9166	11.550	0.08300
300,000.	460.98	0.8978	16.436	0.08300
500,000.	574.39	0.8678	25.633	0.08300
700,000.	669.84	0.8467	34.351	0.08300
1,000,000.	790.12	0.8273	46.849	0.08300
1,500,000.	955.50	0.8084	66.665	0.08300
2,000,000.	1094.84	0.7970	85.624	0.08300
3,000,000.	1328.44	0.7831	121.841	0.08300
5,000,000.	1698.58	0.7729	190.021	0.08300

Table 2.2.4-9 — 24 Gauge Pulp Cable at 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	PR (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	307.43	0.9300	0.560	0.08540
5.	307.43	0.9300	0.566	0.08535
10.	307.43	0.9300	0.574	0.08533
15.	307.43	0.9300	0.582	0.08531
20.	307.43	0.9300	0.590	0.08530
30.	307.43	0.9300	0.606	0.08528
50.	307.43	0.9299	0.639	0.08525
70.	307.43	0.9299	0.672	0.08523
100.	307.43	0.9299	0.722	0.08521
150.	307.43	0.9299	0.808	0.08518
200.	307.44	0.9298	0.895	0.08516
300.	307.44	0.9297	1.076	0.08512
500.	307.45	0.9296	1.456	0.08507
700.	307.47	0.9294	1.860	0.08504
1,000.	307.49	0.9292	2.502	0.08500
1,500.	307.53	0.9288	3.655	0.08495
2,000.	307.57	0.9284	4.893	0.08491
3,000.	307.67	0.9276	7.575	0.08485
5,000.	307.89	0.9260	13.580	0.08477
7,000.	308.14	0.9245	20.237	0.08471
10,000.	308.57	0.9221	31.164	0.08464
15,000.	309.44	0.9181	51.321	0.08456
20,000.	310.48	0.9141	73.387	0.08449
30,000.	313.05	0.9061	121.941	0.08439
50,000.	320.02	0.8904	232.178	0.08425
70,000.	329.14	0.8795	335.449	0.08415
100,000.	343.77	0.8678	558.820	0.08403
150,000.	372.85	0.8531	935.452	0.08300
200,000.	405.52	0.8420	1348.793	0.08377
300,000.	469.90	0.8223	2259.977	0.08360
500,000.	586.42	0.7908	4332.104	0.08336
700,000.	684.39	0.7686	6651.430	0.08336
1,000,000.	807.82	0.7479	10480.000	0.08336
1,500,000.	977.55	0.7275	16181.359	0.08336
2,000,000.	1120.56	0.7148	22011.598	0.08336
3,000,000.	1360.30	0.6992	33940.115	0.08336
5,000,000.	1740.17	0.6864	58504.338	0.08336

Table 2.2.4-10 — 24 Gauge PIC Cable at 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	277.19	0.9861	0.000	0.08300
5.	277.19	0.9861	0.001	0.08300
10.	277.19	0.9861	0.002	0.08300
15.	277.19	0.9861	0.003	0.08300
20.	277.19	0.9861	0.004	0.08300
30.	277.19	0.9861	0.005	0.08300
50.	277.19	0.9861	0.008	0.08300
70.	277.19	0.9861	0.011	0.08300
100.	277.19	0.9861	0.016	0.08300
150.	277.20	0.9860	0.022	0.08300
200.	277.20	0.9860	0.028	0.08300
300.	277.20	0.9860	0.040	0.08300
500.	277.21	0.9859	0.063	0.08300
700.	277.22	0.9858	0.084	0.08300
1,000.	277.23	0.9857	0.115	0.08300
1,500.	277.25	0.9854	0.164	0.08300
2,000.	277.28	0.9852	0.210	0.08300
3,000.	277.34	0.9848	0.299	0.08300
5,000.	277.48	0.9839	0.466	0.08300
7,000.	277.66	0.9829	0.625	0.08300
10,000.	277.96	0.9816	0.853	0.08300
15,000.	278.58	0.9793	1.213	0.08300
20,000.	279.35	0.9770	1.558	0.08300
30,000.	281.30	0.9723	2.217	0.08300
50,000.	286.82	0.9577	3.458	0.08300
70,000.	294.29	0.9464	4.634	0.08300
100,000.	308.41	0.9347	6.320	0.08300
150,000.	337.22	0.9204	8.993	0.08300
200,000.	369.03	0.9087	11.550	0.08300
300,000.	431.55	0.8885	16.436	0.08300
500,000.	541.69	0.8570	25.633	0.08300
700,000.	632.08	0.8350	34.351	0.08300
1,000,000.	746.04	0.8146	46.849	0.08300
1,500,000.	902.84	0.7947	66.665	0.08300
2,000,000.	1035.03	0.7825	85.624	0.08300
3,000,000.	1256.77	0.7676	121.841	0.08300
5,000,000.	1608.38	0.7523	190.021	0.08300

Table 2.2.4-11 — 24 Gauge Pulp Cable at 70°F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	277.19	0.9231	0.560	0.08540
5.	277.19	0.9231	0.566	0.08535
10.	277.19	0.9231	0.574	0.08533
15.	277.19	0.9230	0.582	0.08531
20.	277.19	0.9230	0.590	0.08530
30.	277.19	0.9230	0.606	0.08528
50.	277.19	0.9230	0.639	0.08525
70.	277.20	0.9230	0.672	0.08523
100.	277.20	0.9230	0.722	0.08521
150.	277.20	0.9229	0.808	0.08518
200.	277.20	0.9229	0.895	0.08516
300.	277.21	0.9228	1.076	0.08512
500.	277.22	0.9227	1.456	0.08507
700.	277.23	0.9225	1.860	0.08504
1,000.	277.25	0.9223	2.502	0.08500
1,500.	277.29	0.9219	3.655	0.08495
2,000.	277.32	0.9215	4.893	0.08491
3,000.	277.41	0.9207	7.575	0.08485
5,000.	277.61	0.9192	13.580	0.08477
7,000.	277.83	0.9176	20.237	0.08471
10,000.	278.23	0.9152	31.164	0.08464
15,000.	279.01	0.9113	51.321	0.08456
20,000.	279.95	0.9073	73.387	0.08449
30,000.	282.27	0.8993	121.941	0.08439
50,000.	288.54	0.8837	232.178	0.08425
70,000.	296.77	0.8729	355.449	0.08415
100,000.	311.93	0.8613	558.820	0.08403
150,000.	342.29	0.8468	935.452	0.08388
200,000.	375.24	0.8348	1348.793	0.08377
300,000.	439.90	0.8138	2259.977	0.08360
500,000.	553.04	0.7810	4332.104	0.08336
700,000.	645.81	0.7579	6651.430	0.08336
1,000,000.	762.77	0.7364	10480.000	0.08336
1,500,000.	923.69	0.7151	16181.359	0.08336
2,000,000.	1059.34	0.7018	22011.598	0.08336
3,000,000.	1286.91	0.6854	33940.115	0.08336
5,000,000.	1647.76	0.6681	58504.338	0.08336

Table 2.2.4-12 — 24 Gauge PIC Cable at 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	234.87	0.9758	0.000	0.08300
5.	234.87	0.9758	0.001	0.08300
10.	234.87	0.9758	0.002	0.08300
15.	234.87	0.9758	0.003	0.08300
20.	234.87	0.9758	0.004	0.08300
30.	234.87	0.9758	0.005	0.08300
50.	234.87	0.9757	0.008	0.08300
70.	234.87	0.9757	0.011	0.08300
100.	234.87	0.9757	0.016	0.08300
150.	234.87	0.9757	0.022	0.08300
200.	234.87	0.9757	0.028	0.08300
300.	234.87	0.9756	0.040	0.08300
500.	234.88	0.9755	0.063	0.08300
700.	234.89	0.9755	0.084	0.08300
1,000.	234.90	0.9753	0.115	0.08300
1,500.	234.92	0.9751	0.164	0.08300
2,000.	234.94	0.9749	0.210	0.08300
3,000.	234.99	0.9744	0.299	0.08300
5,000.	235.11	0.9735	0.466	0.08300
7,000.	235.26	0.9726	0.625	0.08300
10,000.	235.51	0.9713	0.853	0.08300
15,000.	236.04	0.9690	1.213	0.08300
20,000.	236.69	0.9667	1.558	0.08300
30,000.	238.35	0.9621	2.217	0.08300
50,000.	243.02	0.9476	3.458	0.08300
70,000.	249.35	0.9365	4.634	0.08300
100,000.	264.34	0.9249	6.320	0.08300
150,000.	294.92	0.9107	8.993	0.08300
200,000.	327.32	0.8976	11.550	0.08300
300,000.	390.34	0.8756	16.436	0.08300
500,000.	495.92	0.8419	25.633	0.08300
700,000.	579.22	0.8186	34.351	0.08300
1,000,000.	684.34	0.7969	46.849	0.08300
1,500,000.	829.13	0.7756	66.665	0.08300
2,000,000.	951.29	0.7623	85.624	0.08300
3,000,000.	1156.42	0.7459	121.841	0.08300
5,000,000.	1482.09	0.7235	190.021	0.08300

Table 2.2.4-13 — 24 Gauge Pulp Cable at 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	234.87	0.9134	0.560	0.08540
5.	234.87	0.9134	0.566	0.08535
10.	234.87	0.9134	0.574	0.08533
15.	234.87	0.9134	0.582	0.08531
20.	234.87	0.9134	0.590	0.08530
30.	234.87	0.9133	0.606	0.08528
50.	234.87	0.9133	0.639	0.08525
70.	234.87	0.9133	0.672	0.08523
100.	234.87	0.9133	0.722	0.08521
150.	234.87	0.9133	0.808	0.08518
200.	234.87	0.9132	0.895	0.08516
300.	234.88	0.9131	1.076	0.08512
500.	234.89	0.9130	1.456	0.08507
700.	234.90	0.9128	1.860	0.08504
1,000.	234.91	0.9126	2.502	0.08500
1,500.	234.94	0.9122	3.655	0.08495
2,000.	234.98	0.9118	4.893	0.08491
3,000.	235.05	0.9111	7.575	0.08485
5,000.	235.22	0.9095	13.580	0.08477
7,000.	235.41	0.9080	20.237	0.08471
10,000.	235.74	0.9056	31.164	0.08464
15,000.	236.41	0.9017	51.321	0.08456
20,000.	237.20	0.8978	73.387	0.08449
30,000.	239.16	0.8899	121.941	0.08439
50,000.	244.48	0.8745	232.178	0.08425
70,000.	251.45	0.8638	355.449	0.08415
100,000.	267.34	0.8523	558.820	0.08403
150,000.	299.27	0.8379	935.452	0.08388
200,000.	332.83	0.8246	1348.793	0.08377
300,000.	397.89	0.8019	2259.977	0.08360
500,000.	506.31	0.7672	4332.104	0.08336
700,000.	591.80	0.7431	6651.430	0.08336
1,000,000.	699.68	0.7204	10480.000	0.08336
1,500,000.	848.27	0.6979	16181.359	0.08336
2,000,000.	973.64	0.6837	22011.598	0.08336
3,000,000.	1184.15	0.6660	33940.115	0.08336
5,000,000.	1518.38	0.6425	58504.338	0.08336

Table 2.2.4-14 — 22 Gauge PIC Cable at 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	193.28	0.9935	0.000	0.08300
5.	193.28	0.9935	0.001	0.08300
10.	193.28	0.9935	0.001	0.08300
15.	193.28	0.9935	0.001	0.08300
20.	193.28	0.9935	0.002	0.08300
30.	193.28	0.9935	0.003	0.08300
50.	193.28	0.9935	0.005	0.08300
70.	193.28	0.9935	0.006	0.08300
100.	193.28	0.9935	0.009	0.08300
150.	193.28	0.9934	0.013	0.08300
200.	193.28	0.9934	0.017	0.08300
300.	193.29	0.9934	0.024	0.08300
500.	193.29	0.9932	0.040	0.08300
700.	193.30	0.9931	0.054	0.08300
1,000.	193.32	0.9930	0.076	0.08300
1,500.	193.35	0.9927	0.110	0.08300
2,000.	193.39	0.9924	0.145	0.08300
3,000.	193.47	0.9918	0.211	0.08300
5,000.	193.66	0.9906	0.341	0.08300
7,000.	193.90	0.9895	0.467	0.08300
10,000.	194.33	0.9877	0.652	0.08300
15,000.	195.26	0.9847	0.954	0.08300
20,000.	196.43	0.9817	1.248	0.08300
30,000.	199.48	0.9744	1.824	0.08300
50,000.	208.10	0.9562	2.943	0.08300
70,000.	217.24	0.9443	4.032	0.08300
100,000.	234.48	8.9309	5.630	0.08300
150,000.	266.20	0.9141	8.229	0.08300
200,000.	296.40	0.8993	10.772	0.08300
300,000.	353.55	0.8749	15.744	0.08300
500,000.	446.65	0.8430	25.396	0.08300
700,000.	522.27	0.8252	34.796	0.08300
1,000,000.	617.56	0.8090	48.587	0.08300
1,500,000.	748.59	0.7933	71.014	0.08300
2,000,000.	858.98	0.7838	92.958	0.08300
3,000,000.	1044.05	0.7759	135.865	0.08300
5,000,000.	1337.29	0.7685	219.158	0.08300

Table 2.2.4-15 — 22 Gauge Pulp Cable at 120° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C(MU-F/MI)
1.	193.28	0.9201	0.560	0.08540
5.	193.28	0.9201	0.566	0.08535
10.	193.28	0.9201	0.574	0.08533
15.	193.28	0.9201	0.582	0.08531
20.	193.28	0.9201	0.590	0.08530
30.	193.28	0.9201	0.606	0.08528
50.	193.28	0.9201	0.639	0.08525
70.	193.28	0.9200	0.672	0.08523
100.	193.28	0.9200	0.722	0.08521
150.	193.28	0.9200	0.808	0.08518
200.	193.29	0.9199	0.895	0.08516
300.	193.29	0.9198	1.076	0.08512
500.	193.31	0.9196	1.456	0.08507
700.	193.32	0.9194	1.860	0.08504
1,000.	193.35	0.9190	2.502	0.08500
1,500.	193.40	0.9185	3.655	0.08495
2,000.	193.45	0.9180	4.893	0.08491
3,000.	193.56	0.9169	7.575	0.08485
5,000.	193.83	0.9147	13.580	0.08477
7,000.	194.15	0.9126	20.237	0.08471
10,000.	194.71	0.9093	31.164	0.08464
15,000.	195.85	0.9038	51.321	0.08456
20,000.	197.26	0.8983	73.387	0.08449
30,000.	200.80	0.8871	121.941	0.08439
50,000.	210.36	0.8702	232.178	0.08425
70,000.	220.31	0.8587	355.449	0.08415
100,000.	238.57	0.8454	558.820	0.08403
150,000.	271.68	0.8280	935.452	0.08388
200,000.	303.09	0.8127	1348.793	0.08377
300,000.	361.99	0.7871	2259.977	0.08360
500,000.	457.89	0.7535	4332.104	0.08336
700,000.	535.80	0.7344	6651.430	0.08336
1,000,000.	633.96	0.7166	10480.000	0.08336
1,500,000.	768.93	0.6991	16181.359	0.08336
2,000,000.	882.64	0.6883	22011.598	0.08336
3,000,000.	1073.29	0.6779	33940.115	0.08336
5,000,000.	1375.35	0.6674	58504.338	0.08336

Table 2.2.4-16 — 22 Gauge PIC Cable at 70° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	174.27	0.9861	0.000	0.08300
5.	174.27	0.9861	0.001	0.08300
10.	174.27	0.9861	0.001	0.08300
15.	174.27	0.9861	0.001	0.08300
20.	174.27	0.9861	0.002	0.08300
30.	174.27	0.9861	0.003	0.08300
50.	174.27	0.9861	0.005	0.08300
70.	174.27	0.9861	0.006	0.08300
100.	174.27	0.9861	0.009	0.08300
150.	174.27	0.9860	0.013	0.08300
200.	174.27	0.9860	0.017	0.08300
300.	174.28	0.9860	0.024	0.08300
500.	174.29	0.9858	0.040	0.08300
700.	174.29	0.9857	0.054	0.08300
1,000.	174.31	0.9856	0.076	0.08300
1,500.	174.34	0.9853	0.110	0.08300
2,000.	174.37	0.9850	0.145	0.08300
3,000.	174.44	0.9844	0.211	0.08300
5,000.	174.62	0.9833	0.341	0.08300
7,000.	174.83	0.9821	0.467	0.08300
10,000.	175.22	0.9804	0.652	0.08300
15,000.	176.06	0.9778	0.954	0.08300
20,000.	177.11	0.9744	1.248	0.08300
30,000.	179.86	0.9672	1.824	0.08300
50,000.	187.64	0.9491	2.943	0.08300
70,000.	197.71	0.9372	4.032	0.08300
100,000.	215.55	0.9237	5.630	0.08300
150,000.	247.57	0.9055	8.229	0.08300
200,000.	277.95	0.8898	10.772	0.08300
300,000.	333.39	0.8642	15.744	0.08300
500,000.	421.57	0.8309	25.396	0.08300
700,000.	493.24	0.8123	34.796	0.08300
1,000,000.	583.59	0.7950	48.587	0.08300
1,500,000.	707.91	0.7783	71.014	0.08300
2,000,000.	812.72	0.7681	92.958	0.08300
3,000,000.	988.53	0.7557	135.865	0.08300
5,000,000.	1267.31	0.7429	219.158	0.08300

Table 2.2.4-17 — 22 Gauge Pulp Cable at 70°F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	174.27	0.9133	0.560	0.08540
5.	174.27	0.9133	0.566	0.08535
10.	174.27	0.9133	0.574	0.08533
15.	174.27	0.9133	0.582	0.08531
20.	174.27	0.9132	0.590	0.08530
30.	174.27	0.9132	0.606	0.08528
50.	174.27	0.9132	0.639	0.08525
70.	174.27	0.9132	0.672	0.08523
100.	174.27	0.9132	0.722	0.08521
150.	174.28	0.9131	0.808	0.08518
200.	174.28	0.9131	0.895	0.08516
300.	174.28	0.9130	1.076	0.08512
500.	174.30	0.9127	1.456	0.08507
700.	174.31	0.9125	1.860	0.08504
1,000.	174.33	0.9122	2.502	0.08500
1,500.	174.38	0.9117	3.655	0.08495
2,000.	174.42	0.9111	4.893	0.08491
3,000.	174.53	0.9101	7.575	0.08485
5,000.	174.77	0.9079	13.580	0.08477
7,000.	175.05	0.9058	20.237	0.08471
10,000.	175.56	0.9025	31.164	0.08464
15,000.	176.59	0.8971	51.321	0.08456
20,000.	177.86	0.8916	73.387	0.08449
30,000.	181.05	0.8805	121.941	0.08439
50,000.	189.68	0.8637	232.178	0.08425
70,000.	200.51	0.8523	355.449	0.08415
100,000.	219.32	0.8309	558.820	0.08403
150,000.	252.66	0.8203	935.452	0.08388
200,000.	284.22	0.8041	1348.793	0.08377
300,000.	341.35	0.7775	2259.977	0.08360
500,000.	432.18	0.7427	4332.104	0.08336
700,000.	506.01	0.7229	6651.430	0.08336
1,000,000.	599.08	0.7043	10480.000	0.08336
1,500,000.	727.15	0.6859	16181.359	0.08336
2,000,000.	835.11	0.6745	22011.598	0.08336
3,000,000.	1016.21	0.6603	33940.115	0.08336
5,000,000.	1303.38	0.6452	58504.338	0.08336

Table 2.2.4-18 — 22 Gauge PIC Cable at 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	147.66	0.9758	0.000	0.08300
5.	147.66	0.9758	0.001	0.08300
10.	147.66	0.9758	0.001	0.08300
15.	147.66	0.97587	0.001	0.08300
20.	147.66	0.9758	0.002	0.08300
30.	147.66	0.9758	0.003	0.08300
50.	147.66	0.9758	0.005	0.08300
70.	147.66	0.9757	0.006	0.08300
100.	147.66	0.9757	0.009	0.08300
150.	147.66	0.9757	0.013	0.08300
200.	147.66	0.9757	0.017	0.08300
300.	147.67	0.9756	0.024	0.08300
500.	147.67	0.9755	0.040	0.08300
700.	147.68	0.9754	0.054	0.08300
1,000.	147.69	0.9752	0.076	0.08300
1,500.	147.72	0.9749	0.110	0.08300
2,000.	147.74	0.9747	0.145	0.08300
3,000.	147.80	0.9741	0.211	0.08300
5,000.	147.95	0.9729	0.341	0.08300
7,000.	148.13	0.9718	0.467	0.08300
10,000.	148.47	0.9701	0.652	0.08300
15,000.	149.17	0.9671	0.954	0.08300
20,000.	150.07	0.9642	1.248	0.08300
30,000.	152.39	0.9570	1.824	0.08300
50,000.	158.98	0.9391	2.943	0.08300
70,000.	170.37	0.9274	4.032	0.08300
100,000.	189.06	0.9137	5.630	0.08300
150,000.	221.40	0.8935	8.229	0.08300
200,000.	252.11	0.8765	10.772	0.08300
300,000.	305.18	0.8492	15.744	0.08300
500,000.	386.45	0.8140	25.396	0.08300
700,000.	452.58	0.7941	34.796	0.08300
1,000,000.	536.03	0.7756	48.587	0.08300
1,500,000.	650.97	0.7574	71.014	0.08300
2,000,000.	747.95	0.7460	92.958	0.08300
3,000,000.	910.79	0.7275	135.865	0.08300
5,000,000.	1169.33	0.7071	219.158	0.08300

Table 2.2.4-19 — 22 Gauge Pulp Cable at 0° F

PRIMARY CONSTANTS 1 Hz to 5 MHz				
FREQ (HZ)	R (OHMS/MI)	L (MH/MI)	G (MU-MHO/MI)	C (MU-F/MI)
1.	147.66	0.9037	0.560	0.08540
5.	147.66	0.9037	0.566	0.08535
10.	147.66	-0.9037	0.574	0.08533
15.	147.66	0.9037	0.582	0.08531
20.	147.66	0.9037	0.590	0.08530
30.	147.66	0.9037	0.606	0.08528
50.	147.66	0.9036	0.639	0.08525
70.	147.66	0.9036	0.672	0.08523
100.	147.66	0.9036	0.722	0.08521
150.	147.66	0.9035	0.808	0.08518
200.	147.67	0.9035	0.895	0.08516
300.	147.67	0.9034	1.076	0.08512
500.	147.68	0.9032	1.456	0.08507
700.	147.69	0.9029	1.860	0.08504
1,000.	147.71	0.9026	2.502	0.08500
1,500.	147.75	0.9021	3.655	0.08495
2,000.	147.79	0.9016	4.893	0.08491
3,000.	147.88	0.9005	7.575	0.08485
5,000.	148.08	0.8984	13.580	0.08477
7,000.	148.32	0.8963	20.237	0.08471
10,000.	148.75	0.8931	31.164	0.08464
15,000.	149.63	0.8877	51.321	0.08456
20,000.	150.70	0.8822	73.387	0.08449
30,000.	153.40	0.8712	121.941	0.08439
50,000.	160.71	0.8547	232.178	0.08425
70,000.	172.78	0.8434	355.449	0.08415
100,000.	192.36	0.8298	558.820	0.08403
150,000.	226.04	0.8094	935.452	0.08388
200,000.	257.80	0.7921	1348.793	0.08377
300,000.	312.47	0.7640	2259.977	0.08360
500,000.	396.18	0.7276	4332.104	0.08336
700,000.	464.30	0.7067	6651.430	0.08336
1,000,000.	550.26	0.6871	10480.000	0.08336
1,500,000.	668.65	0.6675	16181.359	0.08336
2,000,000.	768.55	0.6551	22011.598	0.08336
3,000,000.	936.29	0.6357	33940.115	0.08336
5,000,000.	1202.61	0.6141	58504.338	0.08336

2.2.4.4 Optional Powering Across the Interface

This section is not part of the specification — for information only.

In some configurations a power source common to multiple NTs may be desirable. For example, in Figure 2.2.4-3, multiple NTs are connected to a cross-connect field located in a remote wiring closet. For configurations in which a common powering source is desirable, optional powering across the interface (if provided) shall be provided using Contacts 7 and 8 of the connector specified in "Connector," Section 2.2.1.5.2. If backup battery is provided, its status shall be provided by the common power source to the NT on an optional basis using Contacts 1 and 2 of the connector specified in "Connector," Section 2.2.1.5.2.

The power source should provide a nominal 48 volts DC. The maximum voltage of the power source (if provided) shall be 56.5 volts, and the minimum voltage shall be high enough to assure a minimum of 32 volts at the inputs of the NTs. The polarity of the voltage shall be minus at Contact 7 and plus at contact 8. When this power source is not floating, the polarity of the voltage with reference to ground shall be negative. Secondary power (if provided) from the common power source should indicate when the restricted power condition is entered by reversing polarity as described in Section 10.2 of T1.605 and "Wiring Polarity Integrity," Section 2.2.1.5.1.

Secondary power (if provided) by the common power source should support proactive maintenance by providing backup battery status to an NT, with the following characteristics:

- Battery status is indicated on pins 1 and 2 as:
  - ON state - good battery, a unidirectional current from the common power source of 1.0 to 10.0 mA and with a resistance greater than 100 kohms in the reverse direction. The maximum voltage across the unidirectional device when indicating good battery should be less than 2.0 volts.
  - OFF state (greater than 100 kohms) - battery not provided, marginal, or status not available.
- Pins 1 and 2 are designated as:
  - Pin 1 - Positive,
  - Pin 2 - Negative.
- Battery monitoring using this mechanism is optional. In general, it will not be necessary to provide battery status information to all NTs connected to the common power supply. One or two of the NTs may be designated to monitor the common power supply.
- If battery monitoring capability is not provided at the NT, the ps_2 bit should be set to 0 in the M-channel toward the network (see "Superframes," Section 2.2.1.7.2.6, "NT Power Status (ps) Bits," Section 2.2.3.1.2.4, Figure 2.2.1-14, and Table 2.2.3-1).

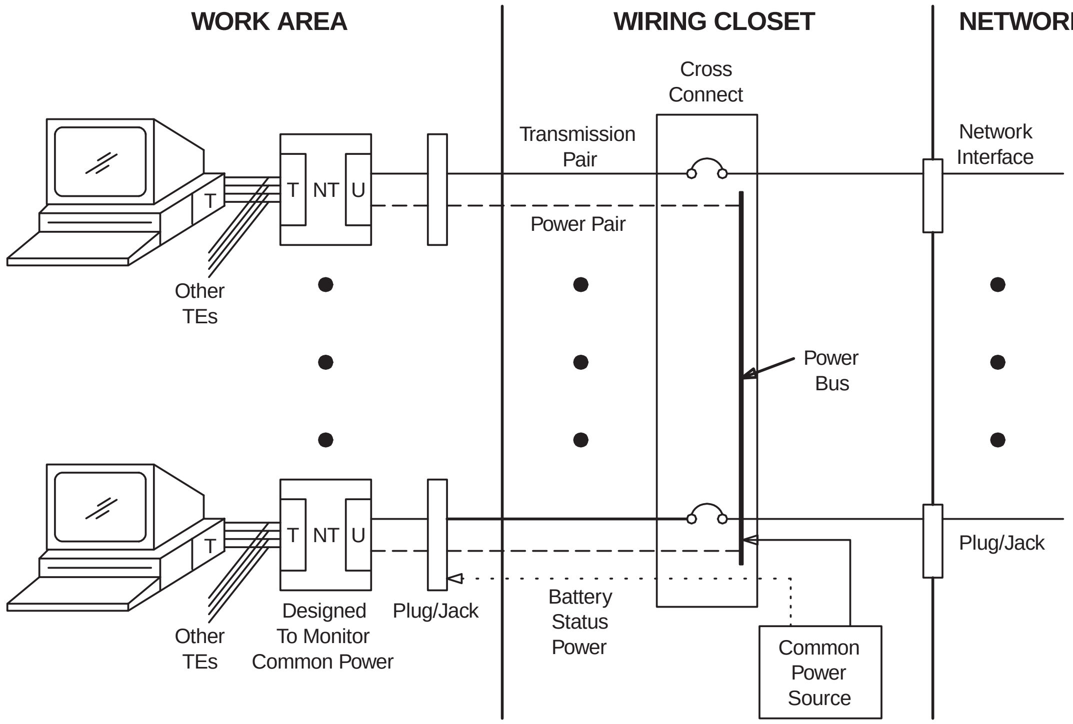


Figure 2.2.4-3 — NT Wiring Configuration

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

3. DATA LINK LAYER

This specification defines the frame structure, elements of procedure, format of fields, and procedures for the proper operation of the Link Access Procedure on the D-channel, LAPD. It is based on ITU-TS Recommendation Q.921, *ISDN User-Network Interface Data Link Layer Specification*.

The concepts, terminology, overview description of LAPD functions and procedures, and the relationship with other recommendations are described in general terms in ITU-TS Recommendation Q.920 (I.440), "ISDN User-Network Interface Data Link Layer—General Aspects."

Note 1: As stated in Recommendation Q.920 (I.440), the term "data link layer" is used in the main text of this specification. However, mainly in figures and tables, the terms "Layer 2" and "L2" are used as abbreviations. Furthermore, in accordance with the following ITU-TS recommendations, the term "Layer 3" is used to indicate the layer above the data link layer: ITU-TS Recommendation Q.930 (I.450), "ISDN User-Network Interface Layer 3 - General Aspects," and ITU-TS Recommendation Q.931 (I.451), "ISDN User-Network Interface Layer 3 - Specification."

Note 2: All references within this document to "layer management entity" and/or "connection management entity" refer to those entities at the data link layer.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

3.1 ELEMENTS OF LAYER 2 COMMUNICATION

3.1.1 FRAME STRUCTURE FOR PEER-TO-PEER COMMUNICATION

All data link layer peer-to-peer exchanges are in frames conforming to one of the formats shown in Figure 3.1-1. Two format types are shown in the figure: Format A for frames where there is no information field; and Format B for frames containing an information field.

3.1.1.1 Flag Sequence

All frames shall start and end with the flag sequence consisting of one "0" bit followed by six contiguous "1" bits and one "0" bit. The flag preceding the address field is defined as the opening flag. The flag following the frame checking sequence (FCS) field is defined as the closing flag. In transmitting frames, the user side data link layer entity will send separate opening and closing flags for each frame. However, it will be able to receive from the network side frames that are separated from each other by one or more flags.

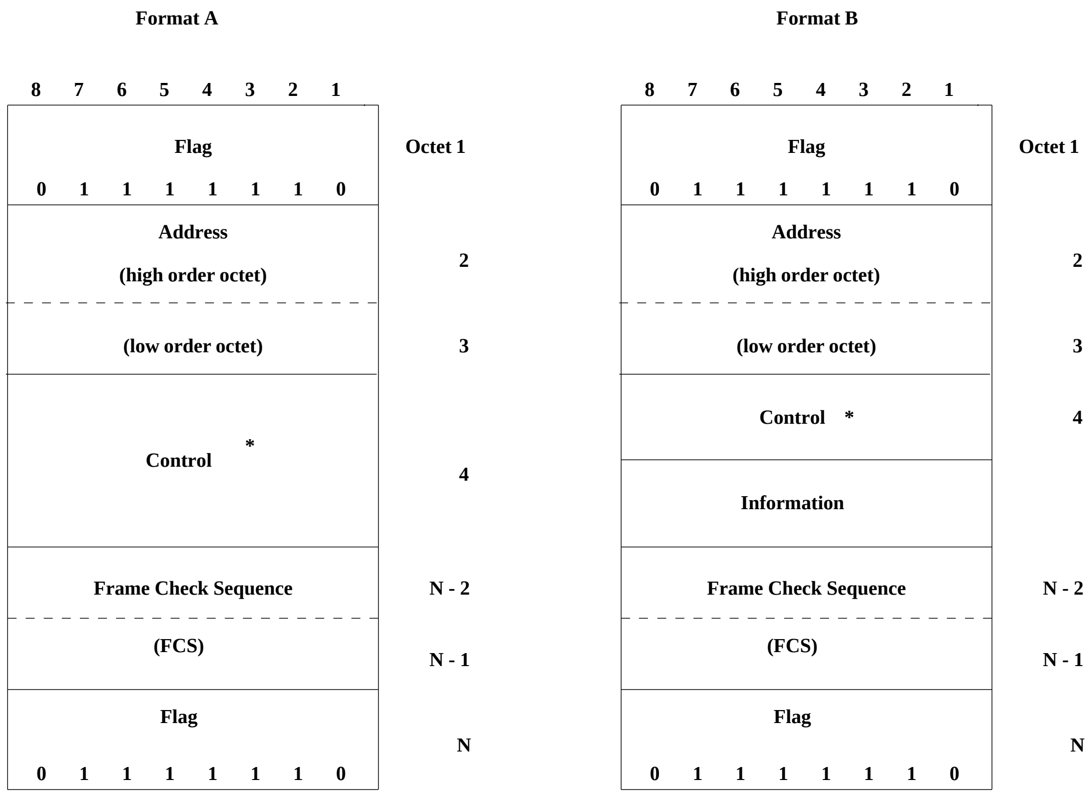
3.1.1.2 Address Field

The address field shall consist of two octets as illustrated in Figure 3.1-1. The address field identifies the intended receiver of a command frame and the transmitter of a response frame. The format of the address field is defined in "Address Field Format," Section 3.1.2.1.

3.1.1.3 Control Field

The control field shall consist of one or two octets. Figure 3.1-1 illustrates the two frame formats (A and B), each with a control field of one or two octets, depending upon the type of operation being used.

The format of the control field is defined in "Control Field Formats," Section 3.1.2.3.



* Unacknowledged operation - 1 octet
Multiple frame operation
Modulo 128 - 2 octets for frames with sequence numbers;
1 octet for frames without sequence numbers

Figure 3.1-1 — Frame Formats

3.1.1.4 Information Field

The information field of a frame, when present, follows the control field (see "Control Field," Section 3.1.1.3) and precedes the frame check sequence [see "Frame Checking Sequence (FCS) Field," Section 3.1.1.6]. The contents of the information field shall consist of an integral number of octets.

The maximum number of octets in the information field is defined in "Maximum Number of Octets in an Information Field (N201)," Section 3.2.9.3.

3.1.1.5 Transparency

A transmitting data link layer entity shall examine the frame content between the opening and closing flag sequences (address, control, information, and FCS fields) and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag or an abort sequence is not simulated within the frame. A receiving data link layer entity shall examine the frame contents between the opening and closing flag sequences and shall discard any "0" bit that directly follows five contiguous "1" bits.

3.1.1.6 Frame Checking Sequence (FCS) Field

The FCS field shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

a. The remainder of (x raised to k power) ($x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x^1 +1$) divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

b. The remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all "1s" and is then modified by division by the generator polynomial on the address, control, and information fields; the "1s" complement of the resulting remainder is transmitted as the 16-bit FCS sequence.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder is preset to all "1s." The final remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the FCS, will be "0001 1101 0000 1111" (x^{15} through x^0, respectively) in the absence of transmission errors.

3.1.1.7 Format Convention

3.1.1.7.1 Numbering Convention

The basic convention used in this specification is illustrated in Figure 3.1-2. The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n.

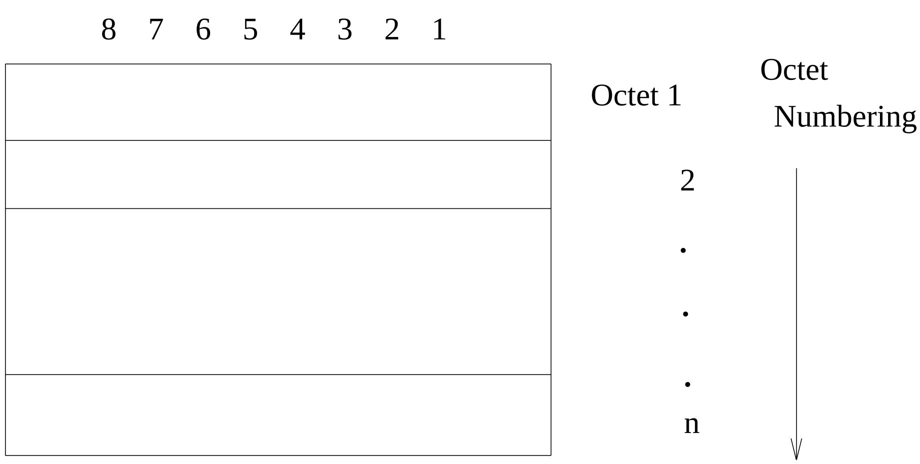


Figure 3.1-2 — Format Convention

3.1.1.7.2 Order of Bit Transmission

The octets are transmitted in ascending numerical order; inside an octet Bit 1 is the first bit to be transmitted.

3.1.1.7.3 Field Mapping Convention

When a field is contained within a single octet, the lowest bit number of the field represents the lowest order value.

When a field spans more than one octet, the order of bit values within each octet progressively decreases as the octet number increases. The lowest bit number associated with the field represents the lowest order value.

For example, a bit number can be identified as a couple (o,b) where o is the octet number and b is the relative bit number within the octet. Figure 3.1-3 illustrates a field that spans from bit (1,3) to bit (2,7). The high order bit of the field is mapped on bit (1,3) and the low order bit is mapped on bit (2,7).

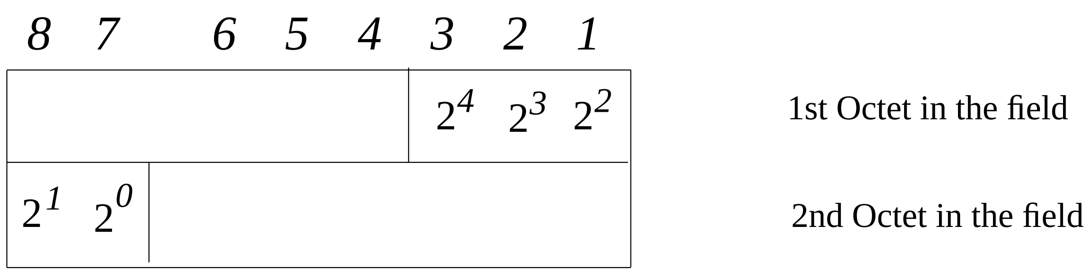


Figure 3.1-3 — Field Mapping Convention

An exception to the preceding field mapping convention is the data link layer FCS field, which spans two octets. In this case, Bit 1 of the first octet is the high order bit and Bit 8 of the second octet is the low order bit (Figure 3.1-4).

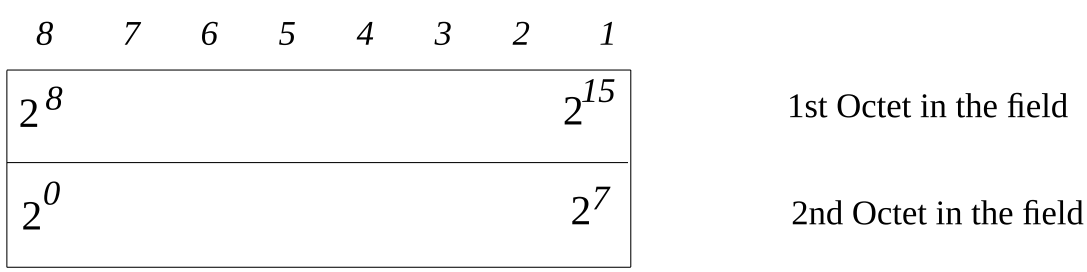


Figure 3.1-4 — FCS Mapping Convention

3.1.1.8 Invalid Frames

An invalid frame is a frame that:

- Is not properly bounded by two flags
- Has fewer than 6 octets between flags of frames that contain sequence numbers and fewer than 5 octets between flags of frames that do not contain sequence numbers
- Does not consist of an integral number of octets prior to zero bit insertion or following zero bit extraction
- Contains a frame check sequence error
- Contains a single octet address field

- Contains a service access point identifier [see "Service Access Point Identifier (SAPI)," Section 3.1.2.2.3] that is not supported by the receiver.

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of that frame.

3.1.1.9 Frame Abort

Receipt of seven or more contiguous "1" bits shall be interpreted as an abort, and the data link layer shall ignore the frame being received.

3.1.2 ELEMENTS OF PROCEDURES AND FORMATS OF FIELDS FOR DATA LINK LAYER PEER-TO-PEER COMMUNICATION

The elements of procedures define the commands and responses that are used on the data link connections carried on the D-channel.

Procedures are derived from these elements of procedures and are described in "Definition of the Peer-to-Peer Procedures of the Data Link Layer," Section 3.2.

3.1.2.1 Address Field Format

The address field format shown in Figure 3.1-5 contains the address field extension bits, a command/response indication bit, a data link layer service access point identifier (SAPI) subfield, and a terminal endpoint identifier (TEI) subfield.

3.1.2.2 Address Field Variables

3.1.2.2.1 Address Field Extension Bit (EA)

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address field. The presence of a "1" in the first bit of an address field octet signals that it is the final octet of the address field. The double octet address field for LAPD operation shall have Bit 1 of the first octet set to "0" and Bit 1 of the second octet set to "1".

8	7	6	5	4	3	2	1	
SAPI						C/R	EA 0	Octet 2
TEI							EA 1	3

Legend:

EA = Address field extension bit

C/R = Command/response field bit

SAPI = Service access point identifier

TEI = Terminal endpoint identifier

Figure 3.1-5 — Address Field Format

3.1.2.2.2 Command/Response Field Bit (C/R)

The C/R bit identifies a frame as either a command or a response. The user side shall send commands with the C/R bit set to "0", and responses with the C/R bit set to "1". The network side shall do the opposite; that is, commands are sent with C/R set to "1", and responses are sent with C/R set to "0". The combinations for the network side and user side are shown in Table 3.1-1.

Table 3.1-1 — Combinations for Network Side and User Side

COMMAND/RESPONSE	DIRECTION	C/R VALUE
Command	Network side → user side	1
	User side → network side	0
Response	Network side → user side	0
	User side → network side	1

In conformance with HDLC rules, commands use the peer data link layer entity's address, whereas responses use their own data link layer entity's address. According to these rules, both peer entities on a point-to-point data link connection use the same Data Link Connection Identifier (DLCI) composed of a SAPI-TEI where SAPI and TEI conform to the definitions contained in "Service Access Point Identifier (SAPI)," Section 3.1.2.2.3, and "Terminal Endpoint Identifier (TEI)," Section 3.1.2.2.4, and define the data link connection as described in Q.920, Section 3.4.1.

3.1.2.2.3 Service Access Point Identifier (SAPI)

The SAPI identifies a point at which data link layer services are provided by a data link layer entity to a Layer 3 or management entity. Consequently, the SAPI specifies a data link layer entity that will process a data link layer frame and also a Layer 3 or management entity that is to receive information carried by the data link layer frame. The SAPI allows 64 service access points to be specified, where Bit 3 of the address field octet containing the SAPI is the least significant binary digit and Bit 8 is the most significant. The SAPI values are allocated as follows:

SAPI Value	Related Layer 3 entity
0	Call control procedures
1	Reserved for packet mode communications using Q.931 call control procedures
16	Packet communication conforming to X.25 Level 3 procedures
63	Layer 2 Management procedures
All Others	Reserved for future standardization

3.1.2.2.4 Terminal Endpoint Identifier (TEI)

The TEI for a point-to-point data link connection may be associated with a single terminal (TE). A TE may contain one or more TEIs. The TEI for a broadcast data link connection is associated with all user side data link layer entities containing the same SAPI. The TEI subfield allows 128 values, where Bit 2 of the address field octet containing the TEI is the least significant binary digit and Bit 8 is the most significant binary digit. The following conventions shall apply in the assignment of these values.

3.1.2.2.4.1 TEI for Broadcast Data Link Connection

The TEI subfield bit pattern "111 1111" (=127) is defined as the group TEI. The group TEI is assigned to the broadcast data link connection associated with the addressed SAP.

3.1.2.2.4.2 TEI for Point-to-Point Data Link Connection

The remaining TEI values are used for the point-to-point data link connections associated with the addressed SAP. The range of TEI values shall be allocated in the following manner:

TEI Value	User Type
0-63	Nonautomatic TEI assignment user equipment
64-126	Automatic TEI assignment user equipment

Nonautomatic TEI values are selected by the user, and their allocation is the responsibility of the user. Automatic TEI values are selected by the network, and their allocation is the responsibility of the network.

3.1.2.3 Control Field Formats

The control field identifies the type of frame, which will be either a command or a response. The control field will contain sequence numbers, where applicable.

Three types of control field formats are specified; numbered information transfer (I format), supervisory functions (S format), and unnumbered information transfers and control functions (U format). The control field format is shown in Table 3.1-2.

Table 3.1-2 — Control Field Formats

<table>
<tr><th>CONTROL FIELD BITS (MODULO 128)</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td rowspan="2">I format</td><td colspan="7">N(S)[a]</td><td>0</td><td>Octet 4</td></tr>
<tr><td colspan="7">N(R)[b]</td><td>P[f]</td><td>5</td></tr>
<tr><td rowspan="2">S format</td><td>X[e]</td><td>X[e]</td><td>X[e]</td><td>X[e]</td><td>S[c]</td><td>S[c]</td><td>0</td><td>1</td><td>Octet 4</td></tr>
<tr><td colspan="7">N(R)[b]</td><td>P/F[f]</td><td>5</td></tr>
<tr><td>U format</td><td>M[d]</td><td>M[d]</td><td>M[d]</td><td>P/F[f]</td><td>M[d]</td><td>M[d]</td><td>1</td><td>1</td><td>Octet 4</td></tr>
<tr><td colspan="10">Note(s):
a. N(S) = Transmitter send sequence number
b. N(R) = Transmitter receive sequence number
c. S = Supervisory function bit
d. M = Modifier function bit
e. X = Reserved and set to 0
f. P/F = Poll bit when issued as a command, final bit when issued as a response</td></tr>
</table>

3.1.2.3.1 Information Transfer Format - I

The I format shall be used to perform an information transfer between Layer 3 entities. The functions of N(S), N(R), and P (defined in "Control Field Parameters and Associated State Variables," Section 3.1.2.4) are independent; that is, each I frame has an N(S) sequence number, an N(R) sequence number that may or may not acknowledge additional I frames received by the data link layer entity, and a P bit that may be set to "0" or "1".

The use of N(S), N(R), and P is defined in "Definition of the Peer-to-Peer Procedures of the Data Link Layer," Section 3.2.

3.1.2.3.2 Supervisory Format - S

The S format shall be used to perform data link supervisory control functions such as acknowledge I frames, request retransmission of I frames, and request a temporary suspension of transmission of I frames. The functions of N(R) and P/F are independent; that is, each supervisory frame has an N(R) sequence number that may or may not acknowledge additional I frames received by the data link layer entity, and a P/F bit that may be set to "0" or "1".

3.1.2.3.3 Unnumbered Format - U

The U format shall be used to provide additional data link control functions and unnumbered information transfers for unacknowledged information transfer. This format does not contain sequence numbers. It does include a P/F bit that may be set to "0" or "1".

3.1.2.4 Control Field Parameters and Associated State Variables

The various parameters associated with the control field formats are described in this section. The coding of the bits within these parameters is such that the lowest numbered bit within the parameter field is the least significant bit.

3.1.2.4.1 Poll/Final Bit

All frames contain P/F, the Poll/Final bit. The Poll/Final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit. The P bit set to "1" is used by a data link layer entity to solicit (poll) a response frame from the peer data link layer entity. The F bit set to "1" is used by a data link layer entity to indicate the response frame transmitted as a result of a soliciting (poll) command.

The use of the P/F bit is described in "Definition of the Peer-to-Peer Procedures of the Data Link Layer," Section 3.2.

3.1.2.4.2 Multiple Frame Operation - Variables and Sequence Numbers

3.1.2.4.2.1 Modulus

Each I frame is sequentially numbered and may have the value 0 through "n" minus 1 (where "n" is the modulus of the sequence numbers). The modulus equals 128 and the sequence numbers cycle through the entire range, 0 through 127.

3.1.2.4.2.2 Send State Variable V(S)

Each point-to-point data link connection endpoint shall have an associated send state variable [V(S)] when using I frame commands. The send state variable denotes the sequence number of the next I frame to be transmitted. The send state variable can take on the value 0 through "n" minus 1. The value of the send state variable shall be incremented by 1 with each successive I frame transmission, and shall not exceed V(A) by more than the maximum number of outstanding I frames, k. The value of k may be in the range of $1 \leq k \leq 127$.

3.1.2.4.2.3 Acknowledge State Variable V(A)

Each point-to-point data link connection endpoint shall have an associated acknowledge state variable [V(A)] when using I frame commands and supervisory frame commands/responses. The acknowledge state variable identifies the last frame that has been acknowledged by its peer [V(A)-1 equals the N(S) of the last acknowledged I frame]. The acknowledge state variable can take on the value 0 through "n" minus 1. The value of the acknowledge state variable shall be updated by the valid N(R) values received from its peer [see "Receive Sequence Number N(R)," Section 3.1.2.4.2.6]. A valid N(R) value is one that is in the range 0<= [N(R) - V(A)]mod128 <= [V(S)- V(A)]mod128.

3.1.2.4.2.4 Send Sequence Number N(S)

Only I frames contain N(S), the send sequence number of transmitted I frames. At the time that an in-sequence I frame is designated for transmission, the value of N(S) is set equal to the value of the send state variable V(S).

3.1.2.4.2.5 Receive State Variable V(R)

Each point-to-point data link connection endpoint shall have an associated receive state variable [V(R)] when using I frame commands and supervisory frame commands/responses. The receive state variable denotes the sequence number of the next in-sequence I frame expected to be received. The receive state variable can take on the value 0 through "n" minus 1. The value of the receive state variable shall be incremented by one with the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable [V(R)].

3.1.2.4.2.6 Receive Sequence Number N(R)

All I frames and supervisory frames contain N(R), the expected send sequence number of the next received I frame. At the time that an I or supervisory frame is designated for transmission, the value of N(R) is set equal to the current value of the receive state variable V(R). The N(R) indicates that the data link layer entity transmitting the N(R) has correctly received all I frames numbered up to and including N(R) - 1.

3.1.2.4.3 Unacknowledged Operation - Variables and Parameters

No variables are defined. One parameter is defined, N201 [see "Maximum Number of Octets in an Information Field (N201)," Section 3.2.9.3]. If the length of the information field in a received UI frame exceeds the value of N201 in the TEI unassigned state, the frames shall be discarded.

3.1.2.5 Frame Types

3.1.2.5.1 Commands and Responses

The following commands and responses are used by either user or network data link layer entities and are represented in Table 3.1-3. Each data link connection shall support the full set of commands and responses for each application implemented. The frame types associated with each of the two applications are identified in Table 3.1-3.

Frame types associated with an application not implemented are treated as invalid frames (see "Invalid Frame Condition," Section 3.2.8.4).

For purposes of the LAPD procedures in each application, the supervisory function bit encoding "11" and those encodings of the modifier function bits in Table 3.1-2 not identified in Table 3.1-3 are identified as undefined command and response control fields (see "Frame Rejection Condition," Section 3.2.8.5).

The commands and responses in Table 3.1-3 are defined in the following paragraphs.

3.1.2.5.2 Information (I) Command

The function of the information (I) command is to transfer, across a data link connection, sequentially numbered frames containing information fields provided by Layer 3. This command is used in the multiple frame operation on point-to-point data link connections.

Table 3.1-3 — Commands and Responses - Modulo 128

APPLICATION	FORMAT	COMMANDS	RESPONSES	ENCODING 8	7	6	5	4	3	2	1	OCTET
Unacknowledged and Multiple Frame Acknowledged Information Transfer	Information Transfer	I (information)		N(S)							0	4
				N(R)							P	5
	Supervisory	RR (receive ready	RR (receive ready	0	0	0	0	0	0	0	1	4
				N(R)							P/F	5
		RNR (receive not ready)	RNR (receive not ready)	0	0	0	0	0	0	0	1	4
				N(R)							P/F	5
		REJ (reject	REJ (reject)0	0	0	0	0	1	0	0	1	4
				N(R)							P/F	5
	Unnumbered	SABME (set asynchronous balanced mode extended)		0	1	1	P	1	1	1	1	4
			DM (disconnected mode)	0	0	0	F	1	1	1	1	4
		UI (unnumbered information)		0	0	0	P	0	0	1	1	4
		DISC (disconnect)		0	1	0	P	0	0	1	1	4
			UA (unnumbered acknowledgement)	0	1	1	F	0	0	1	1	4
			FRMR (frame reject	1	0	0	F	0	1	1	1	4
Connection management		XID (exchange identification)[a]	XID (exchange identification)[a]	1	0	1	P/F	1	1	1	1	4

Note(s):

a. Receipt of an XID frame (p=1) is acknowledged with an XID response. The switch never sends an XID frame (p=1).

3.1.2.5.3 Set Asynchronous Balanced Mode Extended (SABME) Command

The SABME unnumbered command is used to place the addressed user side or network side into modulo 128 multiple frame acknowledged operation.

No information field is permitted with the SABME command. A data link layer entity confirms acceptance of a SABME command by the transmission at the first opportunity of a UA response. Upon acceptance of this command, the data link layer entity's send state variable V(S), acknowledge state variable V(A), receive state variable V(R), and retransmission counter are set to "0". The transmission of a SABME command indicates the clearance of all exception conditions.

Previously transmitted I frames that are unacknowledged when this command is processed remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, Layer 3) or the management entity to recover from the possible loss of the contents of such I frames.

3.1.2.5.4 Disconnect (DISC) Command

The DISC unnumbered command is used to terminate the multiple frame operation.

No information field is permitted with the DISC command. The data link layer entity receiving the DISC command confirms the acceptance of a DISC command by the transmission of a UA response. The data link layer entity sending the DISC command terminates the multiple frame operation when it receives the acknowledging UA or DM response.

Previously transmitted I frames that are unacknowledged when this command is processed remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, Layer 3) or the management entity to recover from the possible loss of the contents of such I frames.

3.1.2.5.5 Unnumbered Information (UI) Command

When a Layer 3 or management entity requests unacknowledged information transfer, the UI unnumbered command is used to send information to its peer without affecting data link layer variables. The UI command frames do not carry a sequence number; therefore, the UI frame may be lost without notification.

3.1.2.5.6 Receive Ready (RR) Command/Response

The RR supervisory frame is used by a data link layer entity to:

- Indicate it is ready to receive an I frame
- Acknowledge previously received I frames numbered up to and including N(R) 1 (as defined in "Definition of the Peer-to-Peer Procedures of the Data Link Layer," Section 3.2)
- Clear a busy condition that was indicated by the earlier transmission of an RNR frame by that same data link layer entity.

In addition to indicating the status of a data link layer entity, the RR command with the P bit set to "1" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

3.1.2.5.7 Reject (REJ) Command/Response

The REJ supervisory frame is used by a data link layer entity to request retransmission of I frames starting with the frame numbered N(R). The value of N(R) in the REJ frame acknowledges I frames numbered up to and including N(R)-1. New I frames pending initial transmission shall be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer is established at a time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ frame.

The transmission of a REJ frame also indicates the clearance of any busy condition within the sending data link layer entity that was reported in an earlier transmission of an RNR frame by that same data link layer entity.

In addition to indicating the status of a data link layer entity, the REJ command with the P bit set to "1" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

3.1.2.5.8 Receive Not Ready (RNR) Command/Response

The RNR supervisory frame is used by a data link layer entity to indicate a busy condition; that is, a temporary inability to accept additional incoming I frames. The value of N(R) in the RNR frame acknowledges I frames numbered up to and including N(R)-1.

In addition to indicating the status of a data link layer entity, the RNR command with the P bit set to "1" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

3.1.2.5.9 Unnumbered Acknowledgement (UA) Response

The UA unnumbered response is used by a data link layer entity to acknowledge the receipt and acceptance of the mode-setting commands (SABME or DISC). Received mode-setting commands are not processed until the UA response is transmitted. No information field is permitted with the UA response. The transmission of the UA response indicates the clearance of any busy condition that was reported by the earlier transmission of an RNR frame by that same data link layer entity.

3.1.2.5.10 Disconnected Mode (DM) Response

The DM unnumbered response is used by a data link layer entity to report to its peer that the data link layer is in a state such that multiple frame operation cannot be performed. No information field is permitted with the DM response.

3.1.2.5.11 Frame Reject (FRMR) Response

The FRMR unnumbered response may be received by a data link layer entity as a report of an error condition not recoverable by retransmission of the identical frame; that is, at least one of the following conditions, which results from the receipt of a valid frame:

- The receipt of a command or response control field that is undefined or not implemented
- The receipt of a frame with an information field that is not permitted or the receipt of a supervisory or unnumbered frame with the incorrect length
- The receipt of an invalid N(R)
- The receipt of an I frame with an information field that exceeds the maximum established length.

An undefined control field is any of the control field encodings that are not identified in Table 3.1-3.

A valid N(R) value is one that is in the range 0<=[N(R)-V(A)]mod128<=[V(S)-(V(A)]mod128.

An information field that immediately follows the control field and consists of five octets (modulo 128 extended operation), is returned with this response and provides the reason for the FRMR response. This information field format is given in Figure 3.1-6.

8	7	6	5	4	3	2	1	
Rejected frame								**Octet 5**
Control field								**6**
V(S)							**0**	**7**
V(R)							**C/R**	**8**
0	**0**	**0**	**0**	**Z**	**Y**	**X**	**W**	**9**

— Rejected frame control field is the control field of the received frame that caused the frame reject. When the rejected frame is an unnumbered frame, the control field of the rejected frame is positioned in Octet 5, with Octet 6 set to "0000 0000."

— V(S) is the current send state variable value on the user side or network side reporting the rejection condition.

— C/R is set to "1" if the frame rejected was a response and is set to "0" if the frame rejected was a command.

— V(R) is the current receive state variable value on the user side or network side reporting the rejection condition.

— W set to "1" indicates that the control field received and returned in Octets 5 and 6 was undefined.

— X set to "1" indicates that the control field received and returned in Octets 5 and 6 was considered invalid because the frame contained an information field not permitted with this frame or is a supervisory or unnumbered frame with incorrect length. Bit W must be set to "1" in conjunction with this bit.

— Y set to "1" indicates that the information field received exceeded the maximum established information field length (N201) of the user side or network side reporting the rejection condition.

— Z set to "1" indicates that the control field received and returned in Octets 5 and 6 contained an invalid N(R).

— Octet 7 Bit 1 and Octet 9 Bits 5 through 8 shall be set to "0".

Figure 3.1-6 — FRMR Information Field Format - Extended (Modulo 128) Operation

3.1.2.5.12 XID Command

There are no procedures currently defined that require the XID command. Receipt of an XID frame (p=1) is acknowledged with an XID response, but the switch never sends an XID frame (p=1).

3.1.3 ELEMENTS FOR LAYER-TO-LAYER COMMUNICATION

Communications between layers and, for this specification, between the data link layer and the layer management, are accomplished by means of primitives.

Primitives represent, in an abstract way, the logical exchange of information and control between the data link and adjacent layers. They do not specify or constrain implementations.

Primitives consist of commands and their respective responses associated with the services requested of a lower layer. The general syntax of a primitive is:

```
XX-Generic name-Type: Parameters
```

where XX designates the interface across which the primitive flows. For this specification XX is:

- DL for between Layer 3 and the data link layer
- PH for between the data link layer and the physical layer
- MDL for between the layer management and the data link layer.

3.1.3.1 Generic Names

The generic name specifies the activity that will be performed. Table 3.1-4 illustrates the primitives defined in this specification. Note that not all primitives have associated parameters.

The primitive generic names that are defined in this specification are discussed in the following paragraphs.

3.1.3.1.1 DL-ESTABLISH

The DL-ESTABLISH primitives are used to request, indicate and confirm the outcome of the procedures for establishing multiple frame operation.

3.1.3.1.2 DL-RELEASE

The DL-RELEASE primitives are used to request, indicate and confirm the outcome of the procedures for terminating a previously established multiple frame operation, or for reporting an unsuccessful establishment attempt.

3.1.3.1.3 DL-DATA

The DL-DATA primitives are used to request and indicate Layer 3 messages that are to be transmitted, or have been received, by the data link layer using the acknowledged information transfer service.

3.1.3.1.4 DL-UNIT DATA

The DL-UNIT DATA primitives are used to request and indicate Layer 3 messages that are to be transmitted, or have been received, by the data link layer using the unacknowledged information transfer service.

3.1.3.1.5 MDL-ASSIGN

The MDL-ASSIGN primitives are used by the layer management entity to request that the data link layer associate the TEI value contained within the message portion of the primitive with the specified connection endpoint suffix (CES), across all SAPIs. The MDL-ASSIGN primitive is used by the data link layer to indicate to the layer management entity the need for a TEI value to be associated with the CES specified in the primitive message unit.

3.1.3.1.6 MDL-REMOVE

The MDL-REMOVE primitives are used by the layer management entity to request that the data link layer remove the association of the specified TEI value with the specified connection endpoint suffix (CES), across all SAPIs. The TEI and connection endpoint suffix are specified by the MDL-REMOVE primitive message unit.

3.1.3.1.7 MDL-ERROR

The MDL-ERROR primitives are used to indicate to the connection management entity that an error has occurred, associated with a previous management function request or detected as a result of communication with the data link layer peer entity, which cannot be corrected by the data link layer. The layer management entity may respond with an MDL-ERROR primitive if the layer management entity cannot obtain a TEI value.

3.1.3.1.8 MDL-UNIT DATA

The MDL-UNIT DATA primitives are used to request and indicate layer management entity messages that are to be transmitted, or have been received, by the data link layer using the unacknowledged information transfer service.

3.1.3.1.9 MDL-XID

The MDL-XID primitives are used by the connection management entity to request, indicate, respond and confirm the outcome of the actions used in the XID procedures.

3.1.3.1.10 PH-DATA

The PH-DATA primitives are used to request and indicate message units containing frames used for data link layer peer-to-peer communications passed to and from the physical layer.

3.1.3.1.11 PH-ACTIVATE

The PH-ACTIVATE primitives are used to request activation of the physical layer connection or to indicate that the physical layer connection has been activated.

3.1.3.1.12 PH-DEACTIVATE

The PH-DEACTIVATE primitive is used to indicate that the physical layer connection has been deactivated.

3.1.3.2 Primitive Types

The primitive types defined in this specification are discussed in the following paragraphs.

3.1.3.2.1 REQUEST

The REQUEST primitive type is used when a higher layer or layer management is requesting a service from the next lower layer.

3.1.3.2.2 INDICATION

The INDICATION primitive type is used by a layer providing a service to inform the next higher layer or layer management.

3.1.3.2.3 RESPONSE

The RESPONSE primitive type is used by layer management as a consequence of the INDICATION primitive type.

3.1.3.2.4 CONFIRM

The CONFIRM primitive type is used by the layer providing the requested service to confirm that the activity has been completed.

Figure 3.1-7 illustrates the relationship of the primitive types to Layer 3 and the data link layer.

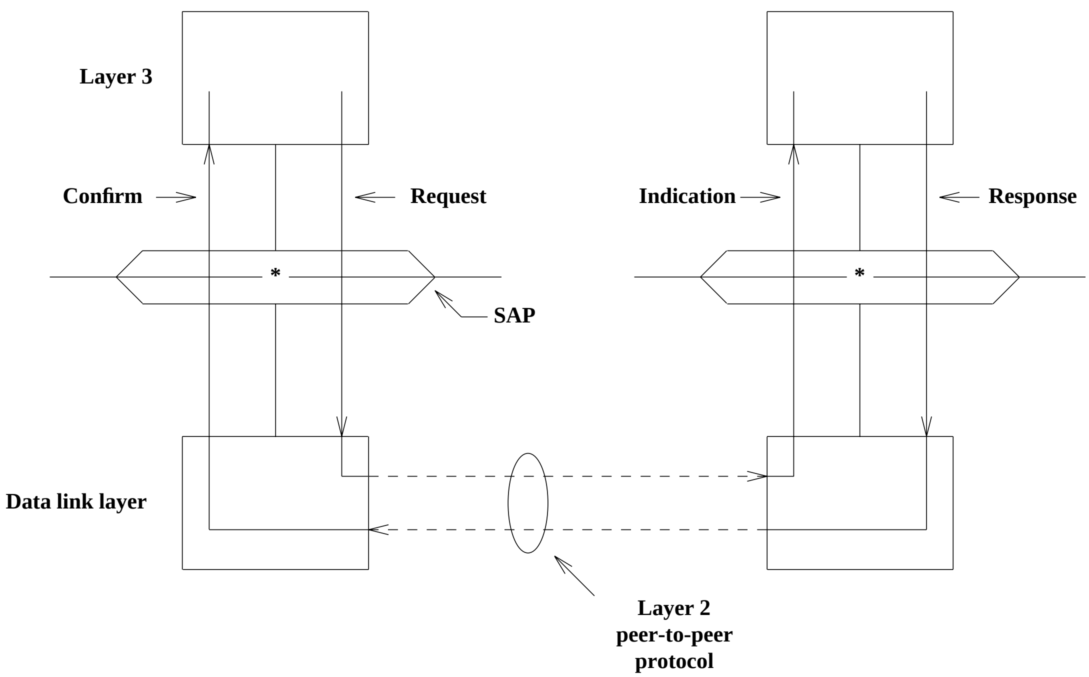


Figure 3.1-7 — Relationship of the Primitive Types to Layer 3 and the Data Link Layer

3.1.3.3 Parameter Definition

3.1.3.3.1 Priority Indicator

Since several SAPs may exist within a network or a user, protocol message units sent by one SAP may contend with those of other service access points for the physical resources available for message transfer. The priority indicator is used to determine which message unit will have greater priority when contention exists.

3.1.3.3.2 Message Unit

The message unit contains additional layer-to-layer information concerning actions and results associated with requests. In the case of the data primitive, the message unit contains the requesting layer peer-to-peer messages. For example, the DL-DATA message unit contains Layer 3 information. The PH-DATA message unit contains the data link frame.

Note: The operations across the data link layer-Layer 3 boundary shall be such that the layer sending the DATA or UNIT DATA primitive can assume a temporal order of the bits within the message unit and that the layer receiving the primitive can reconstruct the message with its assumed temporal order.

Table 3.1-4 — Primitives Associated with the Data Link Layer

GENERIC NAME [a]	TYPE			PARAMETERS		MESSAGE UNIT CONTENTS[a]
	REQUEST	INDICATION	RESPONSE	PRIORITY INDICATOR	MESSAGE UNIT	
L3 <-> L2						
DL-ESTABLISH	X	-	X	-	-	
DL-RELEASE	X	-	X	-	-	
DL-DATA	X	X	-	-	X	NL-NL peer message
DL-UNIT DATA	X	X	-	-	X	NL-NL peer message
M <-> L2						
MDL-ASSIGN	X	X	-	-	X	TEI value, CES
MDL-REMOVE	X	-	-	-	X	TEI value, CES
MDL-ERROR	-	X	X	-	X	Error IND.
MDL-UNIT DATA	X	X	-	-	X	MF-MF peer message
L2 <-> L1						
PH-DATA	X	X	-	X	X	DL-DL peer message
PH-ACTIVATE	X	X	-	-	-	
PH-DEACTIVATE	-	X	-	-	-	

Note(s):

a. Legend:
L3<->L2: Layer 3/data link layer/boundary
L2<->L1: Data link layer/physical layer boundary
M<->L2: Management entity/data link layer boundary
NL = Network Layer
MF = Management Function
DL = Data Link Layer

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

3.2 DEFINITION OF THE PEER-TO-PEER PROCEDURES OF THE DATA LINK LAYER

The procedures for use by the data link layer are specified in the following sections.

The elements of procedure (frame types) that apply are as follows:

- For unacknowledged information transfer (see "Procedures for Unacknowledged UI and Acknowledged XID Information Transfer," Section 3.2.2)
  - — UI-command.
- For multiple frame acknowledged information transfer (see "Procedures for Establishment and Release of Multiple Frame Operation," Section 3.2.5, "Procedures for Information Transfer in Multiple Frame Operation," Section 3.2.6, "Reestablishment of Multiple Frame Operation," Section 3.2.7, "Exception Condition Reporting and Recovery," Section 3.2.8)
  - — SABME-command
  - — UA-response
  - — DM-response
  - — DISC-command
  - — RR-command/response
  - — RNR-command/response
  - — REJ-command/response
  - — I-command
  - — FRMR-response.

3.2.1 PROCEDURE FOR THE USE OF THE P/F BIT

3.2.1.1 Unacknowledged Information Transfer

For unacknowledged information transfer, the P/F bit is not used and shall be set to "0".

3.2.1.2 Acknowledged Multiple Frame Information Transfer

A data link layer entity receiving a SABME, DISC, RR, RNR, REJ or I frame, with the P bit set to "1", shall set the F bit to "1" in the next response frame it transmits, as defined in Table 3.2-1.

Table 3.2-1 — Immediate Response Operation Of P/F Bit

COMMAND RECEIVED WITH P BIT = "1"	RESPONSE TRANSMITTED WITH F BIT = "1"
SABME, DISC	UA, DM
I, RR, RNR, REJ	RR, RNR, REJ, FRMR, DM

3.2.2 PROCEDURES FOR UNACKNOWLEDGED UI AND ACKNOWLEDGED XID INFORMATION TRANSFER

The procedures that apply to the transmission of information in unacknowledged operation using the UI frame are defined in the following paragraphs.

No data link layer error recovery procedures are defined for either operation.

3.2.2.1 Transmission of Unacknowledged Information

Note: The term "transmission of a UI frame" refers to the delivery of a UI frame by the data link layer to the physical layer.

Unacknowledged information is passed to the data link layer by Layer 3 or management entities using the primitives DL-UNIT DATA-REQUEST or MDL-UNIT DATA-REQUEST, respectively. The Layer 3 or management message unit shall be transmitted in a UI command frame.

For broadcast operation, the TEI value in the UI command address field shall be set to 127 (binary "111 1111," the group value).

For point-to-point operation, the appropriate TEI value shall be used.

The P bit shall be set to "0".

3.2.2.2 Receipt of Unacknowledged Information

On receipt of a UI command frame with a SAPI supported by the receiver, the contents of the information field shall be passed to the Layer 3 or management entity using the data link layer to Layer 3 primitive DL-UNIT DATA-INDICATION or the data link layer to management primitive MDL-UNIT DATA-INDICATION, respectively. Otherwise, the UI command frame shall be discarded.

3.2.3 TERMINAL ENDPOINT IDENTIFIER (TEI) MANAGEMENT PROCEDURES

3.2.3.1 General

The TEI management is based on the following procedural means:

- TEI Assignment Procedures (see "TEI Assignment Procedure," Section 3.2.3.2)
- TEI Check Procedures (see "TEI Check Procedure," Section 3.2.3.3)
- TEI Removal Procedures (see "TEI Removal Procedure," Section 3.2.3.4)

A user equipment in the TEI-unassigned state shall use the TEI assignment procedures to enter the TEI-assigned state. Conceptually, these procedures exist in the layer management entity. The layer management entity on the network side is referred to as the Assignment Source Point (ASP) in this specification.

The purpose of these procedures is to:

- Allow automatic TEI equipment to request the network to assign a TEI value that the data link layer entities within the requesting user equipment will use in their subsequent communications
- Allow a network to remove a previously assigned TEI from specific or all user equipments
- Allow a network to check
  - — Whether a TEI value is in use
  - — Whether dual-TEI assignment has occurred.

The user side layer management entity shall instruct the user data link layer entities to remove all TEI values when it is notified that the terminal is disconnected at the interface (as defined in Recommendation I.430).

Additionally, the user side layer management entity will instruct the user data link layer entity to remove a TEI value for its own internal reasons; for example, losing the ability to communicate with the network. The layer management entity shall use the MDL-REMOVE-REQUEST primitive for these purposes.

"Action Taken by the Data Link Layer Entity Receiving the MDL-REMOVE-REQUEST Primitive," Section 3.2.3.4.1, includes the actions taken by a data link layer entity receiving an MDL-REMOVE-REQUEST primitive.

Typically, one TEI value would be used by the user equipment (for example, a data link layer entity that has been assigned a TEI value could use that value for all SAPs it supports). If required, a number of TEI values may be requested by multiple use of the procedures defined in "TEI Assignment Procedure," Section 3.2.3.2. It shall be the responsibility of the user to maintain the association between TEI and SAPI values.

The initiation of TEI assignment procedures occurs on the receipt of a request for establishment or unacknowledged information transfer while in the TEI-unassigned state. The data link layer entity shall inform the management entity using the MDL-ASSIGN-INDICATION primitive. Alternatively, the user side layer management entity may initiate the TEI assignment procedures for its own reasons.

All layer management entity messages used for these TEI management procedures are transmitted to, or received from, the data link layer entity using the MDL-UNIT DATA-REQUEST primitive, or the MDL-UNIT DATA-INDICATION primitive, respectively. The data link layer entity shall transmit management entity messages in UI command frames. The SAPI value shall be 63. The TEI value shall be 127.

3.2.3.2 TEI Assignment Procedure

If the user equipment is of the nonautomatic TEI assignment category and if the optional parameter notification procedure is implemented, the user side layer management entity shall notify the connection management entity(s) of TEI assignment. When the parameters have been initialized by the connection management entity(s), the layer management entity shall deliver the TEI value to be used to the data link layer entity(s) through the MDL-ASSIGN-REQUEST primitive. If this optional parameter notification procedure is not implemented, the user side layer management shall immediately deliver the TEI value to be used to the data link layer entity(s) through the MDL-ASSIGN-REQUEST primitive.

If the user equipment is of the automatic TEI assignment category, upon initiation of the TEI assignment procedure, the user side layer management entity shall transmit to its peer a message containing the following elements:

- Message type = Identity request
- Reference number (Ri)
- Action indicator (Ai).

The Reference number, Ri, shall be used to differentiate between a number of user equipments that may simultaneously request assignment of a TEI value. The Ri shall be 2 octets in length and shall be randomly generated for each request message by the user equipments.

All values in the range 0 to 65535 shall be available from the random number generator.

Note: The design of the random number generator will minimize the probability of identical reference numbers being generated by terminals that initiate their TEI assignment procedures simultaneously.

The single-octet Action indicator, Ai, shall be used to indicate a request to the Assignment Source Point (ASP) for the assignment of any TEI value available.

The coding of the Ai shall be Ai = Group address TEI (127). This Ai value requests the ASP to assign any TEI value within the allowable range (64-126).

A Timer T202 shall be started.

The ASP, on receipt of the Identity request message, shall either:

- Select a TEI value
- Ignore the Identity request message if a previous Identity request message that contains an identical Ri has been received and no response has been issued. In this case, the ASP shall not assign a TEI value to either request.

Selection of a TEI value shall be on the basis of information stored at the ASP. This may consist of:

- A map of the full range of automatic TEI values
- An updated list of all automatic TEI values available for assignment, or a smaller subset.

The ASP, after having selected the TEI value, shall inform the network data link entities by means of the MDL-ASSIGN-REQUEST primitive and transmit to its peer a message containing the following elements:

- Message type = Identity assigned
- Reference number (Ri)
- The assigned TEI value in the Ai field.

If the available TEI information/resources are exhausted, a TEI check procedure will be initiated.

If an Identity request message is outstanding, a user side layer management entity receiving this Identity assigned message shall compare the TEI value to its own to see whether it is already allocated. Additionally, the TEI value may be compared on the receipt of all Identity assigned messages.

If there is a match, the management entity shall:

- Initiate TEI removal

If there is no match, the user side layer management entity shall:

- Compare the Ri value with any outstanding Identity request message and if it matches, consider the TEI value assigned to the user equipment, discard the value of Ri, inform the user side data link layer entities by means of the MDL-ASSIGN-REQUEST primitive and stop Timer T202
- Compare the Ri value with any outstanding Identity request message and if there is no match, do nothing
- If there is no outstanding Identity request message, do nothing.

If a TEI value has been assigned to the layer management entity and if the optional parameter notification procedure is implemented, the layer management entity will notify the connection management entity(s) to initialize the associated link parameters. Upon completion of the parameter initialization procedures, the layer management entity shall inform the user data link layer by means of the MDL-ASSIGN-REQUEST primitive. This primitive shall contain the TEI value received in the Identity Assigned message, and also the connection endpoint suffix (CES) value to which this TEI is to be mapped. When the data link layer receives the MDL-ASSIGN-REQUEST primitive from the layer management entity, the data link layer entity shall:

- Enter the TEI-assigned state
- Proceed with data link establishment procedures if a DL-ESTABLISH-REQUEST primitive is outstanding, or the transmission of a UI command frame if a DL-UNIT DATA-REQUEST primitive is outstanding.

To deny an Identity request message, the ASP shall transmit to its peer a message containing the following elements:

- Message type = Identity denied
- Reference number (Ri)
- The value of TEI denied in the Ai field (a value of 127 indicates that no TEI values are available).

The user side layer management entity receiving the Identity denied message shall, after expiry of Timer T202, re-invoke the TEI assignment procedure in accordance with "Expiry of Timer T202," Section 3.2.3.2.1, to obtain a TEI value.

3.2.3.2.1 Expiry of Timer T202

If the user receives no response to its Identity request message before the expiry of Timer T202, the timer shall be restarted and the Identity request message shall be retransmitted with a new value of Ri.

After N202 unsuccessful attempts to acquire a TEI value, the layer management entity shall inform the data link layer entity using the MDL-ERROR-RESPONSE primitive. The data link layer entity receiving the MDL-ERROR-RESPONSE primitive shall respond with the DL-RELEASE-INDICATION primitive if a request for establishment had previously occurred, and shall discard all unserviced DL-UNIT DATA-REQUEST primitives.

The values of T202 and N202 are specified in "Double Assignment of a TEI Value," Section 3.2.8.8.

The TEI assignment procedure is illustrated in Figure 3.2-1. See the following legend for interpretation of Figure 3.2-1.

SAPI:	Service access point identifier = 63
TEI:	Group TEI = 127
ID request:	Identity request
ID assigned:	Identity assigned
ID denied:	Identity denied
Ai:	Action indicator, see Table 3.2-2
Ri:	Reference number
( ):	Contents of the data link layer command address field
[ ]:	Contents of the data link layer command information field

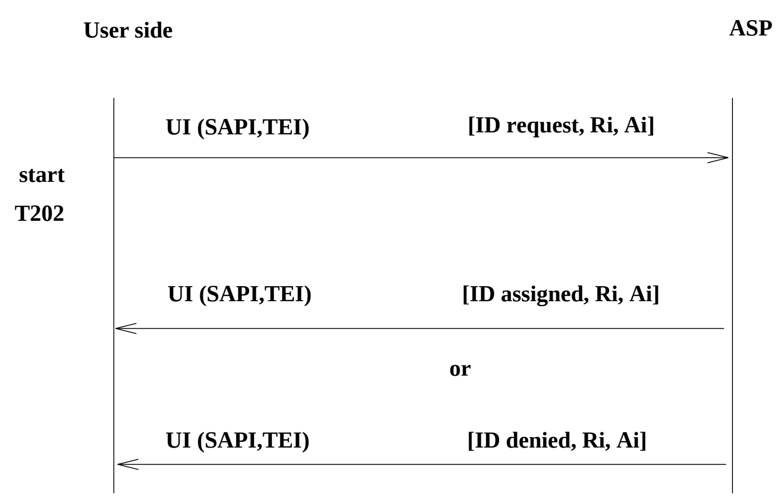


Figure 3.2-1 — TEI Assignment Procedure

3.2.3.3 TEI Check Procedure

This procedure is invoked by the network side of the interface. The user side equipment shall be required to respond to the TEI check messages.

3.2.3.3.1 Use of the TEI Check Procedure

The TEI check procedure shall be used in the TEI audit and recovery procedures. The TEI check procedure allows the network side layer management entity to either:

- Establish that a TEI value is in use
- Verify dual-TEI assignment (the receipt of an MDL-ERROR-INDICATION primitive indicating possible dual TEI assignment could trigger this TEI check procedure).

3.2.3.3.2 Operation of the TEI Check Procedure

The TEI check procedure is illustrated in Figure 3.2-2.

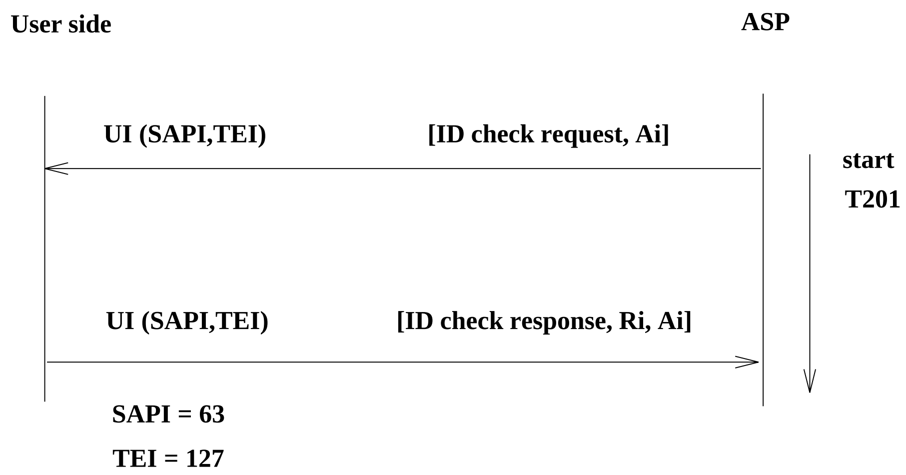


Figure 3.2-2 — TEI Check Procedure

The ASP shall transmit a message containing the following elements:

- Message type = Identity check request
- Ai field that contains the TEI value to be checked or the value 127 when all TEI values are to be checked.

Timer T201 shall be started.

If any user equipment has been assigned the TEI value specified in the Identity check request message, it shall respond by transmitting a message containing the following elements:

- Message type = Identity check response
- The TEI value in the Ai field
- Reference number (Ri).

Note: The randomly-generated Ri is present in the Identity check response to ensure that, if more than one user equipment commences transmission of the Identity check response at precisely the same time (that is, the first "0" bit of the opening flag coincides) due to different Ri values, a collision at Layer 1 (see ISDN user-network interfaces; Layer 1 Recommendations for clarification) occurs. The resolution of this collision results in multiple Identity check responses.

When the TEI check procedure is used to verify dual-TEI assignment:

- If more than one Identity check response is received within T201, then dual-TEI assignment shall be considered present; otherwise, the request shall be repeated once and T201 restarted.
- If more than one Identity check response is received within the second T201 period, dual TEI assignments shall be considered present.
- If no Identity check response is received after both T201 periods, the TEI value shall be assumed to be free and available for (re)assignment.
- If one Identity check response is received in one or both T201 time periods, the TEI value shall be assumed to be in use.

When the TEI check procedure is used to test whether a TEI value is in use, it is completed upon the receipt of the first TEI Identity check response message, and the TEI value is assumed to be in use. Otherwise:

- If no Identity check response is received within T201, the Identity check request shall be repeated once and T201 restarted.
- If no Identity check response is received after the second Identity check request, the TEI value shall be assumed to be free and available for reassignment.

If the Ai value in the Identity check request is equal to 127, it is preferred that the receiving user side layer management entity respond with a single Identity check response message that contains all of the TEI values in use within that user equipment [see "Action Indicator (Ai)," Section 3.2.3.5.5]. If an Identity check request with Ai equal to 127 is transmitted and an Identity check response is received making use of the extension facility, each Ai variable in the Ai field shall be processed as if received in separate Identity check responses for parallel Identity check requests.

3.2.3.4 TEI Removal Procedure

When the network side layer management entity determines that the removal of a TEI value (see "Conditions for TEI Removal," Section 3.2.3.4.2) is necessary, the ASP shall transmit a message containing the following elements and issue an MDL-REMOVE-REQUEST primitive:

- Message type = Identity remove
- TEI value that is to be removed, as indicated in the Ai field (the value of 127 indicates that all user equipments will remove their TEI values; otherwise, the specific TEI value will be removed).

When the user side layer management entity determines that the removal of a TEI value is necessary (see "Conditions for TEI Removal," Section 3.2.3.4.2), it shall instruct the data link layer entity to enter the TEI-unassigned state, using the MDL-REMOVE-REQUEST primitive. This action would also be taken for all TEI values when the Ai field contains the value of 127. Nonautomatic user equipment shall issue an MDL-REMOVE-REQUEST primitive to the data link layer entity and notify the equipment user of corrective action.

Further action to be taken shall be initiation of automatic TEI assignment for a new TEI value. For nonautomatic user equipment, further action may be an attempt to re-establish the data link.

3.2.3.4.1 Action Taken by the Data Link Layer Entity Receiving the MDL-REMOVE-REQUEST Primitive

A data link layer entity receiving an MDL-REMOVE-REQUEST primitive shall:

- If no DL-RELEASE-REQUEST primitive is outstanding and the user equipment is not in the TEI-assigned state, issue a DL-RELEASE-INDICATION primitive.
- If a DL-RELEASE-REQUEST primitive is outstanding, issue a DL-RELEASE primitive.

The data link layer entity shall then enter the TEI-unassigned state after discarding the contents of both UI and I queues.

3.2.3.4.2 Conditions for TEI Removal

At the user equipment, automatic TEI values will be removed, and in the case of non-automatic TEI values, an appropriate indication be made to the user under the following conditions:

- On request from the ASP by an Identity remove message
- Optionally, on receipt of an Identity assigned message containing a TEI value in the Ai field already in use within the user equipment (see "TEI Assignment Procedure," Section 3.2.3.2).

At the network side, TEI values will be removed following a TEI audit procedure showing that a TEI value is no longer in use or that multiple TEI assignment has occurred.

3.2.3.5 Formats and Codes

3.2.3.5.1 Messages

All messages used for TEI management procedures are carried in the information field of UI command frames with a SAPI value set to 63 (binary "11 1111") and TEI value set to 127 (binary "111 1111").

All messages have the structure shown in Figure 3.2-3.

8	7	6	5	4	3	2	1	
Layer management entity identifier								**Octet 5**
Reference number								**6**
								7
Message type								**8**
Action indicator							**E**	**9**

Figure 3.2-3 — Messages Used for TEI Management Procedures

Fields that are not used in a specific message are coded all zeroes, and are not to be processed by either side.

The coding of each field for the various messages is specified in Table 3.2-2.

The action indicator field extension bit is E [see "Action Indicator (Ai)," Section 3.2.3.5.5].

Table 3.2-2 — Codes for Messages Concerning TEI Management Procedures

MESSAGE NAME	LAYER MANAGEMENT ENTITY IDENTIFIER	REFERENCE NUMBER Ri	MESSAGE TYPE	ACTION INDICATOR Ai
Identity request (user to network)	0000 1111	0-65535	0000 0001	Ai = 127 Any TEI value acceptable
Identity assigned (network to user)	0000 1111	0-65535	0000 0010	Ai = 64-126 Assigned TEI value
Identity denied (network to user)	0000 1111	0-65535	0000 0011	Ai = 127 No TEI value available
Identity check request (network to user)	0000 1111	Not used (coded 0)	0000 0100	Ai = 127 Check all TEI values Ai = 0-126 TEI value to be checked
Identity check response (user to network)	0000 1111	0-65535	0000 0101	Ai = 0-126 TEI value in use
Identity remove (network to user)	0000 1111	Not used (coded 0)	0000 0110	Ai = 127 Request for removal of all TEI values Ai = 0-126 TEI value to be removed

3.2.3.5.2 Layer Management Entity Identifier

For TEI administration procedures, the layer management entity identifier octet is 0000 1111. Other values are reserved for further standardization.

3.2.3.5.3 Reference Number (Ri)

Octets 6 and 7 contain the Reference number (Ri). When used, it can assume any value between 0 and 65535.

3.2.3.5.4 Message Type

Octet 8 contains the message type. The purpose of the message type is to identify the function of the message being sent.

3.2.3.5.5 Action Indicator (Ai)

The Ai field is extended by reserving the first transmitted bit of the Ai field octets to indicate the final octet of the Ai field.

Ai variables in the Ai field are coded as follows:

- Bit 1 is the extension bit and is coded as follows:
  - — 0 to indicate an extension
  - — 1 to indicate the final octet.

- Bits 2 to 8 contain the Action indicator.

The purpose of the Action indicator is to identify the concerned TEI value(s).

3.2.4 AUTOMATIC NEGOTIATION OF DATA LINK LAYER PARAMETERS AND LINK TEST PROCEDURE

Each data link layer entity has an associated data link connection management entity. The data link connection management entity is responsible for initializing the link parameters necessary for correct peer-to-peer information transport and testing the data link connection periodically for continuity.

3.2.4.1 Parameter Initialization

The method of initialization of the parameters uses one of the two following methods:

- Initialization to the default values as specified in "Data Link Layer Monitor Function," Section 3.2.10
- Initialization based on the values supplied by its peer entity

The latter method utilizes the parameter notification procedure described in "Parameter Initialization," Section 3.2.4.1.

Typically, after the assignment of a TEI value, the user side data link connection management entity is notified by its layer management entity that parameter initialization is required.

The data link connection management entity either will initialize the parameters to the default values or will invoke the peer-to-peer notification procedure. After parameter initialization, the data link connection management entity will notify the layer management entity that parameter initialization has occurred.

The network side and optionally the user side has the additional responsibility of periodically testing the data link layer connection between peers. The period may be determined by the error rate detected per unit of time on this data link connection. The connection management entity will invoke this test procedure in order to distinguish whether the peer entity is still functionable. If no response is provided, or the contents of the returned information is incorrect, the connection management entity will notify its layer management entity that TEI removal may be necessary.

The parameter initialization procedure within a user side equipment invokes the internal parameter initialization procedure.

3.2.4.2 Internal Parameter Initialization

When the layer management entity notifies the connection management entity of TEI assignment, the connection management entity shall initialize the link parameters to the default values and notify the layer management of task completion.

3.2.5 PROCEDURES FOR ESTABLISHMENT AND RELEASE OF MULTIPLE FRAME OPERATION

3.2.5.1 Establishment of Multiple Frame Operation

The provision of extended multiple frame operation (modulo 128 sequencing) is recommended.

These procedures shall be used to establish multiple frame operation between the network and a designated user entity.

Layer 3 will request establishment of the multiple frame operation by the use of the DL-ESTABLISH-REQUEST primitive. Reestablishment may be initiated as a result of the data link layer procedures defined in "Reestablishment of Multiple Frame Operation," Section 3.2.7. All frames other than unnumbered frame formats received during the establishment procedures shall be ignored.

3.2.5.1.1 Establishment Procedures

A data link layer entity shall initiate a request for the multiple frame operation to be set by transmitting the Set Asynchronous Balanced Mode Extended (SABME) command. All existing exception conditions shall be cleared; the retransmission counter shall be reset, and Timer T200 shall then be started (Timer T200 is defined in "Timer T200," Section 3.2.9.1). All mode setting commands shall be transmitted with the P bit set to "1". The establishment procedures imply the discard of all DL-DATA-REQUESTs and all I frames in queue.

A data link layer entity receiving a SABME command, if it is able to enter the multiple-frame-established state, shall:

- Respond with an Unnumbered Acknowledgment (UA) response with the F bit set to the same binary value as the P bit in the received SABME command
- Set the send state variable V(S), receive state variable V(R) and acknowledge state variable V(A) to "0"
- Enter the multiple-frame-established state and inform Layer 3 using the DL-ESTABLISH-INDICATION primitive
- Reset the retransmission counter
- Clear all existing exception conditions
- Clear any existing peer receiver busy condition
- Start Timer T203, if implemented.

If the data link layer entity is unable to enter the multiple-frame-established state, it shall respond to the SABME command with a DM response with the F bit set to the same binary value as the P bit in the received SABME command.

Upon reception of the UA response with the F bit set to "1", the originator of the SABME command shall do the following:

- Reset Timer T200
- Start Timer T203, if implemented
- Reset the transmission counter
- Set the send state variable V(S), receive state variable V(R), and acknowledge state variable V(A) to "0"
- Reset the retransmission counter
- Enter the multiple-frame-established state and inform Layer 3 using the DL-ESTABLISH primitive.

Upon reception of a DM response with the F bit set to "1", the originator of the SABME command shall indicate this to Layer 3 by means of the

DL-RELEASE-INDICATION primitive, and reset Timer T200. It shall then enter the TEI-assigned state. The DM responses with the F bit set to "0" shall be ignored in this case.

3.2.5.1.2 Procedure on Expiry of Timer T200

If Timer T200 expires before the UA or DM response with the F bit set to "1" is received, the data link layer entity shall do the following:

- Retransmit the SABME command
- Restart Timer T200
- Increment the retransmission counter.

After retransmission of the SABME command N200 times, the data link layer entity shall indicate this to Layer 3 and the connection management entity by means of the DL-RELEASE-INDICATION and MDL-ERROR-INDICATION primitives, respectively, and enter the TEI-assigned state, after discarding all outstanding DL-DATA-REQUEST primitives and all I frames in queue.

The value of N200 is defined in "Maximum Number of Retransmissions (N200)," Section 3.2.9.2.

3.2.5.2 Information Transfer

Having either transmitted the UA response to a received SABME command or received the UA response to a transmitted SABME command, I frames and supervisory frames shall be transmitted and received according to the procedures described in "Procedures for Information Transfer in Multiple Frame Operation," Section 3.2.6.

If a SABME command is received while in the multiple-frame-established state, the data link layer entity shall conform to the reestablishment procedure described in "Reestablishment of Multiple Frame Operation," Section 3.2.7.

On receipt of a UI command, the procedures defined in "Procedures for Unacknowledged UI and Acknowledged XID Information Transfer," Section 3.2.2, shall be followed.

3.2.5.3 Termination of Multiple Frame Operation

These procedures shall be used to terminate the multiple frame operation between the network and a designated user entity.

Layer 3 will request termination of the multiple frame operation by use of the DL-RELEASE-REQUEST primitive.

All frames other than unnumbered frames received during the release procedures shall be ignored.

All outstanding DL-DATA-REQUEST primitives and all I frames in queue shall be discarded.

3.2.5.3.1 Release Procedure

A data link layer entity shall initiate a request for release of the multiple frame operation by transmitting the Disconnect (DISC) command with the P bit set to "1". Timer T200 shall then be started and the retransmission counter reset.

A data link layer entity receiving a DISC command while in the multiple-frame-established state shall transmit a UA response with the F bit set to the same binary value as the P bit in the received DISC command. A DL-RELEASE-INDICATION primitive shall be passed to Layer 3, and the TEI-assigned state shall be entered.

The originator of the DISC command shall enter the TEI-assigned state and reset Timer T200 if it receives either:

- A UA response with the F bit set to "1"
- A DM response with the F bit set to "1", indicating that the peer data link layer entity is already in the TEI-assigned state.

The data link layer entity that issued the DISC command is now in the TEI-assigned state and will notify Layer 3 by means of the DL-RELEASE primitive. The conditions relating to this state are defined in "TEI-Assigned State," Section 3.2.5.4.

3.2.5.3.2 Procedure on Expiry of Timer T200

If Timer T200 expires before a UA or DM response with the F bit set to "1" is received, the originator of the DISC command shall:

- Retransmit the DISC command as defined in "Release Procedure," Section 3.2.5.3.1
- Restart Timer T200
- Increment the retransmission counter

If after N200 attempts to recover, the data link layer entity has not received the correct response as defined in "Release Procedure," Section 3.2.5.3.1, the data link layer entity shall indicate this to the connection management entity by means of the MDL-ERROR-INDICATION primitive, enter the TEI-assigned state and notify Layer 3 by means of the DL-RELEASE primitive.

3.2.5.4 TEI-Assigned State

While in the TEI-assigned state:

- The receipt of a DISC command shall result in the transmission of a DM response with the F bit set to the value of the received P bit.
- The receipt of an I frame or supervisory frame with the P bit set to "1" shall result in the transmission of a DM response with the F bit set to "1" (as defined in "Acknowledged Multiple Frame Information Transfer," Section 3.2.1.2).
- On receipt of an SABME command, procedures defined in "Establishment of Multiple Frame Operation," Section 3.2.5.1, shall be followed.
- On receipt of UI commands, procedures defined in "Procedures for Unacknowledged UI and Acknowledged XID Information Transfer," Section 3.2.2, shall be followed.
- On receipt of any unsolicited UA response or a DM with F bit set to "1" an MDL-ERROR-INDICATION primitive indicating a possible double assignment of a TEI value shall be issued.
- All other frame types shall be discarded.

3.2.5.5 Collision of Unnumbered Commands and Responses

3.2.5.5.1 Identical Transmitted and Received Commands

If the transmitted and received unnumbered commands (SABME or DISC) are the same, the data link layer entities shall send the UA response at the earliest possible opportunity. The indicated state shall be entered after receiving the UA response. The data link layer entity shall notify Layer 3 by means of the appropriate primitive.

3.2.5.5.2 Different Transmitted and Received Commands

If the transmitted and received unnumbered commands (SABME or DISC) are different, the data link layer entities shall issue a DM response at the earliest possible opportunity. Upon receipt of a DM response with the F bit set to "1", the data link layer shall enter the TEI-assigned state and notify Layer 3 by means of the appropriate primitive. The entity receiving the DISC command will issue a DL-RELEASE-INDICATION primitive, while the other entity will issue a DL-RELEASE primitive.

3.2.5.6 Unsolicited DM Response and SABME or DISC Command

When a DM response with the F bit set to "0" is received by a data link layer entity, a collision between a transmitted SABME or DISC command and the unsolicited DM response may have occurred.

In order to avoid misinterpretation of the DM response received, a data link layer entity shall always send its SABME or DISC command with the P bit set to "1".

A DM response with the F bit set to "0" colliding with a SABME or DISC command shall be ignored.

3.2.6 PROCEDURES FOR INFORMATION TRANSFER IN MULTIPLE FRAME OPERATION

The procedures that apply to the transmission of I frames are defined in "Transmitting I Frames," Section 3.2.6.1.

Note: The term "transmission of an I frame" refers to the delivery of an I frame by the data link layer to the physical layer.

3.2.6.1 Transmitting I Frames

Information received by the data link layer entity from Layer 3 by means of a DL-DATA-REQUEST primitive shall be transmitted in an I frame. The control field parameters N(S) and N(R) shall be assigned the values of the send and receive state variables V(S) and V(R), respectively. The value of the send state variable V(S) shall be incremented by 1 at the end of the transmission of the I frame.

If Timer T200 is not running at time of transmission of an I frame, it shall be started. If Timer T200 expires, procedures defined in "Waiting Acknowledgment," Section 3.2.6.7, shall be followed.

If the send state variable V(S) is equal to V(A) plus k [where k is the maximum number of outstanding I frames - see "Maximum Number of Outstanding I Frames (k)," Section 3.2.9.5], the data link layer entity shall not transmit any new I frames, but may retransmit an I frame as a result of the error recovery procedures as described in "Receiving REJ Frames," Section 3.2.6.4, and "Waiting Acknowledgment," Section 3.2.6.7.

When the network side or user side is in the own receiver busy condition, it may still transmit I frames, provided that a peer receiver busy condition does not exist.

Note: Any DL-DATA-REQUEST primitives received while in the timer recovery condition shall be queued.

3.2.6.2 Receiving I Frames

Independent of a timer recovery condition, when a data link layer entity is not in an own receiver busy condition and receives a valid I frame whose send sequence number is equal to the current receive state variable V(R), the following shall be done by the data link layer entity.

- Pass the information field of this frame to Layer 3 using the DL-DATA-INDICATION primitive
- Increment by 1 its receive state variable V(R), and act as indicated in the next section.

3.2.6.2.1 P Bit Set to `1´

If the P bit of the received I frame was set to "1", the data link layer entity shall respond to its peer in one of the following ways:

- If the data link layer entity receiving the I frame is still not in an own receiver busy condition, it shall send an RR response with the F bit set to "1".
- If the data link layer entity receiving the I frame enters the own receiver busy condition upon receipt of the I frame, it shall send an RNR response with the F bit set to "1".

3.2.6.2.2 P Bit Set to `0´

If the P bit of the received I frame was set to "0" and:

- If the data link layer entity is still not in an own receiver busy condition:
  - — If no I frame is available for transmission or if an I frame is available for transmission but a peer receiver busy condition exists, the data link layer entity shall transmit an RR response with the F bit set to "0".
  - — If an I frame is available for transmission and no peer receiver busy condition exists, the data link layer entity shall transmit the I frame with the value of N(R) set to the current value of V(R) as defined in "Transmitting I Frames," Section 3.2.6.1.
- If, on receipt of this I frame, the data link layer entity is now in an own receiver busy condition, it shall transmit an RNR response with the F bit set to "0".

When the data link layer entity is in an own receiver busy condition, it shall process any received I frame according to "Data Link Layer Own Receiver Busy Condition," Section 3.2.6.6.

3.2.6.3 Sending and Receiving Acknowledgments

3.2.6.3.1 Sending Acknowledgments

Whenever a data link layer entity transmits an I frame or a supervisory frame, the value of N(R) shall be set equal to the value of V(R).

3.2.6.3.2 Receiving Acknowledgments

On receipt of a valid I frame or supervisory frame (RR, RNR, or REJ), even in the own receiver busy or timer recovery condition, the data link layer entity shall treat the N(R) contained in this frame as an acknowledgment for all the I frames it has transmitted with an N(S) up to and including the received N(R) - 1. The value of the acknowledge state variable V(A) shall be set to the value of N(R). The data link layer entity shall reset the Timer T200 on receipt of a valid I frame or supervisory frame with the N(R) higher than V(A) (actually acknowledging some I frames), or an REJ frame with an N(R) equal to the V(A).

Note 1: If a supervisory frame with the P bit set to "1" has been transmitted and not acknowledged, Timer T200 shall not be reset.

Note 2: Upon receipt of a valid I frame, Timer T200 shall not be reset if the data link layer entity is in the peer receiver busy condition.

If Timer T200 has been reset by the receipt of an I, RR, or RNR frame, and if there are outstanding I frames still unacknowledged, the data link layer entity shall restart Timer T200. If Timer T200 then expires, the data link layer entity shall follow the recovery procedure as defined in "Waiting Acknowledgment," Section 3.2.6.7, with respect to the unacknowledged I frames.

If Timer T200 has been reset by the receipt of an REJ frame, the data link layer entity shall follow the retransmission procedures in "Receiving REJ Frames," Section 3.2.6.4.

3.2.6.4 Receiving REJ Frames

On receipt of a valid REJ frame, the data link layer entity shall act as follows:

- If it is not in the timer recovery condition:
  - — Clear an existing peer receiver busy condition.
  - — Set its send state variable V(S) and its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field.
  - — Stop Timer T200.
  - — Start Timer T203, if implemented.
  - — Transmit a corresponding I frame as soon as possible, as defined in "Transmitting I Frames," Section 3.2.6.1, taking into account items i) to iii) and the last paragraph in this section.
  - — Send a protocol violation to the connection management entity by means of the MDL-ERROR-INDICATION primitive, if it was a REJ response frame with the F bit set to "1".
- If it is in the timer recovery condition and the frame is a REJ response frame with the F bit set to "1", the following occurs:
  - — Clear an existing peer receiver busy condition.
  - — Set its send state variable V(S) and its acknowledge state variable V(A) to the value N(R) contained in the REJ frame control field.
  - — Stop Timer T200.
  - — Start Timer T203, if implemented.
  - — Enter the multiple-frame-established state.
  - — Transmit corresponding I frame as soon as possible, as defined in "Transmitting I Frames," Section 3.2.6.1, taking into account items i) to iii) and the last paragraph in this section.

- If it is in the timer recovery condition and the frame is a REJ frame other than a REJ response frame with the F bit set to "1":
  - — Clear an existing peer receiver busy condition.
  - — Set its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field.
  - — If it was a REJ command frame with the P bit set to "1", transmit an appropriate supervisory response frame with the F bit set to "1". (See the following Note.)

Note: If the data link layer entity is not in an own receiver busy condition and is in a reject exception condition (that is, an N(S) sequence error has been received, and a REJ frame has been transmitted, but the requested I frame has not been received), the appropriate supervisory frame is RR.

If the data link layer entity is not in an own receiver busy condition but is in an N(S) sequence error exception condition (that is, an N(S) sequence error has been received but a REJ frame has not been transmitted), the appropriate supervisory frame is the REJ frame.

If the data link layer entity is in its own receiver busy condition, the appropriate supervisory frame is the RNR frame.

Otherwise, the appropriate supervisory frame is the RR frame.

Transmission of I frames shall take account of the following:

i. If the data link layer entity is transmitting a supervisory frame when it receives the REJ frame, it shall complete that transmission before commencing transmission of the requested I frame.

ii. If the data link layer entity is transmitting a SABME command, a DISC command, a UA response or a DM response when it receives the REJ frame, it shall ignore the request for retransmission.

iii. If the data link layer entity is not transmitting a frame when the REJ is received, it shall immediately commence transmission of the requested I frame.

All outstanding unacknowledged I frames, commencing with the I frame identified in the received REJ frame, shall be transmitted. Other I frames not yet transmitted may be transmitted following the retransmitted I frames.

3.2.6.5 Receiving RNR Frames

After receiving a valid RNR command or response, if the data link layer entity is not engaged in a mode-setting operation, it shall set a peer receiver busy condition and:

- If it was an RNR command with the P bit set to "1", it shall respond with an RR response with the F bit set to "1" if the data link layer entity is not in an own receiver busy condition, and shall respond with an RNR response with the F bit set to "1" if the data link layer entity is in an own receiver busy condition.
- If it was an RNR response with the F bit set to "1", an existing timer recovery condition shall be cleared and the N(R) contained in this RNR response shall be used to update the send state variable V(S).

The data link layer entity shall take note of the peer receiver busy condition and not transmit any I frames to the peer that has indicated the busy condition (see Note 1).

Note: The N(R) in any received supervisory command (including RNR) with P bit set to "1" will not be used to update send state variable V(S).

The data link layer entity shall then:

- Treat the receive sequence number N(R) contained in the received RNR frame as an acknowledgment for all the I frames that have been (re)transmitted with an N(S) up to and including N(R) minus 1, and set its acknowledge state variable V(A) to the value of the N(R) contained in the RNR frame.
- Restart Timer T200 unless a supervisory response frame with the F bit set to "1" is still expected.

If Timer T200 expires, the data link layer entity shall:

- If it is not yet in a timer recovery condition, enter the timer recovery condition and reset the retransmission count variable.
- If it is already in a timer recovery condition, add one to its retransmission count variable.

The data link layer entity shall then:

- If the value of the retransmission count variable is less than N200:
  - — Transmit an appropriate supervisory command (Note 2) with a P bit set to "1"
  - — Restart Timer T200.
- If the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in "Reestablishment of Multiple Frame Operation," Section 3.2.7, and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The data link layer entity receiving the supervisory frame with the P bit set to "1" shall respond, at the earliest opportunity, with an appropriate supervisory response frame (Note 2) with the F bit set to "1", to indicate whether or not its own receiver busy condition still exists.

Upon receipt of the supervisory response with the F bit set to "1", the data link layer entity shall reset Timer T200.

- If the response is an RR or REJ response, the peer receiver busy condition is cleared and the data link layer entity may transmit new I frames or retransmit I frames as defined in "Transmitting I Frames," Section 3.2.6.1, or "Receiving REJ Frames," Section 3.2.6.4, respectively.
- If the response is an RNR response, the data link layer entity receiving the response shall proceed according to this "Receiving RNR Frames," Section 3.2.6.5, first paragraph.

If a supervisory command (RR, RNR, or REJ) with the P bit set to "0" or "1", or a supervisory response frame (RR, RNR, or REJ) with the F bit set to "0" is received during the inquiry process, the data link layer entity shall:

- If the supervisory frame is an RR or REJ command frame or an RR or REJ response frame with the F bit set to "0", clear the peer receiver busy condition and if the supervisory frame received was a command with the P bit set to "1", transmit the appropriate supervisory response frame (Note 2) with the F bit set to

"1". However, the transmission or retransmission of I frames shall not be undertaken until the appropriate supervisory response frame with the F bit set to "1" is received.

- If the supervisory frame is an RNR command frame or an RNR response frame with the F bit set to "0", retain the peer receiver busy condition and if the supervisory frame received was an RNR command with the P bit set to "1", transmit the appropriate supervisory response frame (Note 2) with the F bit set to "1". The inquiry of the peer status shall be repeated after expiry of Timer T200, or after expiry of Timer T200 following the receipt of the RNR response with the F bit set to "1".

Upon receipt of a SABME command, the data link layer entity shall clear the peer receiver busy condition.

Note: If the data link layer entity is not in an own receiver busy condition and is in a reject exception condition [that is, an N(S) sequence error has been received, and a REJ frame has been transmitted, but a requested I frame has not been received], the appropriate supervisory frame is the RR frame.

If the data link layer entity is not in an own receiver busy condition but is in an N(S) sequence error exception condition (that is, an N(S) sequence error has been received but a REJ frame has not been transmitted), the appropriate supervisory frame is the REJ frame.

If the data link layer entity is in its own receiver busy condition, the appropriate supervisory frame is the RNR frame.

3.2.6.6 Data Link Layer Own Receiver Busy Condition

When the data link layer entity enters an own receiver busy condition, it shall transmit an RNR frame at the earliest opportunity.

The RNR frame may be either:

- An RNR response with the F bit set to "0"
- If this condition is entered on receiving a command frame with the P bit set to "1", an RNR response with the F bit set to "1"
- If this condition is entered on expiry of Timer T200, an RNR command with the P bit set to "1".

All received I frames with the P bit set to "0" shall be discarded, after updating the acknowledge state variable V(A).

All received supervisory frames with the P/F bit set to "0" shall be processed, including updating the acknowledge state variable V(A).

All received I frames with the P bit set to "1" shall be discarded, after updating the acknowledge state variable V(A). However, an RNR response frame with the F bit set to "1" shall be transmitted.

All received supervisory frames with the P bit set to "1" shall be processed including updating the acknowledge state variable V(A). An RNR response with the F bit set to "1" shall be transmitted.

To indicate to the peer data link layer entity the clearance of the own receiver busy condition, the data link layer entity shall transmit an RR frame or, if a previously detected N(S) sequence error has not yet been reported, an REJ frame with the N(R) set to the current value of the receive state variable V(R).

The transmission of a SABME command or a UA response (in reply to a SABME command) also indicates to the peer data link layer entity the clearance of the own receiver busy condition.

3.2.6.7 Waiting Acknowledgment

The data link layer entity shall maintain an internal retransmission count variable.

If Timer T200 expires, the data link layer entity shall do the following:

- If it is not yet in the timer recovery condition, enter the timer recovery condition and reset the retransmission count variable.
- If it is already in timer recovery condition, add one to its retransmission count variable.

The data link layer entity shall then do the following:

- If the value of the retransmission count variable is less than N200:
  - Restart Timer T200; and either Transmit an appropriate supervisory command (see Note 2 in "Receiving RNR Frames," Section 3.2.6.5) with the P bit set to "1".
  - Retransmit the last transmitted I frame [V(S) - 1] with the P bit set to "1".
- If the value of the retransmission count variable is equal to N200, initiate a reestablishment procedure as defined in "Reestablishment of Multiple Frame Operation," Section 3.2.7, and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The timer recovery condition is cleared when the data link layer entity receives a valid supervisory frame response with the F bit set to "1". If the received supervisory frame N(R) is within the range from its current state variable V(A) to its current send state variable V(S) inclusive, it shall set its send state variable V(S) to the value of the received N(R). Timer T200 shall be reset if the received supervisory frame response is an RR or REJ response, and then the data link layer entity shall resume with I frame transmission or retransmission, as appropriate. Timer T200 shall be reset and restarted if the received supervisory response is a Receive Not Ready (RNR) response, to proceed with the enquiry process according to "Receiving RNR Frames," Section 3.2.6.5.

3.2.7 REESTABLISHMENT OF MULTIPLE FRAME OPERATION

3.2.7.1 Criteria for Reestablishment

The criteria for reestablishing the multiple frame mode of operation are defined in this section by the following conditions:

- The receipt, while in the multiple-frame mode of operation of a SABME
- The receipt of a DL-ESTABLISH-REQUEST primitive from Layer 3 (see "Establishment of Multiple Frame Operation," Section 3.2.5.1)
- The occurrence of N200 retransmission failures while in the timer recovery condition (see "Waiting Acknowledgment," Section 3.2.6.7)

- On the occurrence of a frame rejection condition as identified in "Frame Rejection Condition," Section 3.2.8.5
- On the receipt, while in the multiple-frame mode of operation, of an FRMR response frame (see "Receipt of an FRMR Response Frame," Section 3.2.8.6)
- The receipt, while in the multiple-frame mode of operation, of an unsolicited UA (F=1), or DM response
- The receipt, while in the timer-recovery condition, of a DM response with the F bit set to "1".

3.2.7.2 Procedures

If a data link layer initiates a reestablishment procedure, this shall be indicated to the management entity by means of a primitive MDL-ERROR-INDICATION and the contents of all I queues will be discarded.

In all reestablishment situations, the procedures defined in "Establishment of Multiple Frame Operation," Section 3.2.5.1, shall be used. After successful reestablishment initiated by the data link layer, the primitive DL-ESTABLISH-INDICATION shall be used to inform Layer 3. In the case of Layer 3 initiated reestablishment or if a DL-ESTABLISH-REQUEST occurs pending reestablishment, the primitive DL-ESTABLISH shall be used.

3.2.8 EXCEPTION CONDITION REPORTING AND RECOVERY

Exception conditions may occur as the result of physical layer errors or data link layer procedural errors.

The error recovery procedures available to effect recovery following the detection of an exception condition at the data link layer are defined in this section.

3.2.8.1 N(S) Sequence Error

An N(S) sequence error exception condition occurs in the receiver when a valid I frame is received that contains an N(S) value not equal to the receive state variable V(R) at the receiver. The information field of all I frames whose N(S) does not equal the receive state variable V(R) shall be discarded.

The receiver shall not acknowledge (or increment its receive state variable) the I frame causing the sequence error, or any I frames that may follow, until an I frame with the correct N(S) is received.

A data link layer entity that receives one or more I frames with sequence errors but otherwise error-free, or subsequent supervisory frames (RR, RNR, and REJ), shall use control field information contained in N(R) field and the P or F bit to perform data link control functions; for example, to receive acknowledgment of previously transmitted I frames and to cause the data link layer entity to respond if P bit is set to "1". Therefore, the retransmitted I frame may contain an N(R) field value and a P bit that are updated from, and therefore different from, ones contained in the originally transmitted I frame.

The REJ frame is used by a receiving data link layer entity to initiate an exception condition recovery (retransmission) following the detection of an N(S) sequence error.

Only one REJ exception condition for a given direction of information transfer shall be established at a time.

A data link layer entity receiving a REJ command or response shall initiate sequential transmission (retransmission) of I frames starting with the I frame indicated by the N(R) contained in the REJ frame.

A REJ exception condition is cleared when the requested I frame is received or when a SABME or DISC command is received.

3.2.8.2 N(R) Sequence Error

An N(R) sequence error exception condition occurs in the transmitter when a valid supervisory frame or I frame is received that contains an invalid N(R) value. A valid N(R) is one that is in the range $V(A) \le N(R) \le V(S)$.

The information field contained in an I frame correct in sequence and format may be delivered to Layer 3 by means of the DL-DATA-INDICATION primitive.

The data link layer entity shall inform the connection management entity of this exception condition by means of the MDL-ERROR-INDICATION primitive, and initiate reestablishment (which may be preceded by an FRMR) according to "Procedures," Section 3.2.7.2.

3.2.8.3 Timer Recovery Condition

If a data link layer entity, due to a transmission error, does not receive a single I frame or the last I frame(s) in a sequence of I frames, it will not detect an out-of-sequence exception condition and therefore will not transmit a REJ frame.

The data link layer entity that transmitted the unacknowledged I frame(s), shall on the expiry of Timer T200, take appropriate recovery action as defined in "Waiting Acknowledgment," Section 3.2.6.7, to determine at what I frame retransmission must begin.

3.2.8.4 Invalid Frame Condition

Any frame received that is invalid (as defined in "Invalid Frames," Section 3.1.1.8, and "Commands and Responses," Section 3.1.2.5.1) shall be discarded, and no action shall be taken as a result of that frame.

3.2.8.5 Frame Rejection Condition

A frame rejection condition results from one of the conditions described in "Commands and Responses," Section 3.1.2.5.1, (third paragraph) or "Frame Reject (FRMR) Response," Section 3.1.2.5.11, Items b, c, and d.

If a frame rejection condition occurs while in multiple frame operation, the following shall be done by the data link layer entity.

- Issue an MDL-ERROR-INDICATION primitive
- Initiate reestablishment (see "Procedures," Section 3.2.7.2).

If a frame rejection condition occurs during establishment or release from multiple frame operation, or while a data link is not established, the data link layer entity shall:

- Issue an MDL-ERROR-INDICATION primitive
- Otherwise treat the frame as an invalid frame (see "Invalid Frame Condition," Section 3.2.8.4).

3.2.8.6 Receipt of an FRMR Response Frame

Upon receipt of an FRMR response frame in the multiple-frame mode of operation, the data link layer entity shall:

- Issue an MDL-ERROR-INDICATION primitive
- Initiate reestablishment (see "Procedures," Section 3.2.7.2).

3.2.8.7 Unsolicited Response Frames

Action to be taken on receipt of an unsolicited response frame is defined in Table 3.2-3.

The data link layer entity shall assume possible dual-TEI assignment on the receipt of an unsolicited UA response and shall inform layer management.

Table 3.2-3 — Actions Taken on Receipt of Unsolicited Response Frames

UNSOLICITED RESPONSE FRAME	TEI-ASSIGNED	AWAITING ESTABLISHMENT	AWAITING RELEASE	MULTIPLE FRAME MODES OF OPERATION	TIMER RECOVERY CONDITION
UA response F = 1	MDL-Error Indication	Solicited	Solicited	Ignore	MDL-Error Indication Reestablish
UA response F = 0	MDL-Error Indication	MDL-Error Indication	MDL-Error Indication	Ignore	MDL-Error Indication Reestablish
DM response F = 1	MDL-Error Indication	Solicited	Solicited	MDL-Error Indication Reestablish	MDL-Error Indication Reestablish
DM response F = 0	Ignore	Ignore	Ignore	Reestablish MDL-Error Indication	Reestablish MDL-Error Indication
Supervisory Response F = 1	Ignore	Ignore	Ignore	MDL-Error Indication	Solicited
Supervisory Response F = 0	Ignore	Ignore	Ignore	Solicited	Solicited

3.2.8.8 Double Assignment of a TEI Value

A data link layer entity shall assume double assignment of a TEI value and initiate recovery as specified by the following list:

- The receipt of a UA response frame while in the multiple-frame-established state
- The receipt of a UA response frame while in the timer recovery state
- The receipt of a UA response frame while in the TEI-assigned state.

A data link layer entity, after assuming double assignment of a TEI value, shall inform connection management entity by means of primitive MDL-ERROR-INDICATION.

3.2.9 LIST OF SYSTEM PARAMETERS

System parameters listed as follows are associated with each service access point. A method of assigning these parameters is defined in "Automatic Negotiation of Data Link Layer Parameters and Link Test Procedure," Section 3.2.4.

The term default implies that the value defined will be used in the absence of any assignment or negotiation of alternative values.

3.2.9.1 Timer T200

The default value for Timer T200 at the end of which transmission of a frame may be initiated according to the procedures described in "Procedures for Information Transfer in Multiple Frame Operation," Section 3.2.6, shall be 1 second.

Note 1: The proper operation of the procedure requires that Timer T200 be greater than the maximum time between transmission of command frames and the reception of their corresponding response or acknowledgment frames.

Note 2: When an implementation includes multiple terminals on the user side together with a satellite connection in the transmission path, a value of T200 greater than 1 second may be necessary; 2.5 seconds is suggested.

3.2.9.2 Maximum Number of Retransmissions (N200)

The maximum number of retransmissions of a frame (N200) is a system parameter. The default value of N200 shall be 3.

3.2.9.3 Maximum Number of Octets in an Information Field (N201)

The maximum number of octets in an information field (N201) is a system parameter. (See "Information Field," Section 3.1.1.4.)

- For SAPs supporting signaling, the default value shall be 260 octets.
- For SAPs supporting packet information, the default value shall be 260 octets.

3.2.9.4 Maximum Number of Transmissions of TEI Identity Request Message (N202)

The maximum number of transmissions of a TEI Identity request message (when the user requests a TEI) is a system parameter. The default value of N202 shall be 3.

3.2.9.5 Maximum Number of Outstanding I Frames (k)

The maximum number (k) of sequentially numbered I frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter that shall not exceed 127, for extended (modulo 128) operation.

- For SAPs supporting basic access D-channel (16 kbps) signaling, the default value shall be 1.
- For SAPs supporting basic access D-channel (16 kbps) X.31 packet information, the default shall be 3.

3.2.9.6 Timer T201

The minimum time between retransmission of the TEI Identity check messages (T201) is a system parameter that shall be set to T200 seconds.

3.2.9.7 Timer T202

The minimum time between the transmission of TEI Identity request messages is a system parameter (T202) that shall be set to 2 seconds.

3.2.9.8 Timer T203

The default value of Timer T203 shall be 30 seconds.

3.2.10 DATA LINK LAYER MONITOR FUNCTION

The procedural elements defined in "Definition of the Peer-to-Peer Procedures of the Data Link Layer," Section 3.2, allow for the supervision of the data link layer resource. This section describes procedures that may be used to provide this supervision function. The use of this function is optional.

3.2.10.1 Data Link Layer Supervision in the Multiple-Frame-Established State

The procedures specified herein propose a solution that is already identified in the HDLC classes of procedures. Connection verification is a service provided by data link layer to Layer 3. This implies that Layer 3 is informed in case of a failure only. Furthermore, the procedure may be incorporated in "normal" exchange of information and may become more efficient than a procedure based on involvement of Layer 3.

The procedure is based on supervisory command frames (RR command, RNR command) and a Timer T203 and operates in the multiple-frame-established state as follows.

If there are no frames being exchanged on data link connection (neither new nor outstanding I frames, and no supervisory frames with a P bit set to "1" etc.), there is no means to detect a faulty data link connection condition or whether user equipment has been unplugged. Timer T203 represents maximum time allowed without frames being exchanged.

If Timer T203 expires, a supervisory command with a P bit set to "1" is transmitted. Such a procedure is protected against transmission errors, by making use of the normal Timer T200 procedure including retransmission count and N200 attempts.

3.2.10.2 Connection Verification Procedures

3.2.10.2.1 Start Timer T203

The Timer T203 is started:

- When the multiple-frame-established state is entered
- In the multiple-frame-established state whenever T200 is stopped.

Note: These two conditions mean that Timer T203 is only started whenever T200 is stopped and not restarted.

An example of such an event is the receipt of an I or supervisory frame that acknowledges all outstanding I frames.

3.2.10.2.2 Stop Timer T203

The Timer T203 is stopped:

- When in the multiple-frame-established state, the Timer T200 is started
- Upon leaving the multiple-frame-established state.

3.2.10.2.3 Expiry of Timer T203

If Timer T203 expires, the data link layer entity will act as follows (it will be noted that Timer T200 is neither running nor expired):

- Set the retransmission count variable to 0
- Enter timer recovery state

- Transmit a supervisory command with the P bit set to "1" as follows:
  - If there is not a receiver busy condition (own receiver not busy), transmit an RR command
  - If there is a receiver busy condition (own receiver busy), transmit an RNR command.
- Start Timer T200
- Attempt to retransmit the command after T200 expiry
- Attempt to reestablish the data link after N200 retransmissions
- Send MDL-ERROR-INDICATION primitive to connection management and DL-RELEASE-INDICATION to Layer 3 after N200 attempts at reestablishment.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

3.3 AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

3.3.1 INTRODUCTION

The purpose of this section is to provide one example of an SDL representation of the point-to-point procedures of the data link layer, to assist in the understanding of this specification. This representation does not describe all of the possible actions of the data link layer entity, as a nonpartitioned representation was selected in order to minimize its complexity. The SDL representation does not therefore constrain implementations from exploiting the full scope of the procedures as presented within the text of this specification. The text description of the procedures is definitive.

Representation is a peer-to-peer model of point-to-point procedures of the data link layer and is applicable to the data link layer entities at both the user and network sides for all ranges of TEI values. (See Figure 3.3-1.) A key to symbols is provided as Figure 3.3-2. See Figures 3.3-4, 3.3-5, 3.3-6, 3.3-7, 3.3-8, 3.3-9, 3.3-10, 3.3-11, 3.3-12, 3.3-13, 3.3-16, 3.3-17, and 3.3-18 for the SDL representations.

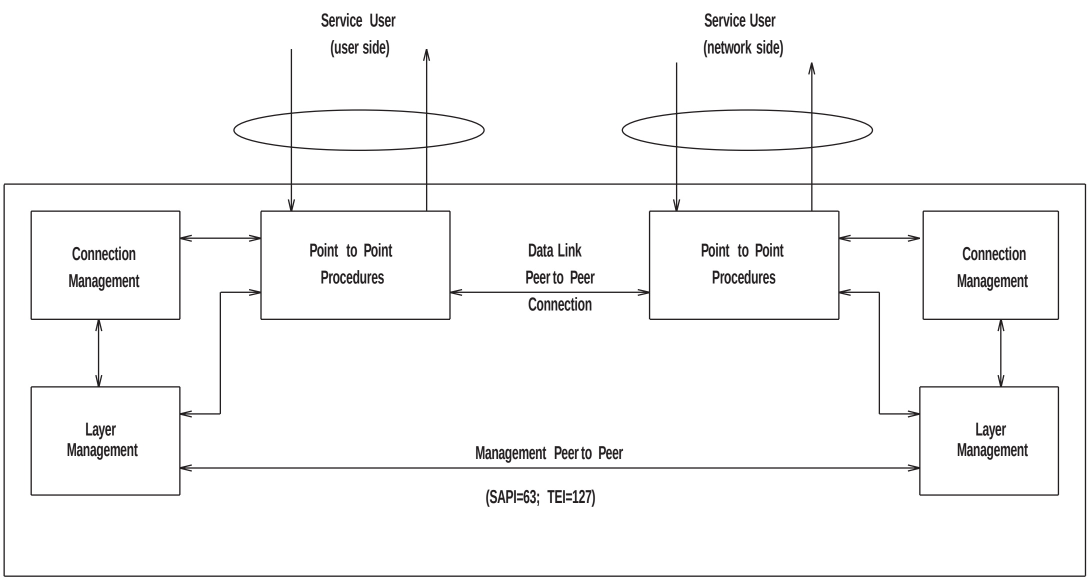


Figure 3.3-1 — Data Link Service Entities

The functions of the connection management and layer management entities within this model are as follows:

- Connection Management (one per data link layer entity) provides:
  - — Link Test Procedures
  - — Parameter Notification Procedures.
- Layer Mangement provides:
  - — TEI Assignment Procedures
  - — TEI Removal Procedures
  - — TEI Check Procedures.

An overview SDL presentation of these management entities is contained in the LM figures of the SDL diagrams.

3.3.2 OVERVIEW OF THE STATES OF THE POINT-TO-POINT DATA LINK LAYER ENTITY

The SDL representation of the point-to-point procedures are based on an expansion of the three basic states identified in the Q.920 document to the following eight states:

1. TEI unassigned
2. Assign awaiting TEI
3. Establish awaiting TEI
4. TEI assigned
5. Awaiting establishment
6. Awaiting release
7. Multiple frame established
8. Timer recovery.

An overview of the inter-relationship of these states is provided in Figure 3.3-3. This overview is incomplete and serves only as an introduction to the SDL representation. All data link layer entities are conceptually initiated in the TEI unassigned state (State 1), and will interact with the management entity in order to request a TEI value. TEI assignment initiated by a unit data request will cause the data link layer entity to move to the TEI assigned state (State 4) through the assign awaiting TEI state (State 2). Initiation by an establishment request will cause a transition to the awaiting establishment state (State 5) through the establish awaiting TEI state (State 3). Direct TEI assignment will cause an immediate transition to the TEI assigned state (State 4). In States 4-8, unit date requests can be directly serviced by the data link layer entity. The receipt of an establish request in the TEI assigned state (State 4) will cause the initiation of the establishment procedures and the transition to the awaiting establishment state (State 5). Completion of the LAP establishment procedures takes the data link layer entity into the multiple-frame-established state (State 7). Peer initiated establishment causes a direct transition from the TEI assigned state (State 4) to the multiple-frame-established state (State 7). In the multiple-frame-established state (State 7), acknowledged data transfer requests can be serviced directly subject, to the restrictions of the procedures. Expiry of the Timer T200, which is used in both the flow control and data transfer aspects of the data link layer entity's procedures initiates the transition to the timer recovery state (State 8). Completion of the timer recovery procedures will return the data link layer entity to the multiple-frame-established state (State 7). In States 7 and 8 of the SDL representation, the following conditions that are identified within the specification are observed:

- Peer receiver busy
- Reject exception
- Own receiver busy.

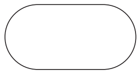
In addition, other conditions are used in order to avoid identification of additional states. The complete combination of both of these categories of conditions with the eight states of the SDL representation, is the basics for the state transition table description of the data link layer entity. Although a peer initiated LAP release will take the data link layer entity directly into the TEI assigned state (State 4), a release request will be through the awaiting release state (State 6). The TEI removal will cause a transition to the TEI unassigned state (State 1).

3.3.3 COVER NOTES

See Figure 3.3-2 for symbols used within this description. A full description of their meaning and application can be found in the Z series.

3.3.4 THE USE OF QUEUES

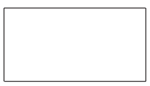
To enable a satisfactory representation of the data link layer entity, conceptual queues for the UI and I frame transmission are explicitly brought out. These conceptual queues are infinite and will in no way restrict the implementation of the point-to-point procedures. Two additional signals are provided in order to cause the servicing of these queues to be initiated—frame queued up and I frame queued up.

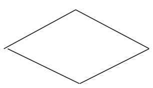
1.  State.

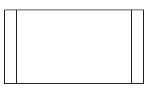
2.  Event occurrence.

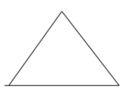
3.  Signal generation (which will lead to an associated event occurrence).

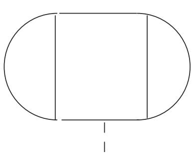
4.  Save an event (until completion of a transition).

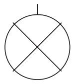
5.  Process description.

6.  Test.

7.  Procedure call.

8.  Implementation option.

9.  Procedure de®nition.

 Procedure end.

10. * To mark an event or signal required as a result of the representation approach adopted which is local to the data link layer entity.

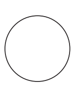
11.  Continuation

Figure 3.3-2 — Key to Symbols

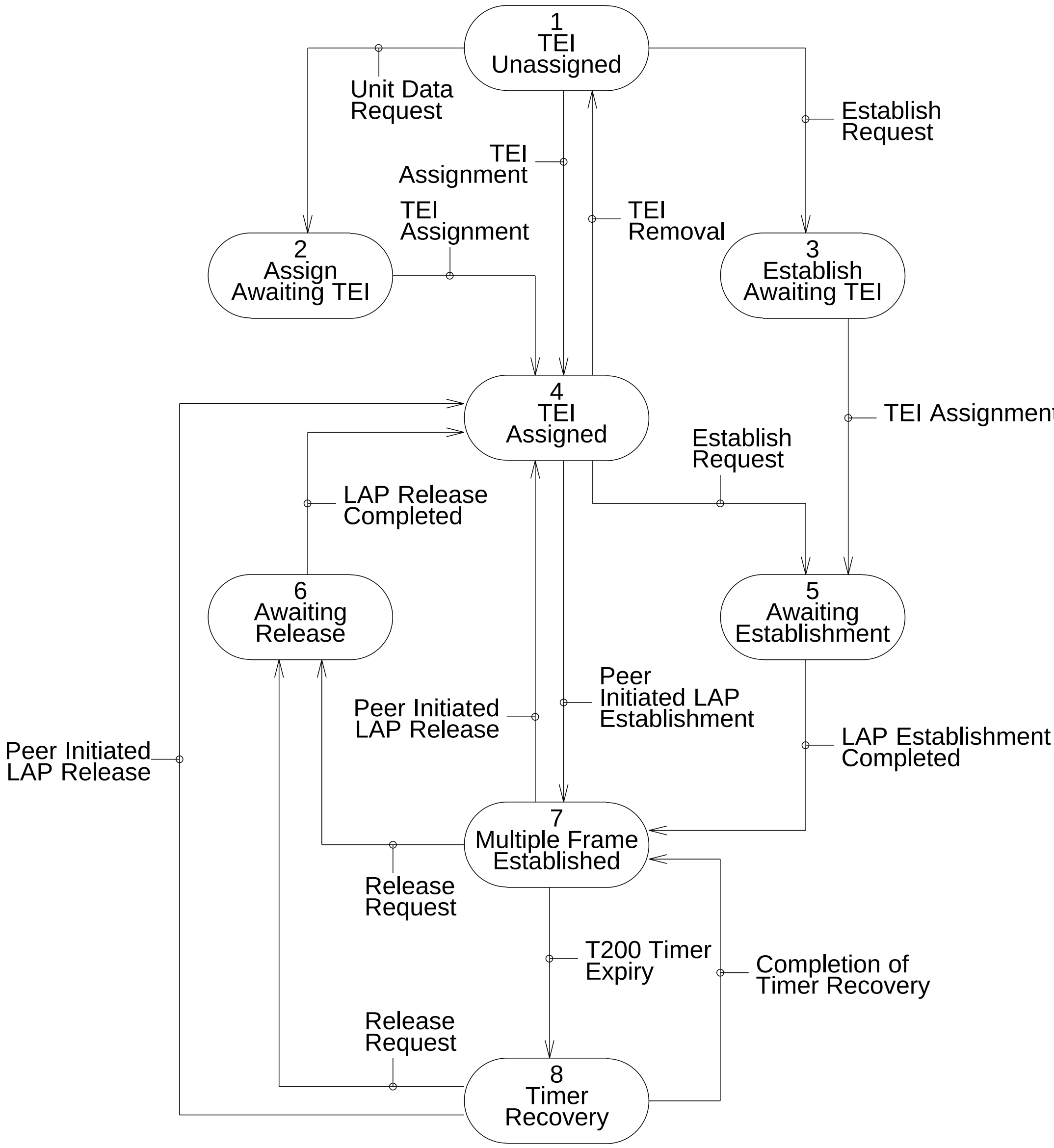
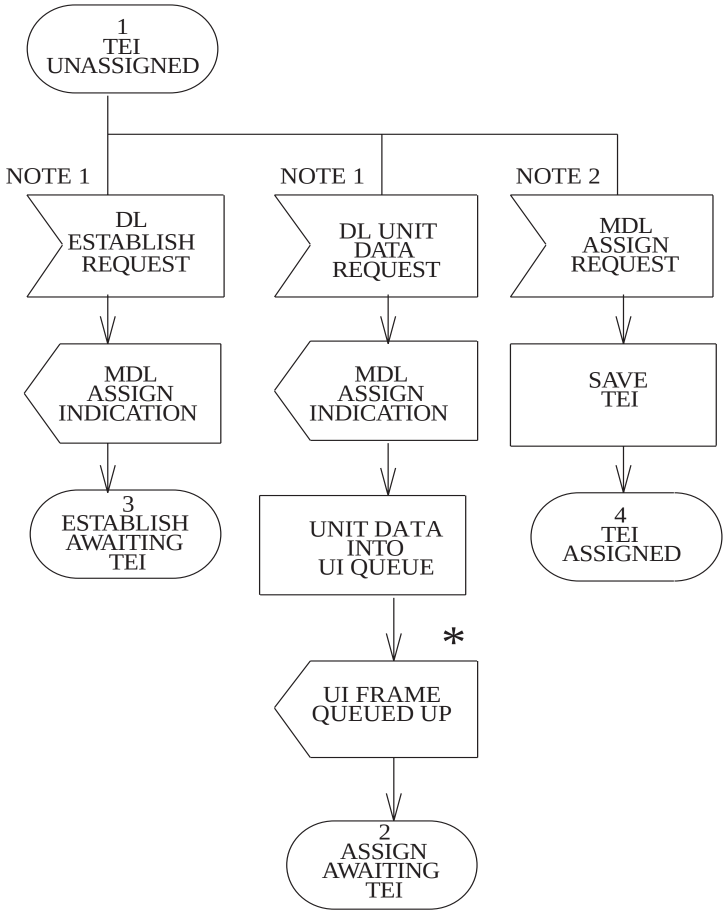


Figure 3.3-3 — TEI Assignment Procedure State Diagram

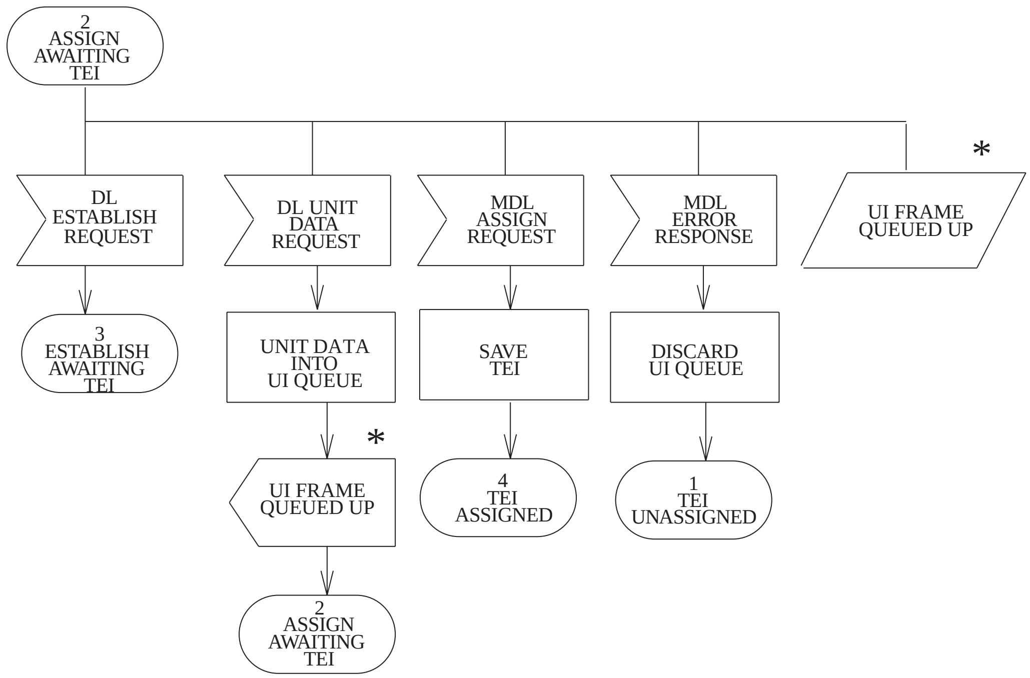


* Processing of UI frame queued up is described in Figure 3.3-12.

NOTE 1: The use of these events on the network side is for further study.

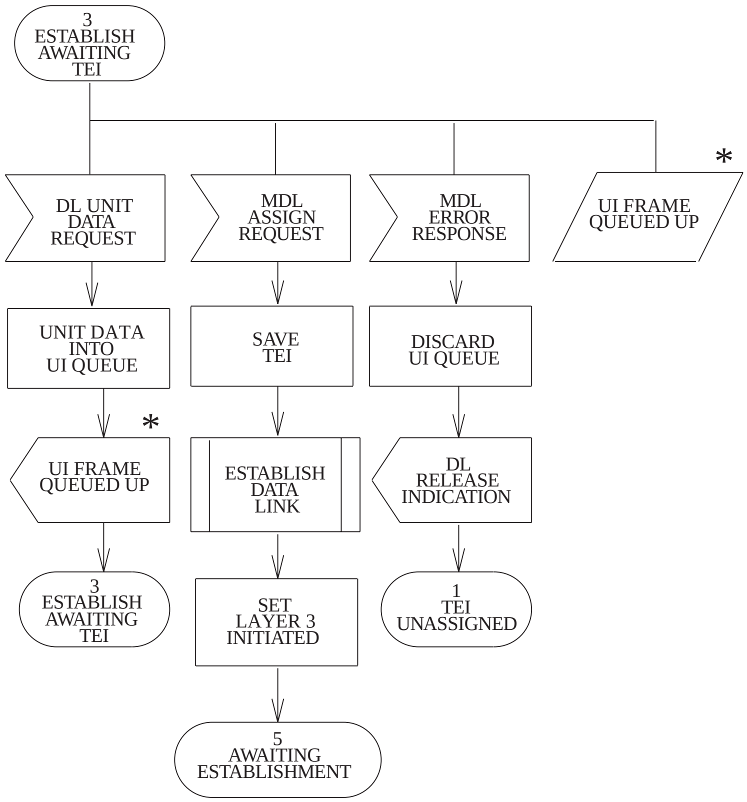
NOTE 2: This primitive may be implemented over a geographically distributed architecture. This primitive may occur on initialization for fixed TEIs at the network side, or as appropriate in order to correctly process a frame carrying a fixed TEI.

Figure 3.3-4 — State 1—TEI Unassigned



* Processing of UI frame queued up is described in Figure 3.3-12.

Figure 3.3-5 — State 2—Assign Awaiting TEI



* Processing of UI frame queued up is described in Figure 3.3-12.

Figure 3.3-6 — State 3—Establish Awaiting TEI

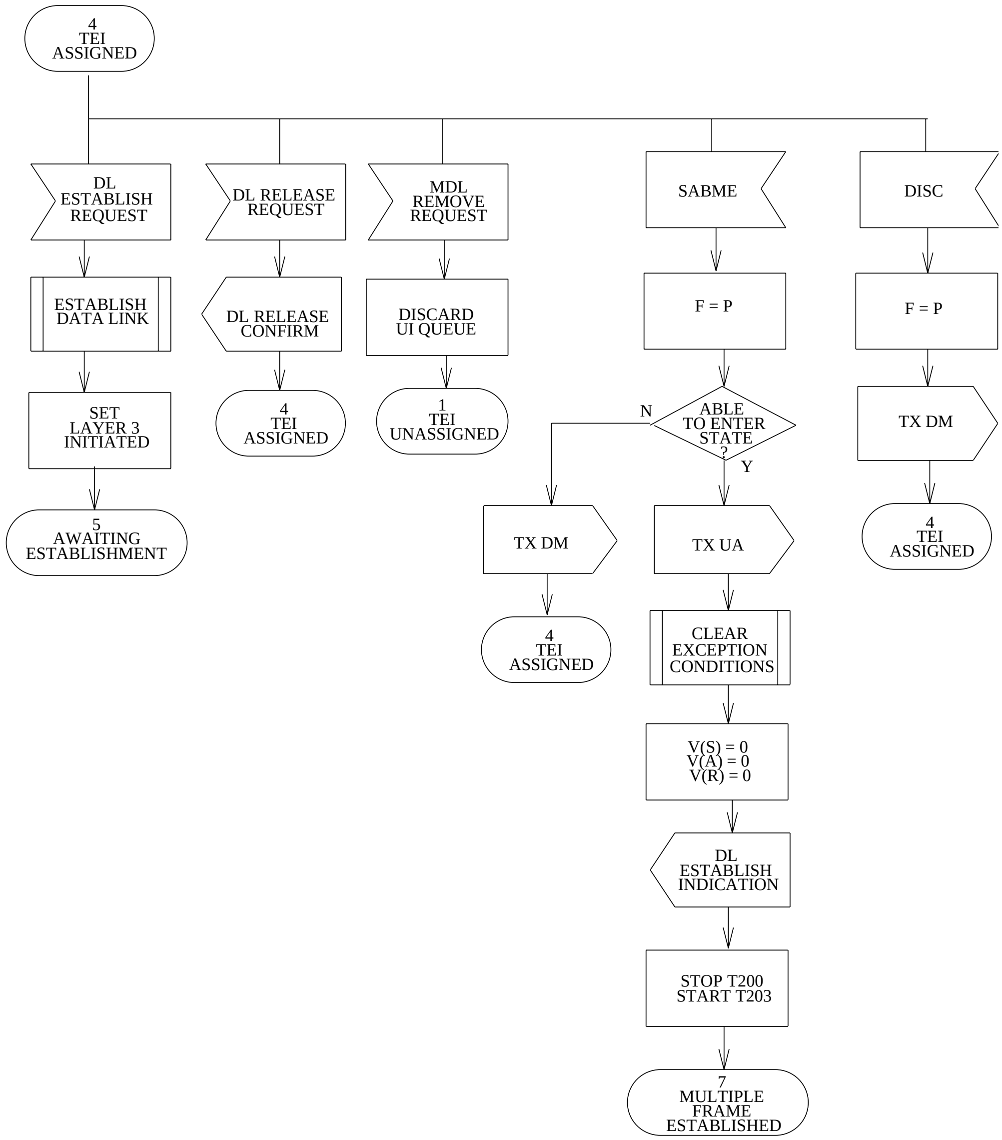


Figure 3.3-7 — State 4—TEI Assigned (1 of 2)

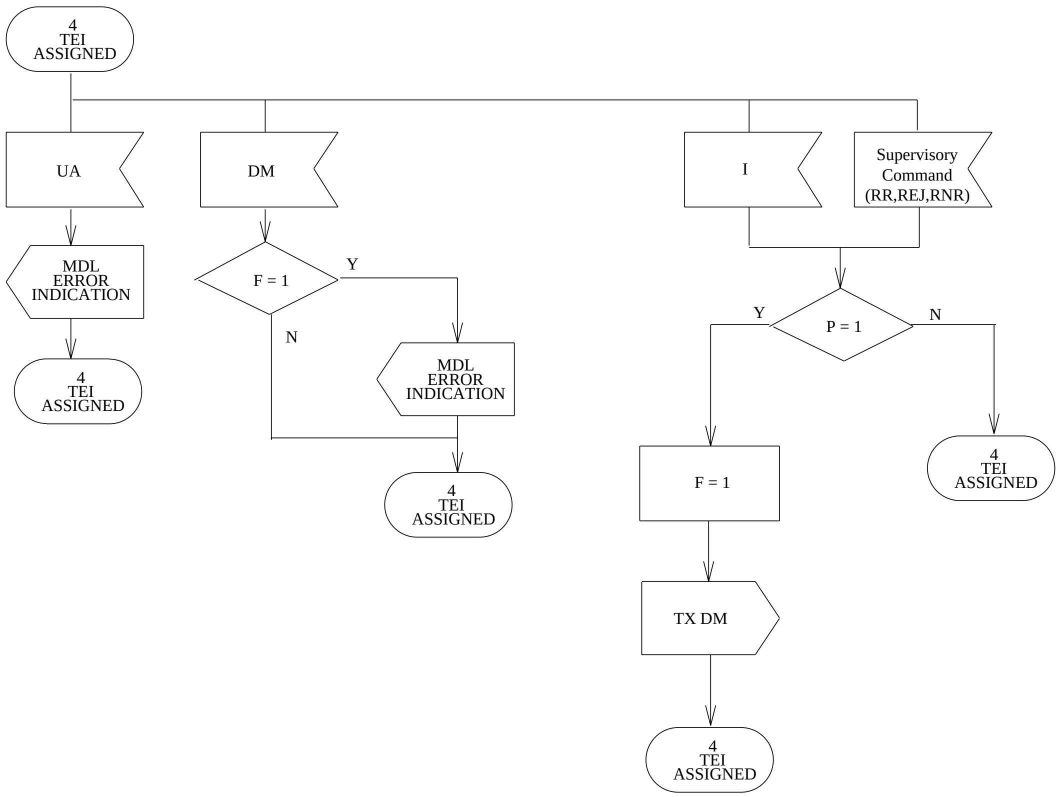
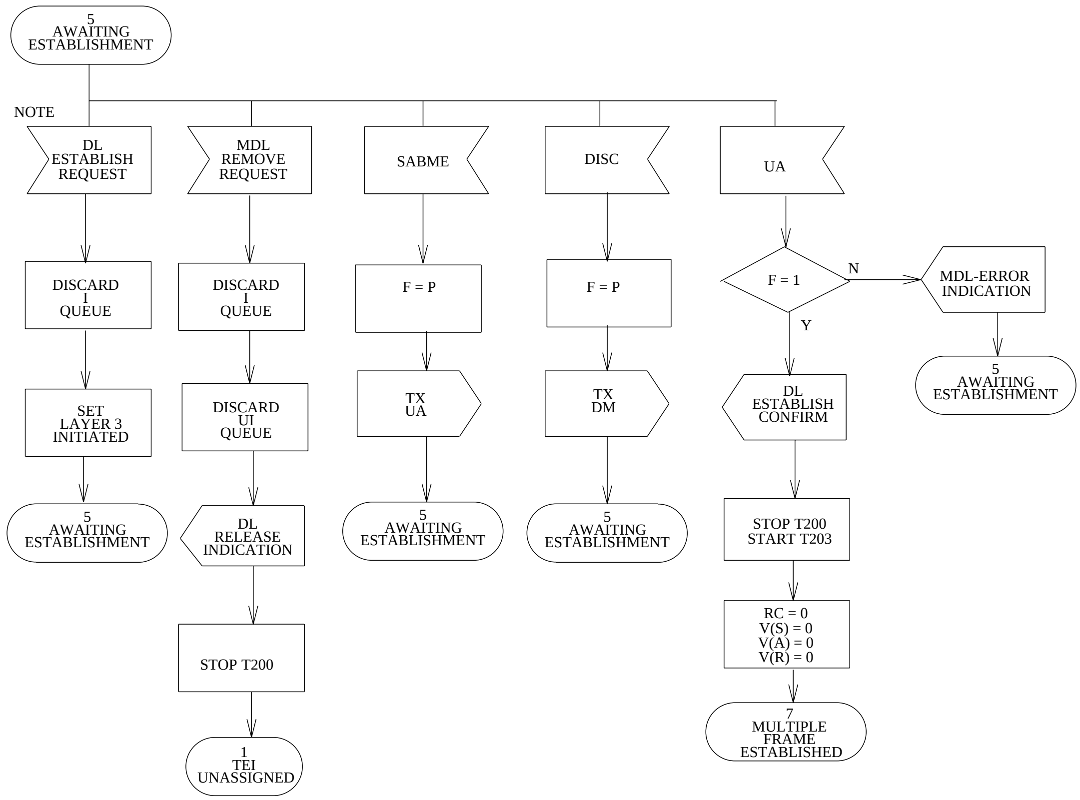


Figure 3.3-7 — State 4—TEI Assigned (2 of 2)



NOTE: Only possible in cases of Layer 2 Initiated Re-establishment

Figure 3.3-8 — State 5—Awaiting Establishment (1 of 2)

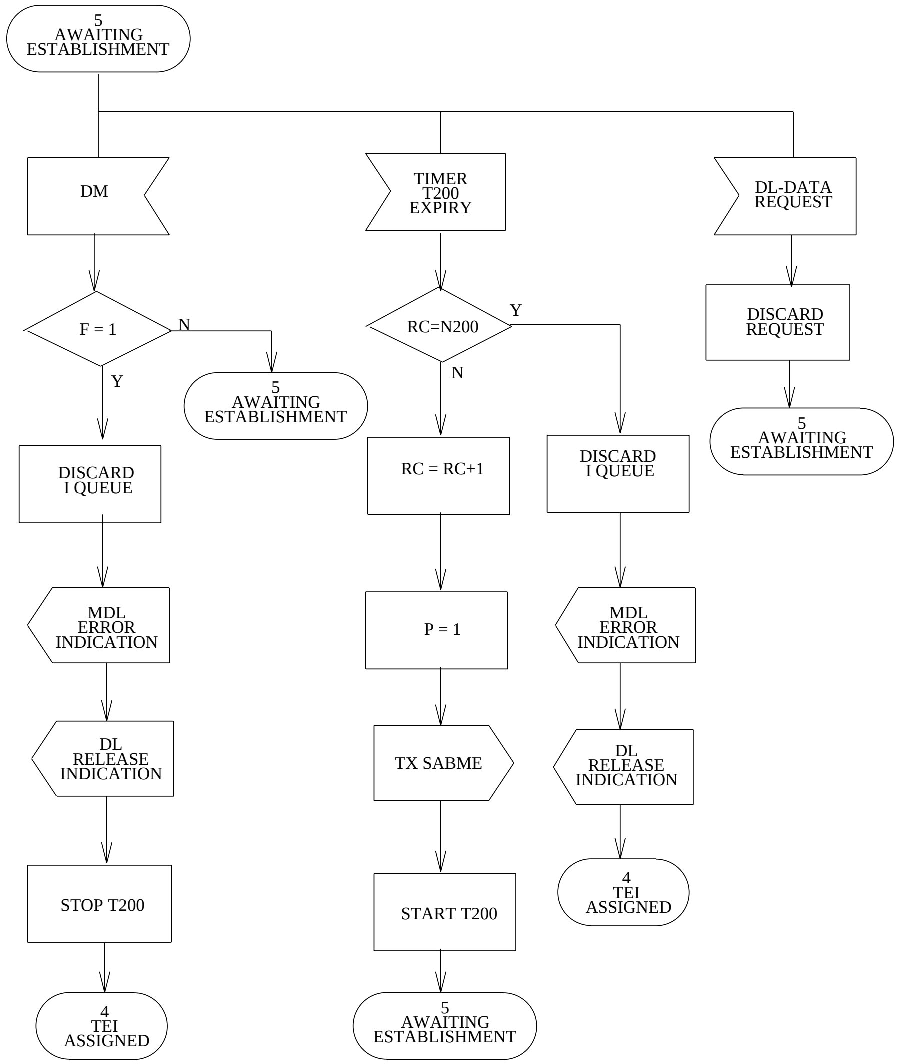


Figure 3.3-8 — State 5—Awaiting Establishment (2 of 2)

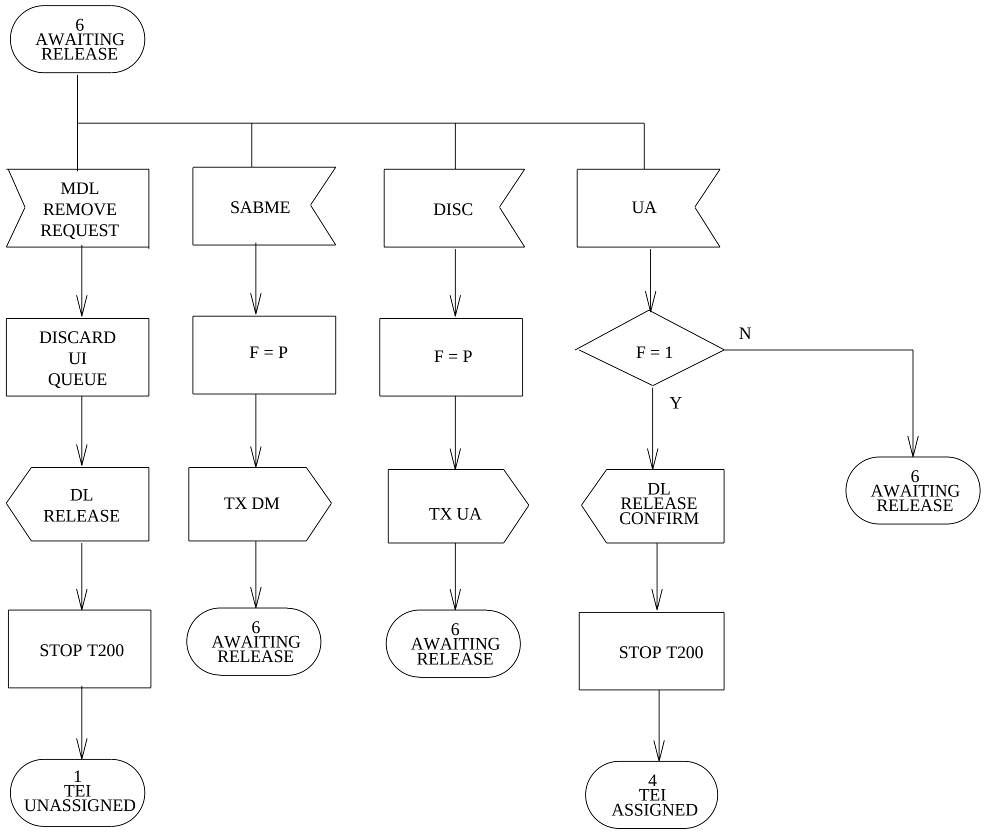


Figure 3.3-9 — State 6—Awaiting Release (1 of 2)

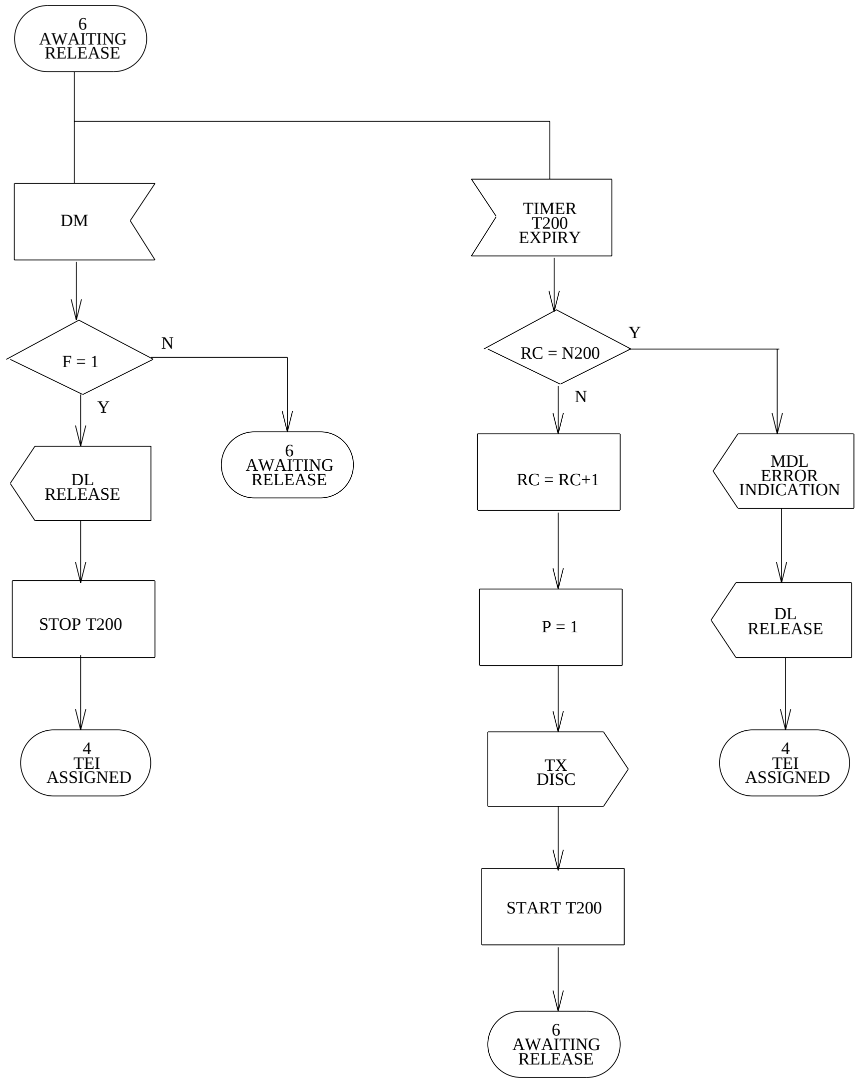


Figure 3.3-9 — State 6—Awaiting Release (2 of 2)

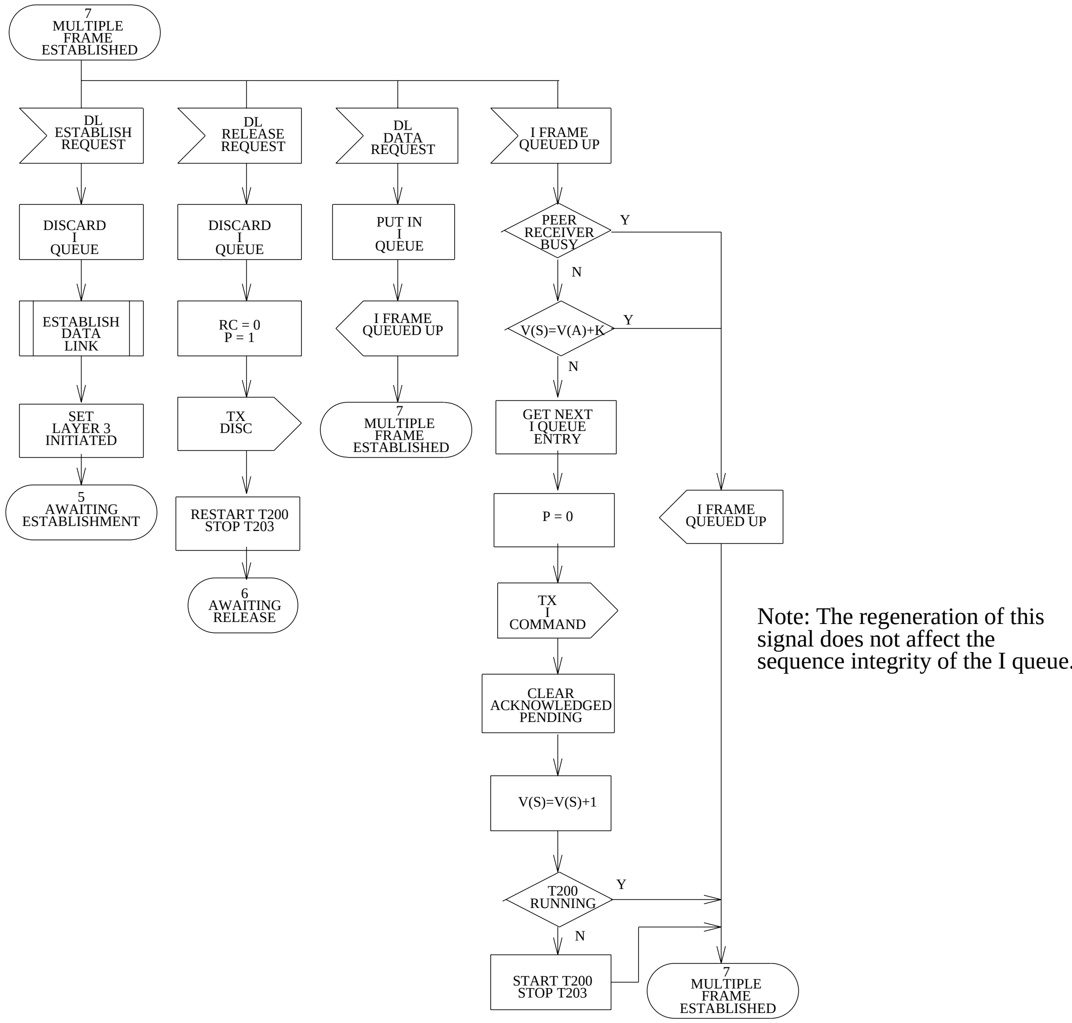


Figure 3.3-10 — State 7—Multiple Frame Established (1 of 8)

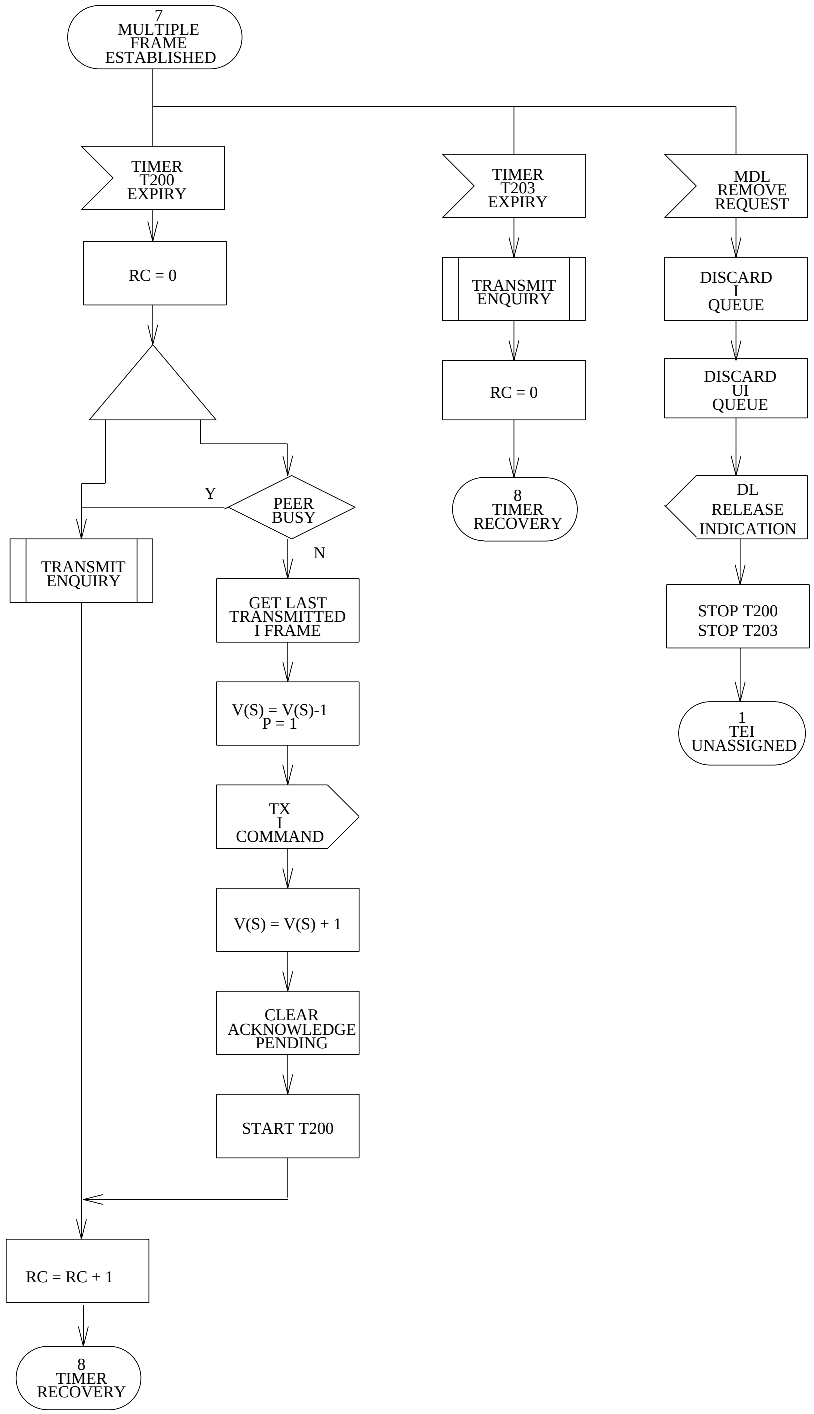


Figure 3.3-10 — State 7—Multiple Frame Established (2 of 8)

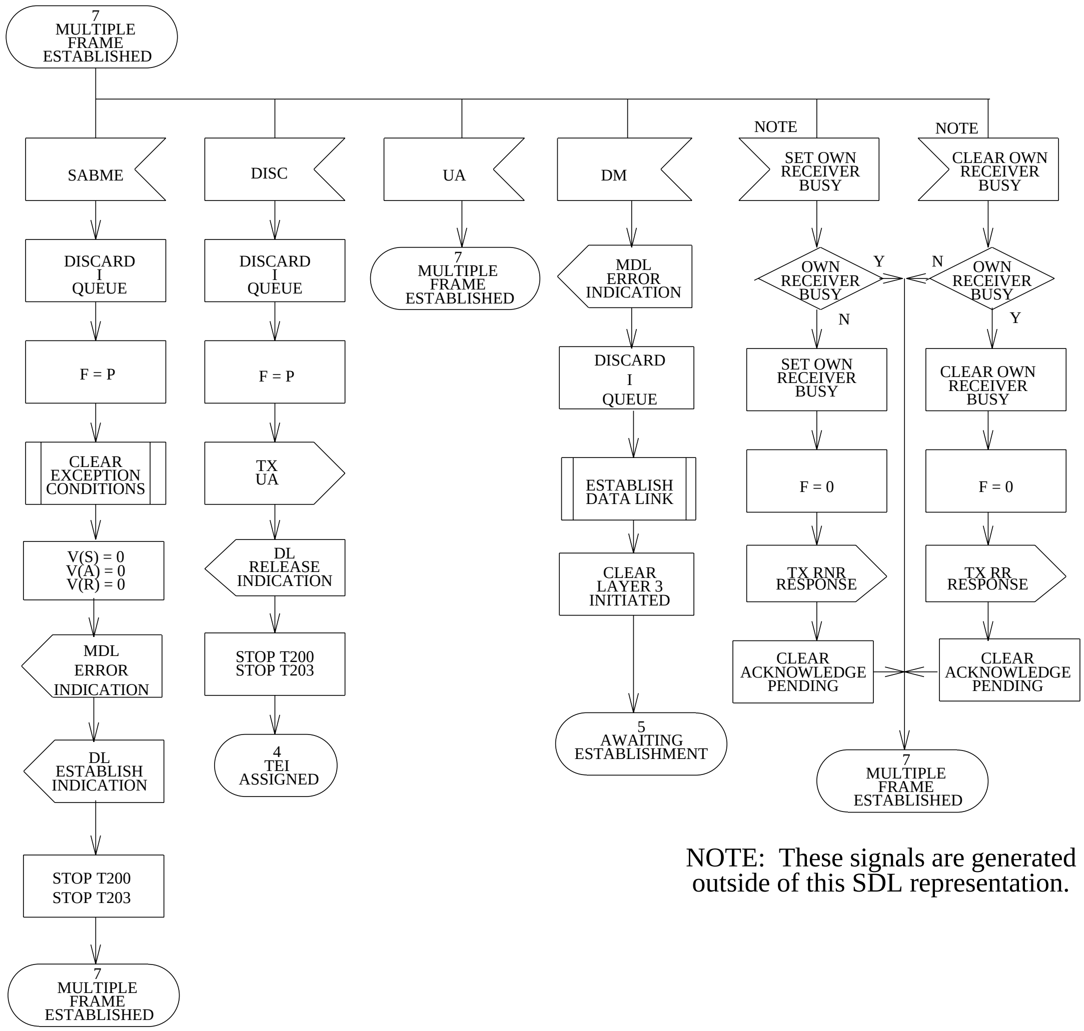


Figure 3.3-10 — State 7—Multiple Frame Established (3 of 8)

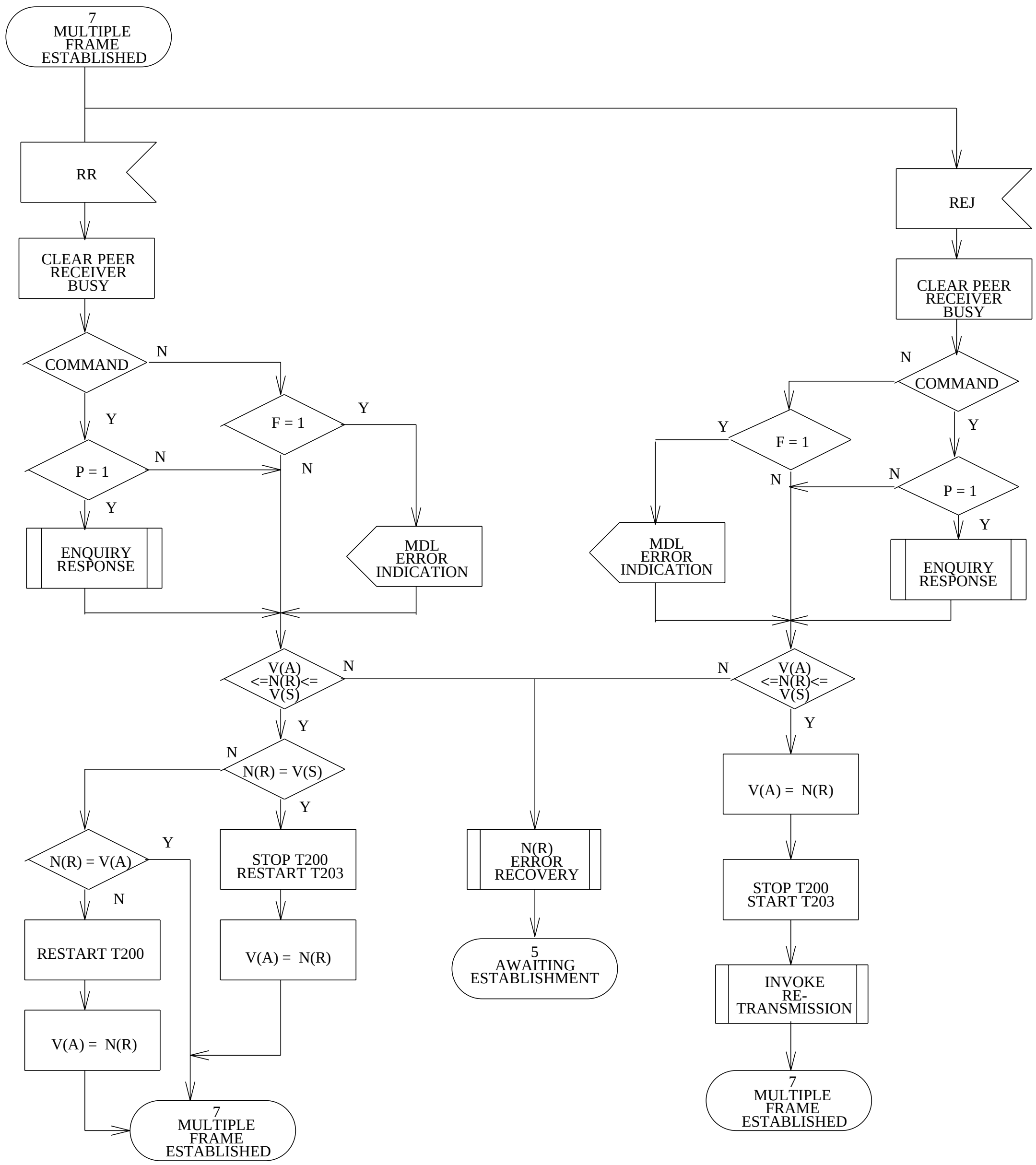


Figure 3.3-10 — State 7—Multiple Frame Established (4 of 8)

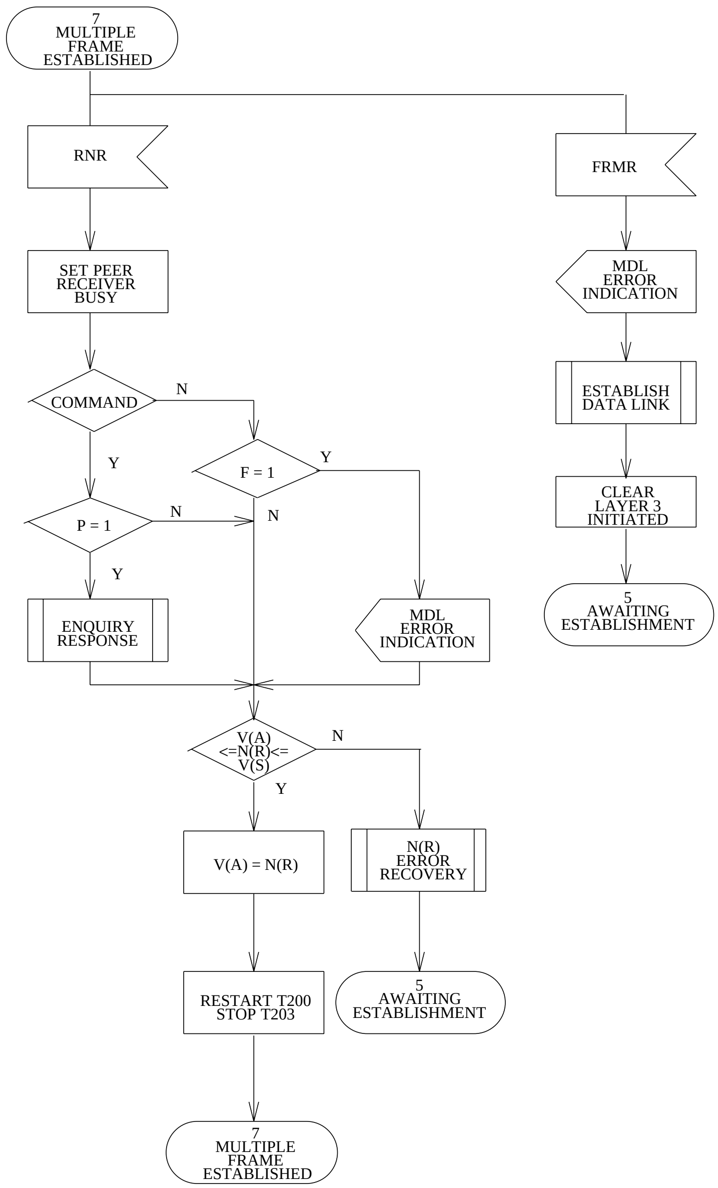
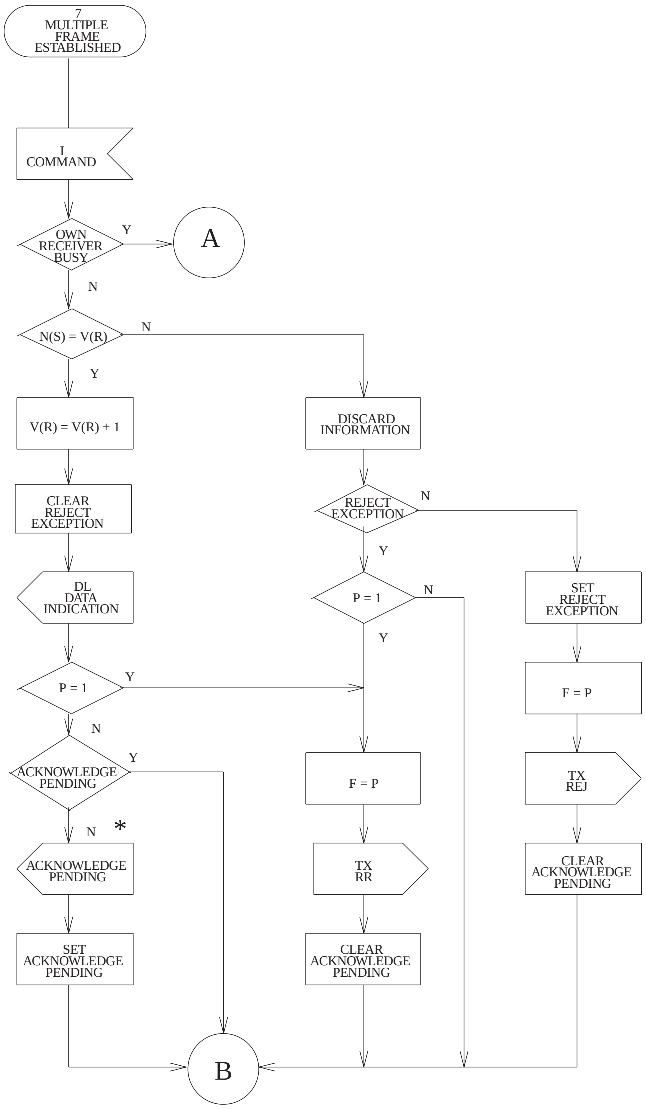


Figure 3.3-10 — State 7—Multiple Frame Established (5 of 8)



* Processing of ACKNOWLEDGE PENDING is described
in the final diagram of this figure.

Figure 3.3-10 — State 7—Multiple Frame Established (6 of 8)

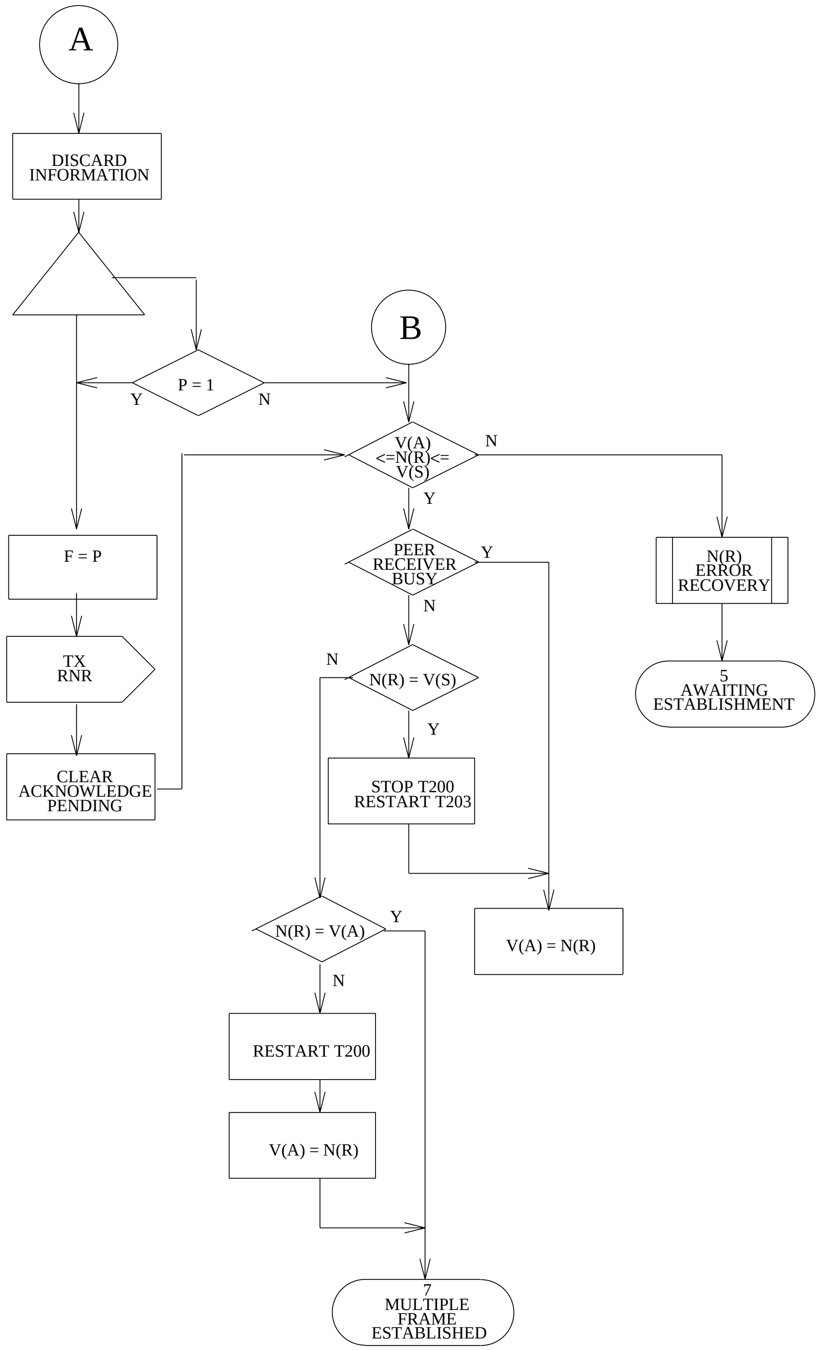


Figure 3.3-10 — State 7—Multiple Frame Established (7 of 8)

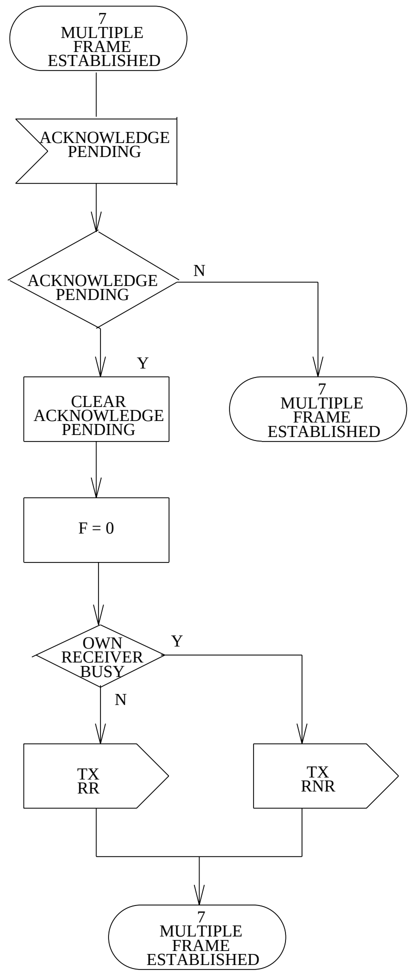


Figure 3.3-10 — State 7—Multiple Frame Established (8 of 8)

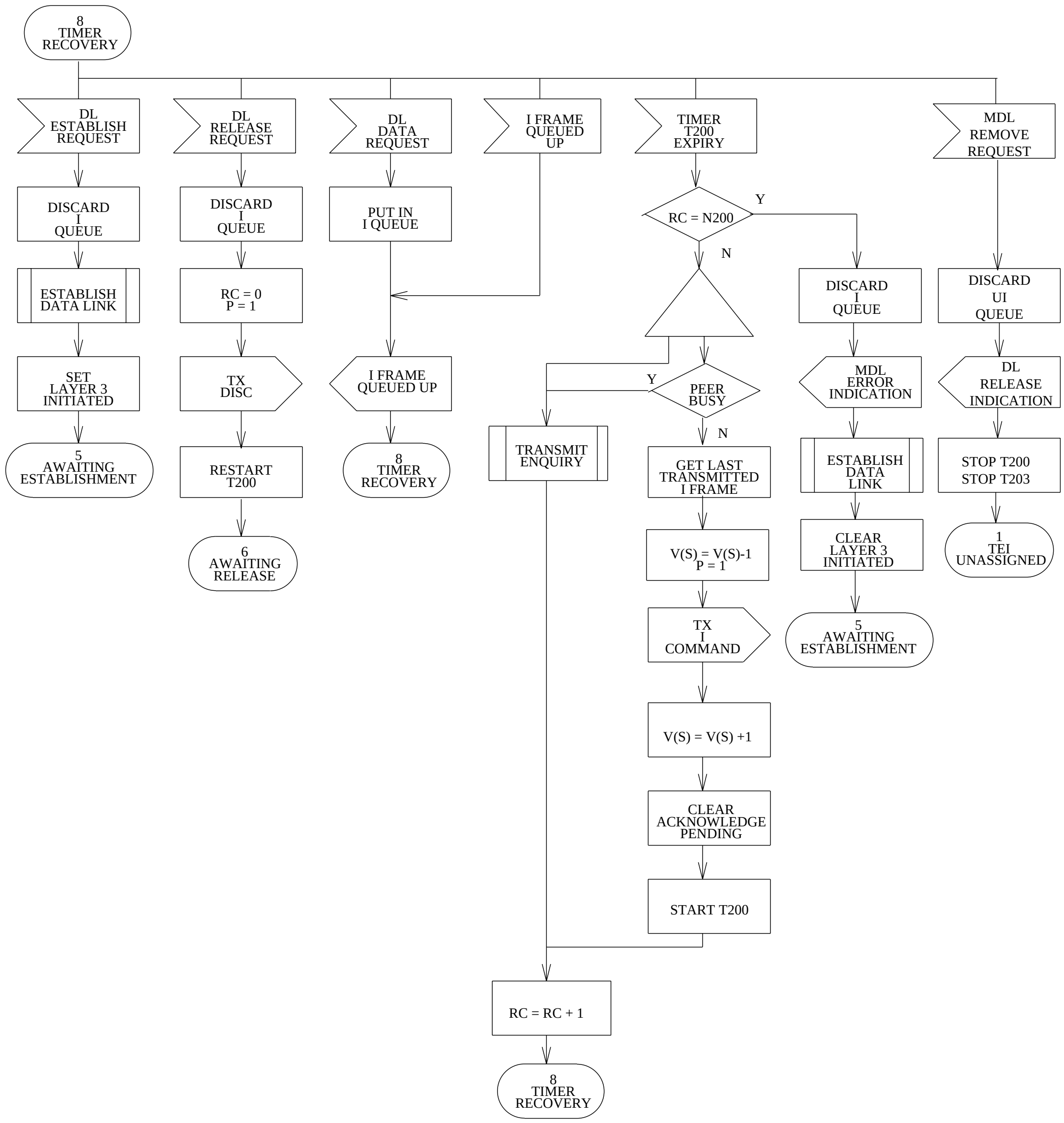


Figure 3.3-11 — State 8—Timer Recovery (1 of 7)

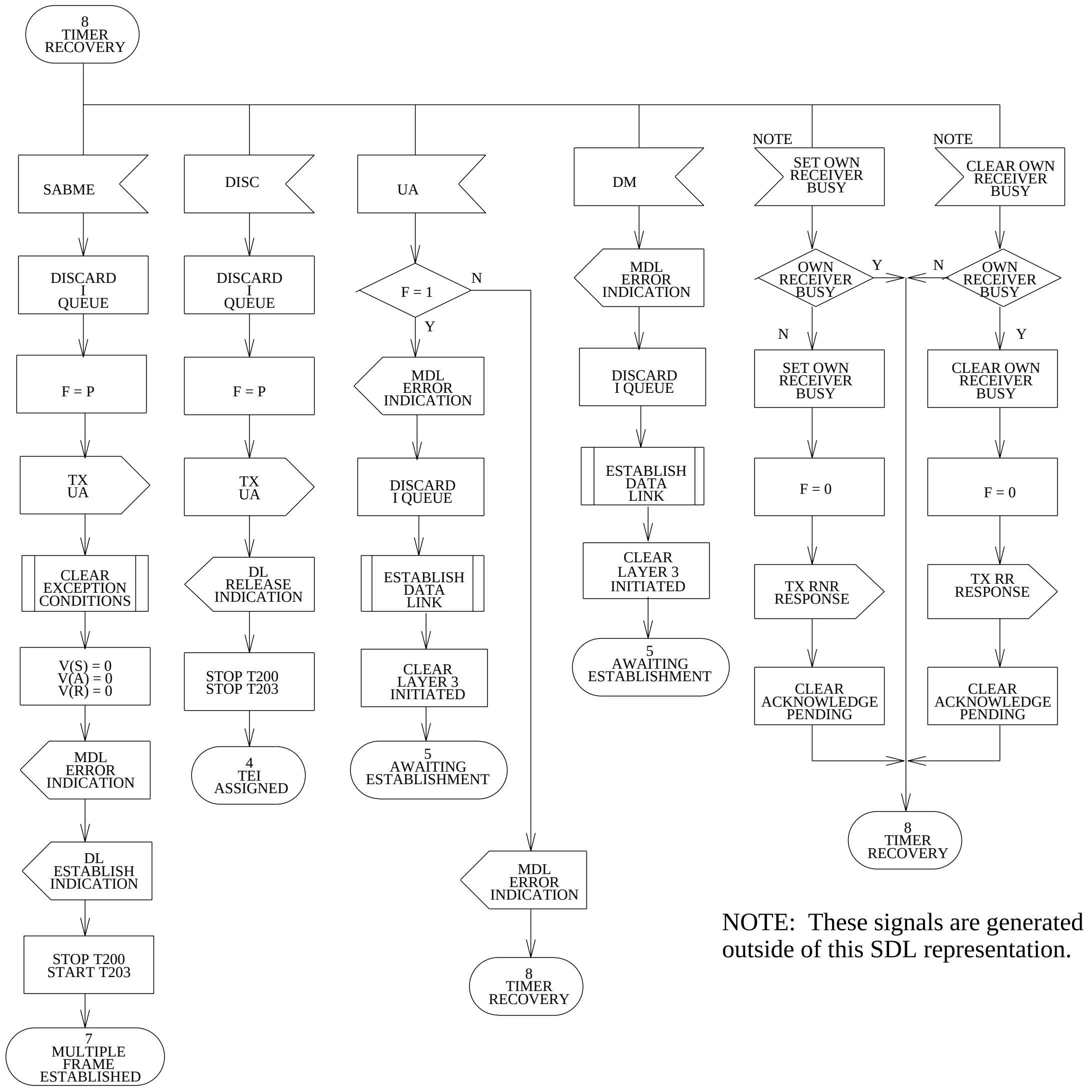


Figure 3.3-11 — State 8—Timer Recovery (2 of 7)

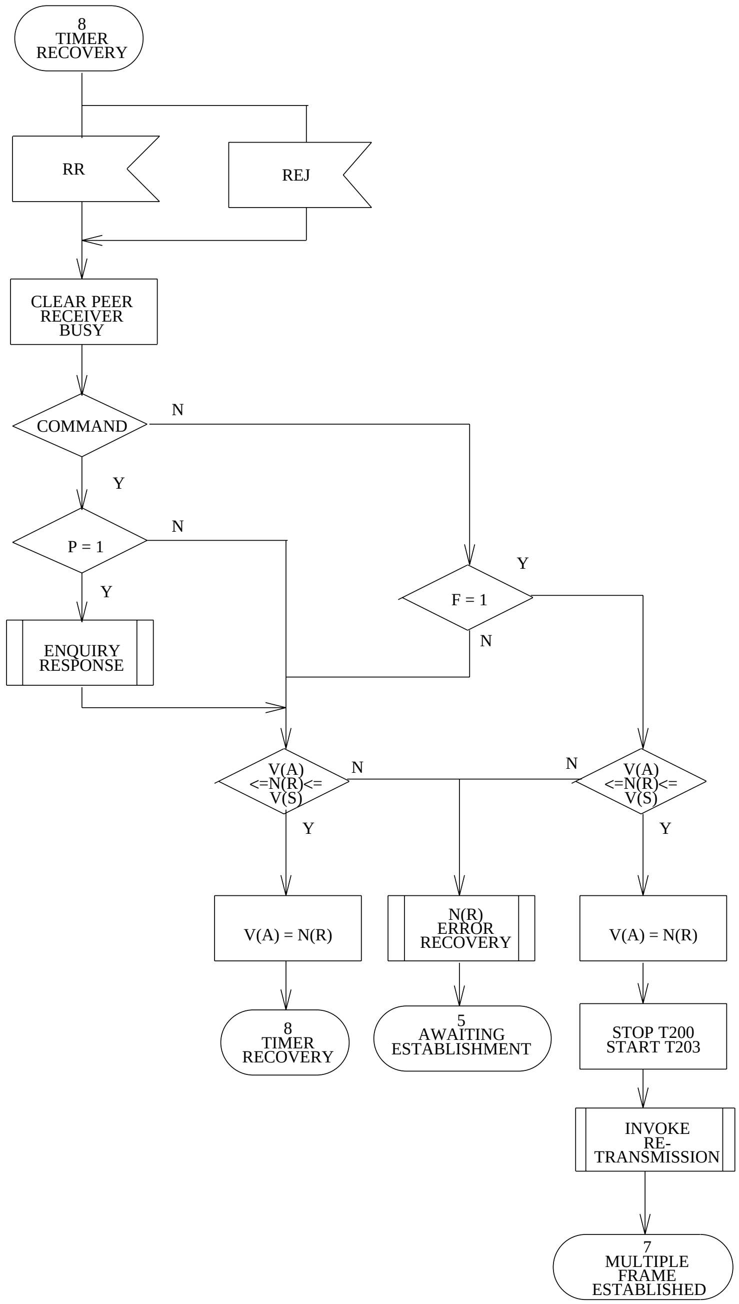


Figure 3.3-11 — State 8—Timer Recovery (3 of 7)

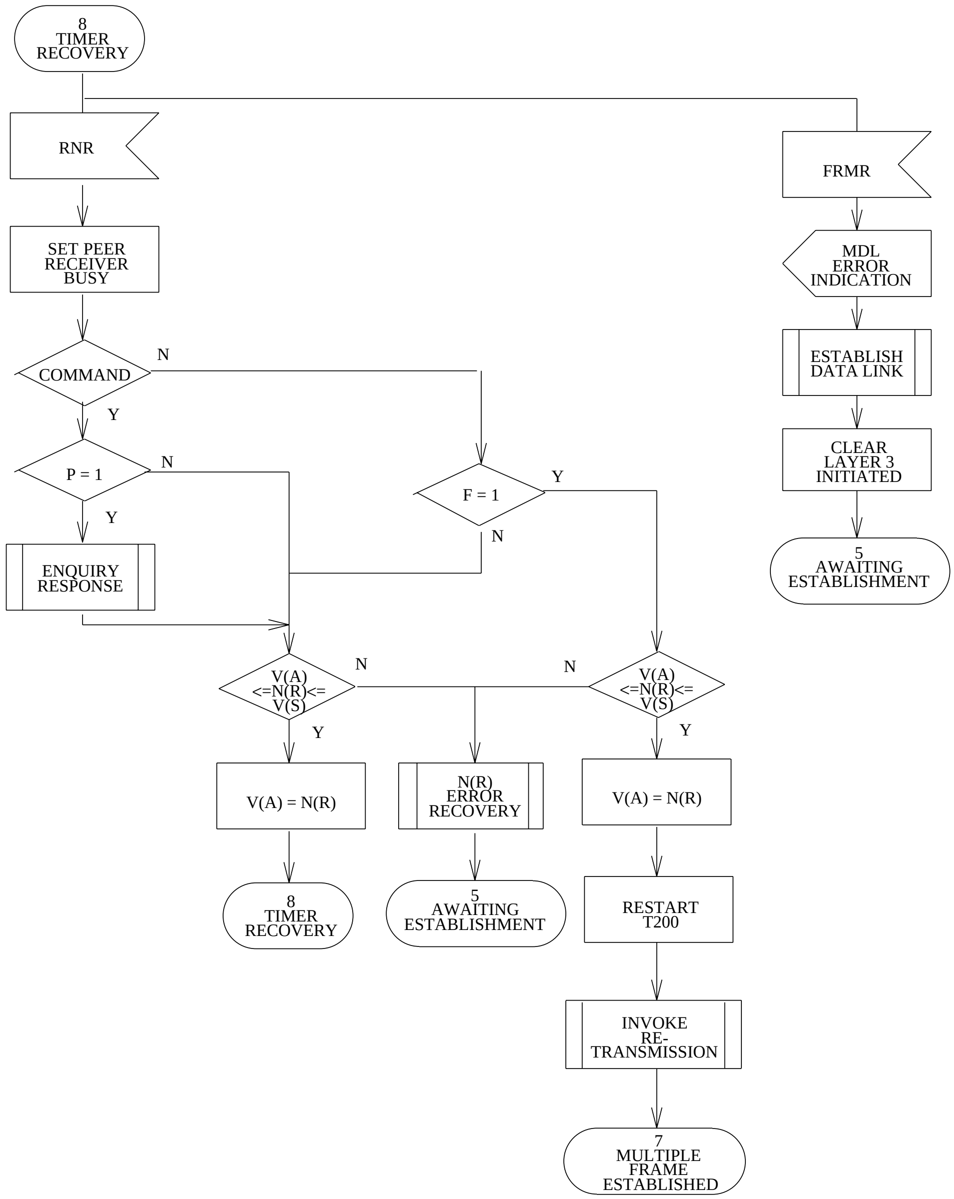
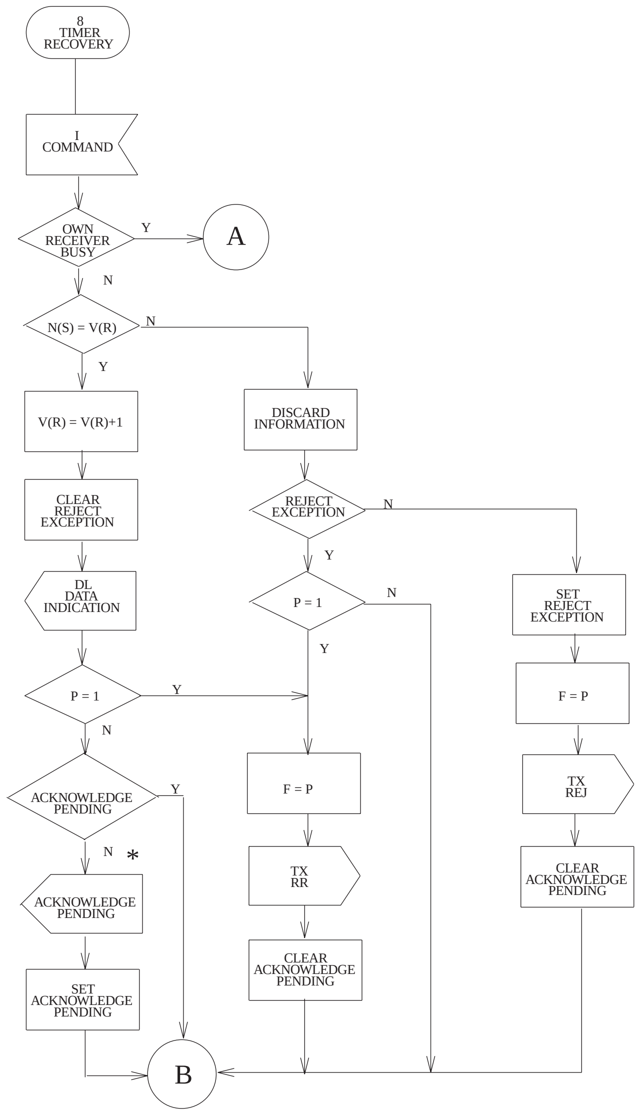


Figure 3.3-11 — State 8—Timer Recovery (4 of 7)



* Processing of ACKNOWLEDGE PENDING is described in the final diagram of this figure.

Figure 3.3-11 — State 8—Timer Recovery (5 of 7)

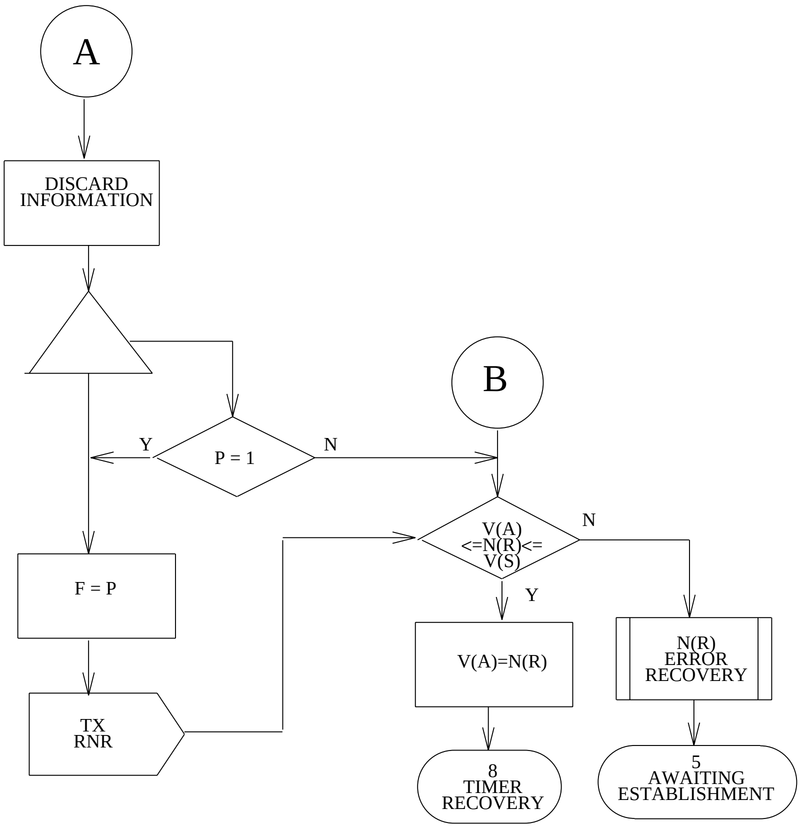


Figure 3.3-11 — State 8—Timer Recovery (6 of 7)

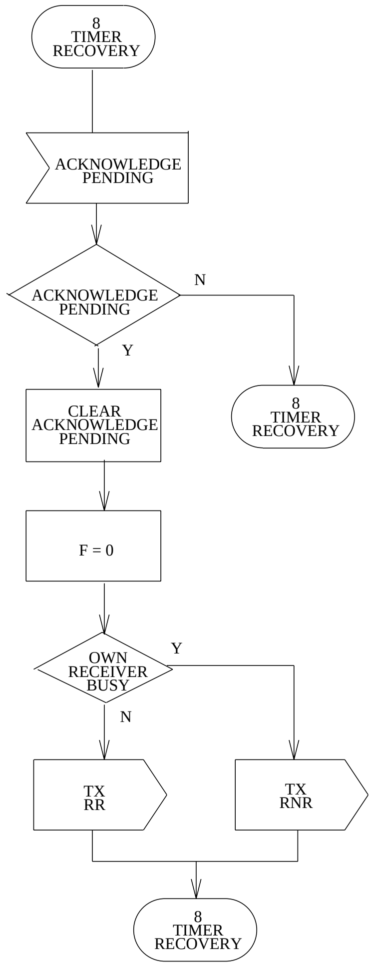
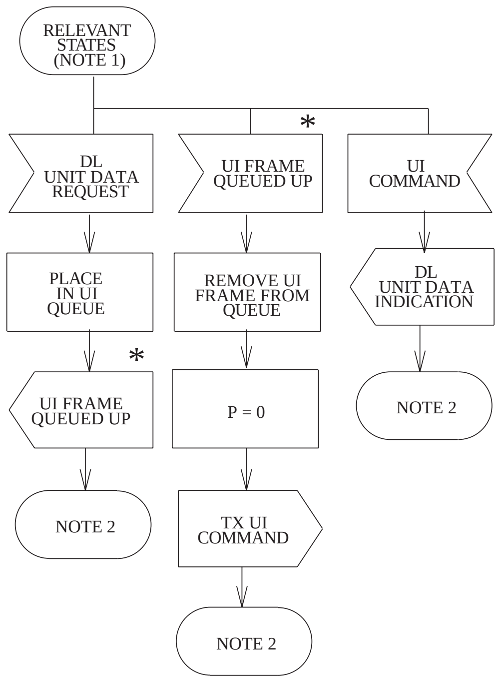


Figure 3.3-11 — State 8—Timer Recovery (7 of 7)



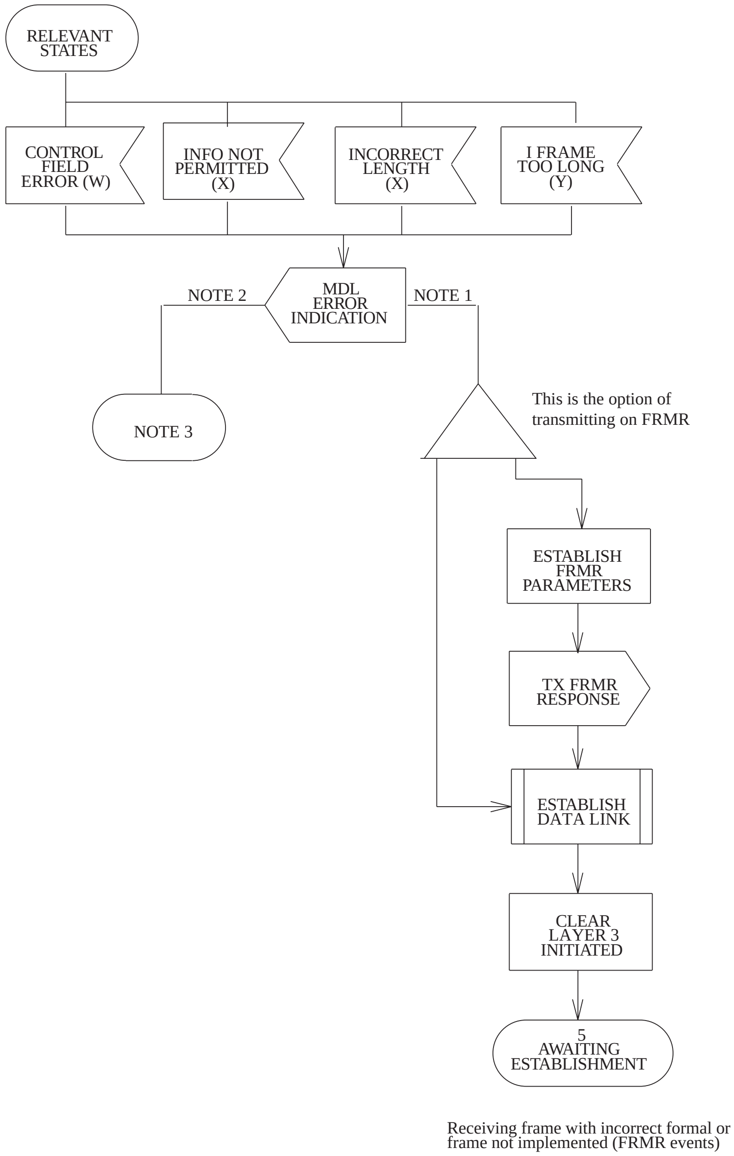
* Unnumbered information transfer on point-to-point data link.

NOTE 1: The relevant states are as follows:

4	TEI Assigned
5	Awaiting Establishment
6	Awaiting Release
7	Multiple Frame Established
8	Timer Recovery

NOTE 2: The data link layer returns to the state it was in prior to the events shown.

Figure 3.3-12 — Relevant States (1 of 3)



NOTE 1: The relevant states are as follows:

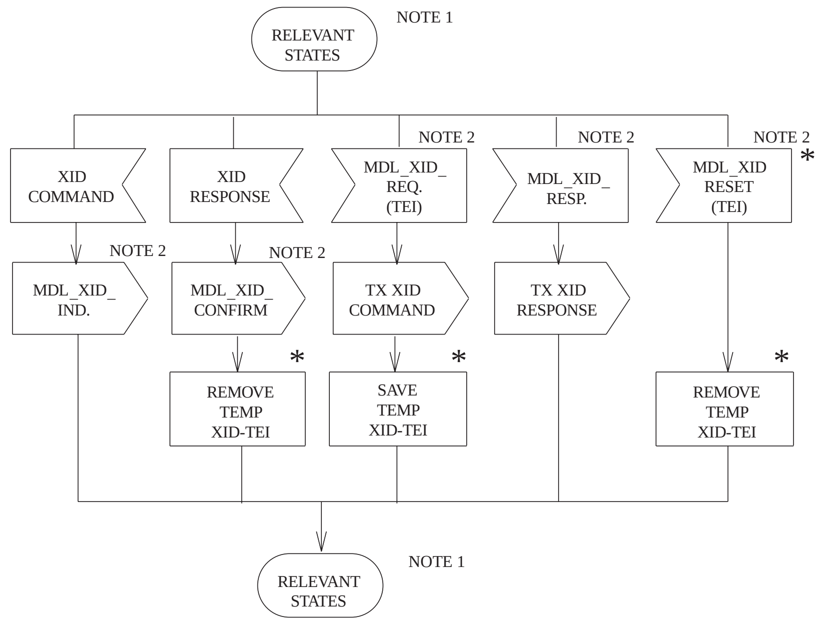
5 Awaiting Establishment
6 Awaiting Release
7 Multiple Frame Established
8 Timer Recovery

NOTE 2: The relevant states are as follows:

4 TEI Assigned
5 Awaiting Establishment
6 Awaiting Release

NOTE 3: The data link layer returns to the state it was in prior to the events shown.

Figure 3.3-12 — Relevant States (2 of 3)



* The SAVE and REMOVE of the TEI value used for the XID frame exchange is necessary for States 1, 2, and 3. All other states use the TEI supplied by the MDL_ASSIGN_REQUEST primitive.
NOTE 1: Relevant for all states except State 1.
NOTE 2: These primitives are associated with the connection management entity.

Figure 3.3-12 — Relevant States (3 of 3)

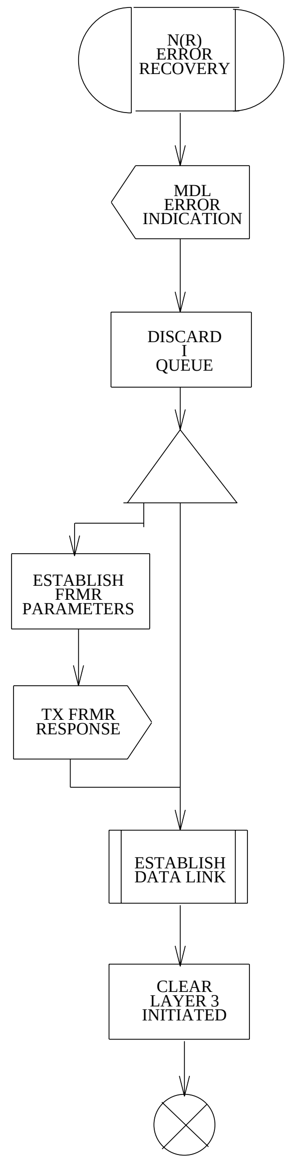


Figure 3.3-13 — N(R) Error Recovery Procedures

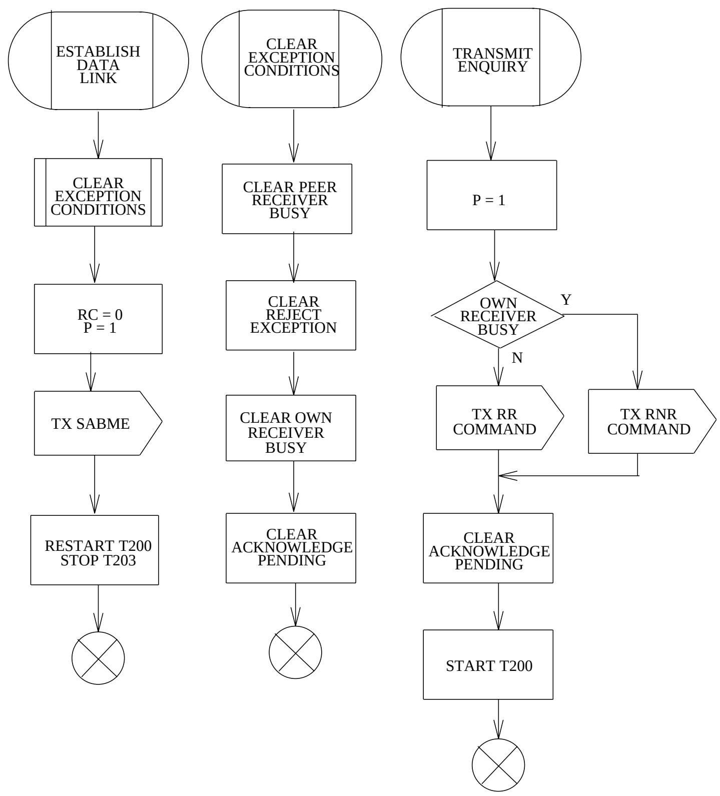
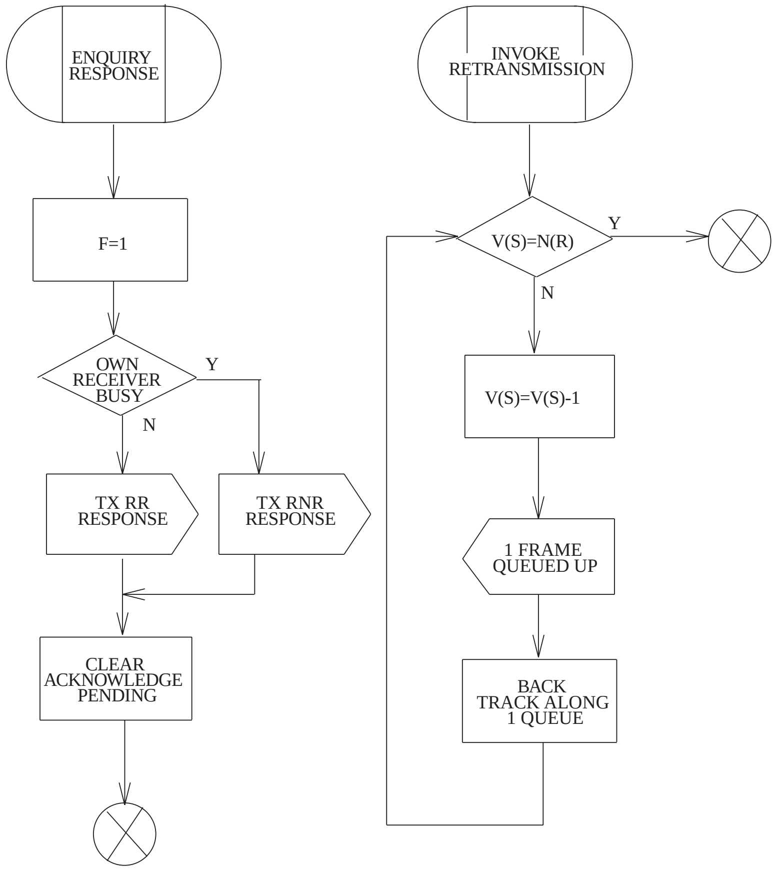


Figure 3.3-14 — Establish Data Link, Clear Exception Conditions, and Transmit Enquiry Procedures



NOTE: The generation of the correct number of signals in order to cause the required transmission of I frames does not alter their sequence integrity.

Figure 3.3-15 — Enquiry Response and Invoke Retransmission Procedures

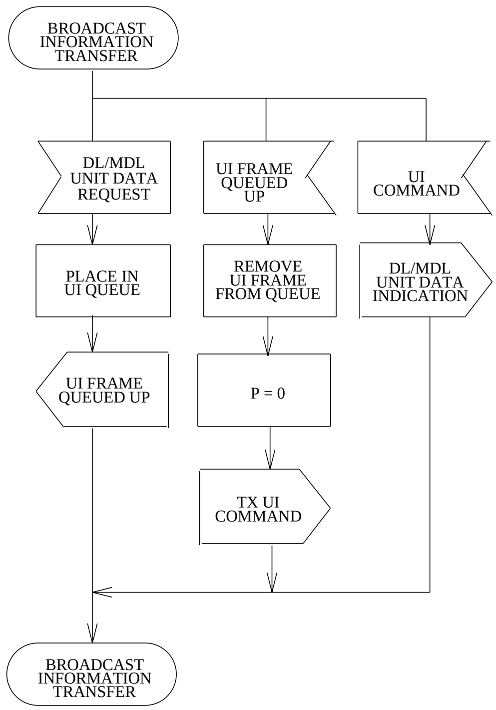
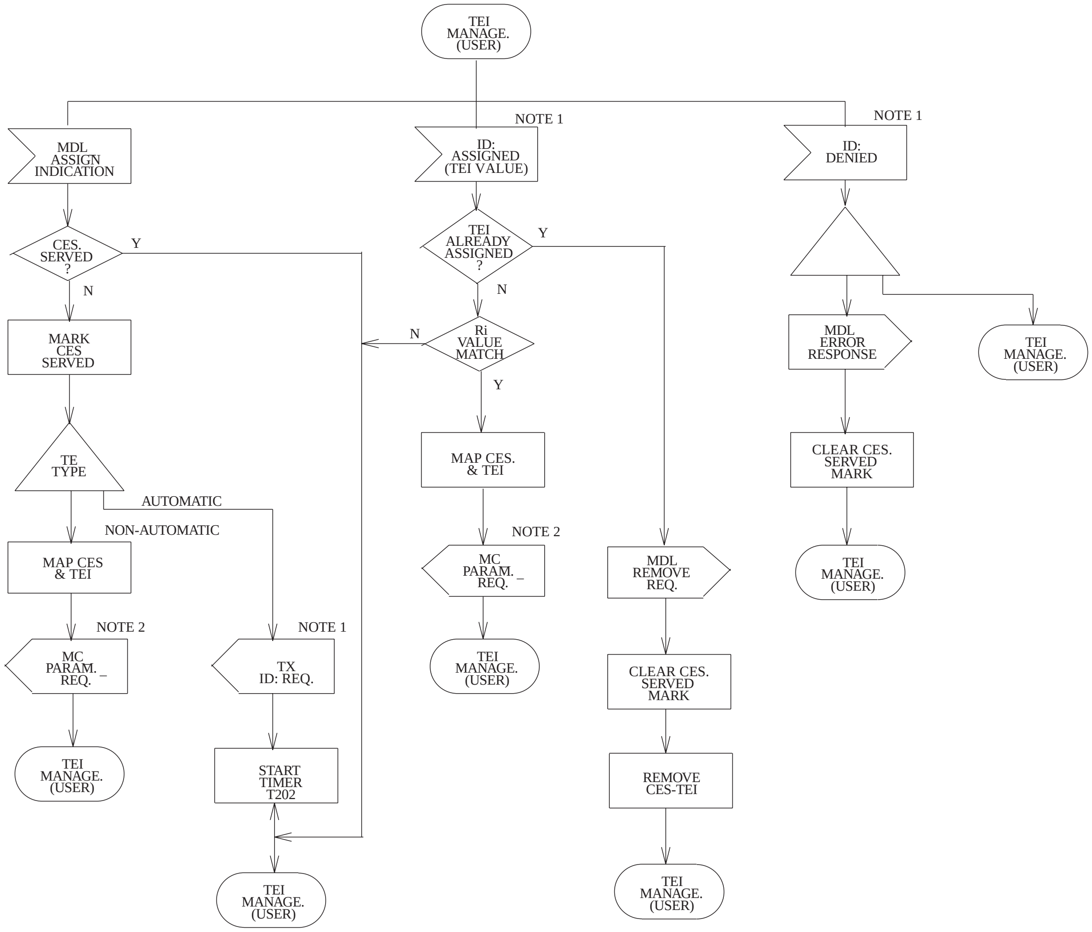
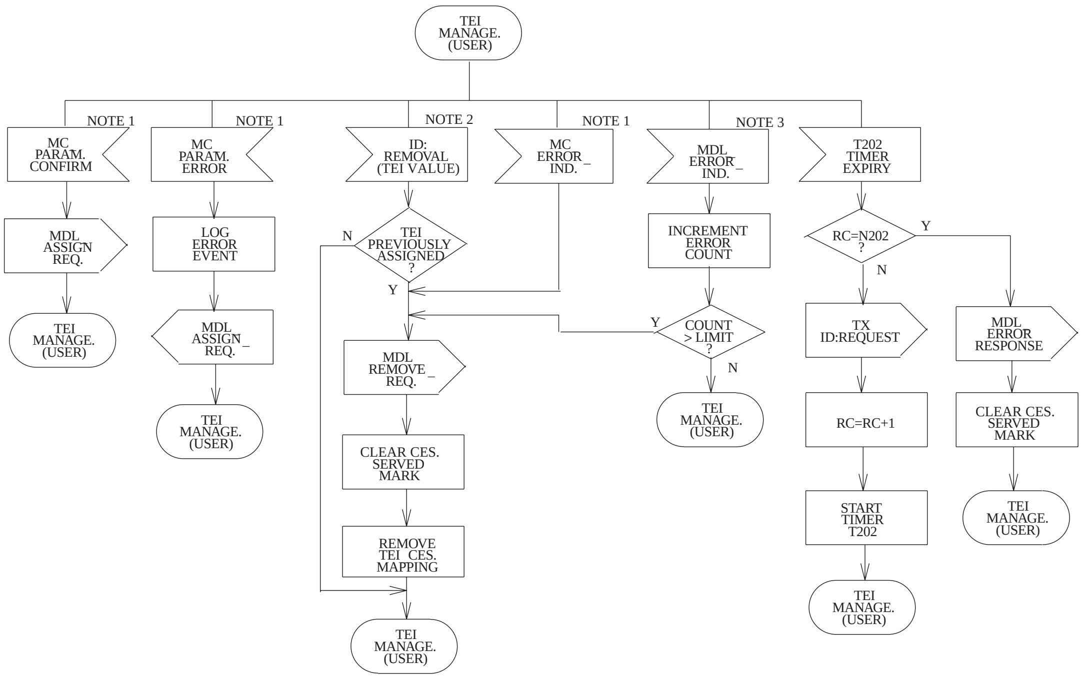


Figure 3.3-16 — Broadcast Information Transfer



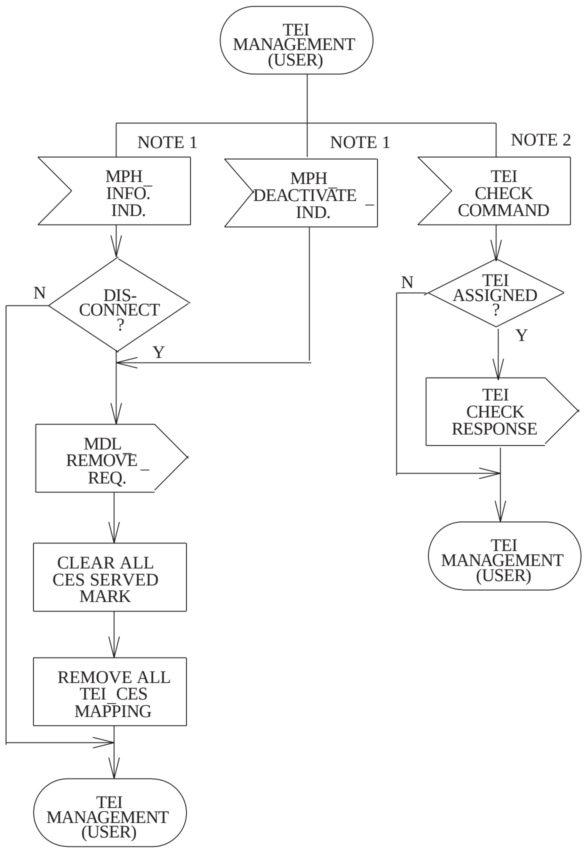
NOTE 1: These are layer management peer-to-peer messages carried on the data link layer connection specified by SAPI=63, TEI=127.
NOTE 2: These primitives are used between the layer management and the CES-related connection management entity.

Figure 3.3-17 — TEI Management (User) (1 of 3)



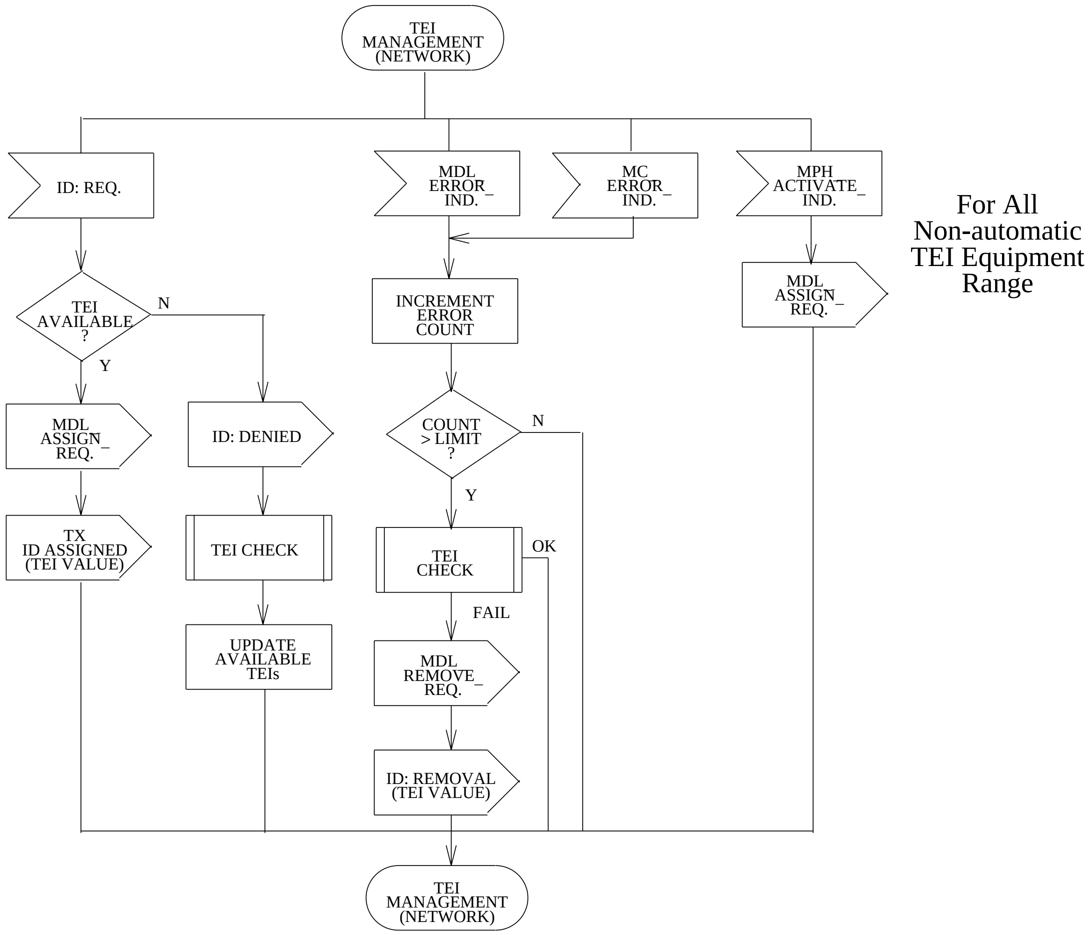
NOTE 1: These primitives are used between the layer management and the CES-related connection management entity.
NOTE 2: These are layer management peer-to-peer messages carried on the data link layer connection specified by SAPI=63, TEI=127.
NOTE 3: SABMETX, SABME:RC, N200 X T200 Errors.

Figure 3.3-17 — TEI Management (User) (2 of 3)



NOTE 1: These primitives are generated by the physical layer.
NOTE 2: These are layer management peer-to-peer messages carried on the data link layer connection specified by SAPI=63, TEI=127.

Figure 3.3-17 — TEI Management (User) (3 of 3)



NOTE: SABME TX, SABME RC, N200 X T200 Errors.

Figure 3.3-18 — TEI Management (Network)

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

4. NETWORK LAYER—BASIC CALL

This section defines the Layer 3 procedures and protocol elements for call control at the user-network Integrated Services Digital Network (ISDN) basic rate interfaces. This section consists of three major sections. "Message Definitions," Section 4.1, provides an overview of the complete set of messages and information elements that appear in this document. A brief description is provided for each message, along with a table identifying the message's information elements and the direction in which the message and the information elements can be signaled. "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, defines the procedures required for establishing, maintaining, and clearing basic circuit mode voice service connections at the ISDN basic rate user-network interface. "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, also provides the coding of the information elements needed to support circuit-switched voice calls. "Packet Services," Section 4.3, defines the procedures required for establishing, maintaining, and clearing of packet mode data service connections at the ISDN basic rate user-network interface. "Packet Services," Section 4.3, also describes the X.25 procedures for packet mode call control for virtual calls and permanent virtual circuits.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

4.1 MESSAGE DEFINITIONS

This section provides an overview of the complete set of messages and information elements (IEs) supported by this specification. This section contains all of the messages and IEs and coding that appear in this document, including those applicable to basic voice services (see "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2) and basic data services (see "Packet Services," Section 4.3). Subsequent sections provide descriptions of Supplementary Services (see "Network Layer—Supplementary Services," Section 5), Terminal Initialization (see "Terminal Initialization," Section 6), and Common Element Procedures for service control (see "Common Element Procedures for Service Control," Section 7).

Terminals that work on the standard interface have to use these specifications for messages and codings at the network layer.

Implementors will note that, while this specification is an accurate and complete description of the standard interface at this point in time, Lucent Technologies intends to maintain compliance with appropriate domestic and international standards. Hence, this interface is subject to possible future modification.

Scope

"Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, describes the procedures and coding of IE used in the control of circuit mode voice calls. "Packet Services," Section 4.3, describes the coding and procedures for the control and information transfer portion of data calls.

"Network Layer—Supplementary Services," Section 5, is based on the set of Layer 3 call control messages and procedures presented in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

"Terminal Initialization," Section 6, contains a description of endpoint initialization procedures, which use the message structure presented in this section.

"Common Element Procedures for Service Control," Section 7, contains common element procedures for service control, including Automatic Terminal Setup (ATS).

Application to Interface Structures

The Layer 3 procedures apply to the basic interface structure defined in "Physical Layer," Section 2. They use the functions and services provided by Layer 2, as defined in "Data Link Layer," Section 3.

Organization

This section of the document is organized as follows:

- "Overview of Call Control," Section 4.1.1, describes the range of possible call states and provides a general description of likely transitions. Note that this section is consistent with ITU-T Recommendation Q.931. As such, the call states shown apply only to the interface, itself, and do not necessarily imply internal implementations on either side of the interface. User endpoints supporting only a subset of these call states are allowed.
- "Call Control Definitions," Section 4.1.1.3, describes the call control messages transferred across the user-network interface to effect the transitions mentioned in the previous list item.

- "Message Content Definitions," Section 4.1.2, includes brief descriptions of message use and information content. The procedures for message use and the coding of the IEs within each message appear in the appropriate sections of this document.
- "Message Element (Structure) Definitions," Section 4.1.3, provides a description of the IEs and their codings.
- "BRI Message Segmentation," Section 4.1.4, provides BRI Message Segmentation.

4.1.1 OVERVIEW OF CALL CONTROL

The terminology used in this specification defines the integrated services digital network (ISDN) system states in terms of outgoing and incoming calls as viewed by the user endpoint of the interface.

When user Endpoint A calls user Endpoint B, the outgoing call originated by A (also known as the originating entity) provides it with access to services provided by the switched network (also known as the terminating entity with respect to the particular interface). The incoming call to user Endpoint B is originated by the network to complete the call initiated by user Endpoint A.

Figure 4.1.1-1 shows an outgoing call from user Endpoint A to the switched network, and the corresponding arrangement for an incoming call from the switched network to the user Endpoint B.

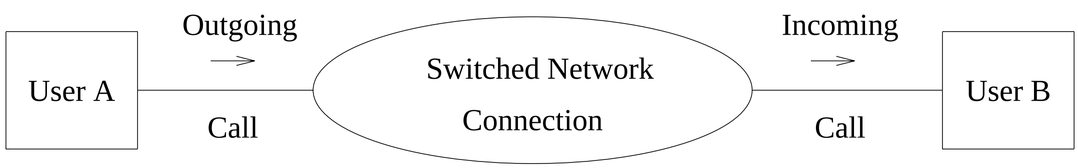


Figure 4.1.1-1 — Call From A to B through a Switched Network Connection

4.1.1.1 Terminology

The following terminology is used throughout this section.

- *Terminal/User Endpoint*: Endpoint of a data connection, such as a personal computer, "dumb" data terminal, host computer, printer, integrated voice/data workstation.
- *Facility*: All packet mode services are referred to in the X.25 document (ITU-TS 1984 "Red Book") as "facilities." To be consistent with X.25, "facility" and "service" are synonymous in this section.
- *User Side*: The terminal side of a terminal-to-switch interface. In X.25, this side is referred to as the data terminal equipment (DTE).
- *Network Side*: The switch side of a terminal-to-switch interface. In X.25, this side is referred to as the data circuit-terminating equipment (DCE).

4.1.1.2 Call Control States

The definitions for possible individual call states provided in this section are consistent with ITU-T Recommendation I.451. These definitions are call states; they do not apply to the state of the interface itself, any attached equipment, the D-channel, or the logical links used for signaling on the D-channel. They do not apply to the state of the call reference. Because several calls may exist simultaneously at a user-network interface and because each call may be in a different state, the state of the interface itself cannot be unambiguously defined.

These call states apply only at the interface. Implementations internal to either side of the interface need not follow this design (implied or otherwise). Each side must, for the purposes of communication across the interface (for example, for consistency verification), be capable of mapping its call status information into this model or some allowable subset described in this section.

Throughout this section of the specification, reference to circuit-switched calls implies B-channel usage.

4.1.1.2.1 Call States at User Side of Interface

This section defines states that may exist on the user side of the user-network interface (See "Call Establishment at the Originating Interface," Section 4.2.1.2, for reduced state mapping). See specification description language (SDL) for more information on these call states.

- *Null (State U0)*: No call exists.
- *Call Init (State U1)*: Exists for an outgoing call, as a result of user action requesting call establishment.
- *Overlap Sending (State U2)*: Exists for an outgoing call while the user is sending call setup information to the network in the overlap mode.
- *Outgoing Call Proceeding (State U3)*: Exists for an outgoing call when the network has acknowledged receipt of the information required for the call to proceed, and the user is awaiting further network response.
- *Call Delivered (State U4)*: Exists for an outgoing call when the network has completed processing the call to the point of receiving alerting from the user-network interface indicated by the called address, or from an alternate interface specified by either the called user or the network.
- *Call Present (State U6)*: Exists for an incoming call when the user has received a call establishment request but has not yet responded.
- *Call Received (State U7)*: Exists for an incoming call when a response/answer from the called end-user is awaited while alerting same.
- *Connect Request (State U8)*: Exists for an incoming call while the user is awaiting receipt of a connect acknowledgment from the network.
- *Incoming Call Proceeding (State U9)*: Exists for an incoming call when the user has acknowledged receipt of the information required for the call to proceed and the network is awaiting further user response.
- *Active (State U10)*: Exists when a call is in the end-to-end communication mode.
- *Disconnect Request (State U11)*: Exists in response to a user request for call disconnection, prior to network acknowledgment of the request.
- *Disconnect Indication (State U12)*: Exists when the network has indicated call disconnection and the user has not yet indicated release.
- *Release Request (State U19)*: Exists in response to a user request for call reference release, prior to network acknowledgment of the request.

4.1.1.2.2 Call States at Network Side of Interface

This section defines the *call* states that may exist on the network side of the user-network interface. See "Specification Description Language Diagrams," Section 4.2.3, for more information on these call states.

- *Null (State N0)*: No call exists.
- *Call Initiated (State N1)*: Exists for an outgoing call when the network has received a call establishment request but has not yet responded.

- *Overlap-Sending (State N2)*: Exists for an outgoing call when the network is awaiting further information from the user before attempting call establishment.
- *Outgoing Call Proceeding (State N3)*: Exists for an outgoing call when the network has acknowledged receipt of the information required for the call to proceed and the user is awaiting further network response.
- *Call Delivered (State N4)*: Exists for an outgoing call when the network is aware that compatible user equipment that can accept the call exists at the called user interface.
- *Call Present (State N6)*: Exists for an incoming call when the network has indicated the call, but no user has indicated whether the call can be accepted.
- *Call Received (State N7)*: Exists for an incoming call after user equipment has indicated the start of end-user alerting.
- *Connect Request (State N8)*: Exists for an incoming call when the network has received a CONNect message from the user, but has not responded.
- *Incoming Call Proceeding (State N9)*: Exists for an incoming call when the user has acknowledged receipt of the information required for the call to proceed and the network is awaiting further user response.
- *Active (State N10)*: Exists when a call is in the end-to-end communication mode.
- *Disconnect Request (State N11)*: Exists in response to a user request for disconnection, prior to network acknowledgment of the request.
- *Disconnect-Indication (State N12)*: Exists when the network has indicated call disconnection and the user has not yet indicated disconnect.
- *Release Request (State N19)*: Exists when the network has initiated the release of the call (that is, disconnected the B-channel) and is awaiting user acknowledgment.

4.1.1.3 Call Control Definitions

Tables 4.1.1-1 and 4.1.1-3 summarize the set of call control messages and IEs that are supported by this specification. The following legend applies to the entries in Tables 4.1.1-1 and 4.1.1-3, and in "Message Content Definitions," Section 4.1.2:

Table Entry	Explanation
(blank)	IE not applicable to message
M	Mandatory IE
O	Optional IE (that is, conditional requirement)

Column Heading	Explanation
Application[a]	V = Basic Voice SV = Supplementary Voice C = Basic Circuit-Switched Data SC = Supplementary Circuit-Switched Data X = X.31 Packet Mode Data ALL = V + SV + C + SC + X NCA = Non-Call-Associated CA = Call Associated (Common Element Procedures)
Reference	Section where the IE is defined
Length	Minimum and maximum length of the IE

Note(s):
a. If an application is indicated for a particular IE, this means that the IE can be used for that application.

Table 4.1.1-1 — Cross-Reference of Information Elements to Message Types (Network → User) (Alert through Key Setup) (1 of 2)

Information Element	Message							
	ALERT	CALL PRO	CONN	CONN ACK	DISCONN	FACILITY	HOLD	HOLD ACK
Protocol Discriminator	M	M	M	M	M	M	M	M
Call Reference	M	M	M	M	M	M	M	M
Message Type	M	M	M	M	M	M	M	M
Segmented Message								
Bearer Capability								
Cause					M			
Extended Facility						O		
Call State								
Channel Identification		O[a]		O				
Facility			O		O	O		
Progress Indicator	O	O	O					
Notification								
Indication		O		O				O
Information Request		O			O			
Keypad								
Signal	M	O	O	O	O		O	O
Feature Activation								
Feature Indication		O	O		O		O	O
Service Profile Identifier								
Endpoint Identifier								
Calling Party Number								
Calling Party								
Subaddress		O						
Called Party Number		O						
Called Party Subaddress		O						
Transit Network								
Selection								
Redirecting Number								
Redirection Number		O			O			
Low-Layer								
Compatibility								
High-Layer								
Compatibility								
Non-Locking Shift to								
Code Set	O	O	O	O	O		O	O
Display Text	O	O	O	O	O		O	O
Operator System								
Access								
Call Appearance								

Note(s):

a. Mandatory if this is the first response to SETUP (X.25).

b. The maximum length of the Extended Facility IE (N) is 4720 if the call reference is 2 octets, or 4700 if the call reference is 3 octets.

Table 4.1.1-2 — Cross-Reference of Information Elements to Message Types (Network → User) (Alert through Key Setup) (2 of 2)

Information Element	Message					Appl	Section	Length
	HOLD REJ	INFO	KEY HOLD	KEY REL	KEY SETUP			
Protocol Discriminator	M	M		M	M	All	4.1.3.1.1	1
Call Reference	M	M		M	M	All	4.1.3.1.2	2-3
Message Type	M	M		M	M	All	4.1.3.1.3	1
Segmented Message						NCA	4.1.3.5.3	4
Bearer Capability		O			M	All	4.1.3.2.3	4-6
Cause	M	O				All	4.1.3.2.9	4-10
Extended Facility						NCA	4.1.3.5.1	5-N
Call State						All	4.1.3.2.4	3
Channel Identification						All	4.1.3.2.10	3
Facility						NCA,CA	4.1.3.5.2	4-239
Progress Indicator		O				V,SV,C.SC	4.1.3.2.20	4
Notification Indication				O	O	SV,SC	4.1.3.2.19	3
Information Request		O				All	4.1.3.2.16	3
Keypad						V,SV,C,SC	4.1.3.2.17	3-34
Signal		O				V,SV,C,SC	4.1.3.2.24	3
Feature Activation						SV,SC	4.1.3.2.13	3-4
Feature Indication		O		O		SV,SC	4.1.3.2.14	4-5
Service Profile Identifier		O				All	4.1.3.2.23	2-22
Endpoint Identifier		O			O	All	4.1.3.2.12	3-4
Calling Party Number						V,SV,C,SC	4.1.3.2.7	4-19
Calling Party Subaddress						V,SV,C,SC	4.1.3.2.8	4-23
Called Party Number		O			O	All	4.1.3.2.5	10
Called Party Subaddress						All	4.1.3.2.6	4-23
Transit Network Selection						V,SV,C,SC	4.1.3.2.25	4-8
Redirecting Number						V,SV,C,SC	4.1.3.2.21	5-20
Redirection Number		O				SV,SC	4.1.3.2.22	6-13
Low-Layer Compatibility						V,SV,C,SC	4.1.3.2.18	4-16
High-Layer Compatibility						V,SV,C,SC	4.1.3.2.15	4-5
Non-Locking Shift to Code Set	O	O		O	O	V,SV,C,SC	4.1.3.2.1	1
Display Text	O	O		O	O	V,SV,C,SC	4.1.3.3.1	5-128
Operator System Access						V,SV,C,SC	4.1.3.3.2	3
Call Appearance					O	SV,SC	4.1.3.4.1	3-4

Note(s):

a. Mandatory if this is the first response to SETUP (X.25).

b. The maximum length of the Extended Facility IE (N) is 4720 if the call reference is 2 octets, or 4700 if the call reference is 3 octets.

Table 4.1.1-3 — Cross-Reference of Information Elements to Message Types (Network → User) (Notify through Status Inq) (1 of 2)

Information Element	Message							
	NOTIFY	PROGRESS	REGISTER	RELEASE	RELEASE COM	RET ACK	RET REJ	SEGMENT
Protocol Discriminator	M	M	M	M	M	M	M	M
Call Reference	M	M	M	M	M	M	M	M
Message Type	M	M	M	M	M	M	M	M
Segmented Message								M
Bearer Capability	O							
Cause		O		O	O		M	
Extended Facility								M
Call State								
Channel Identification				O		O		
Facility			M		O			
Progress Indicator		M						
Notification Indication	M				O			
Information Request				O	O			
Keypad								
Signal	O	O	M	O	O	O		
Feature Activation								
Feature Indication	O			O	O	O		
Service Profile Identifier								
Endpoint Identifier								
Calling Party Number	O							
Calling Party Subaddress	O							
Called Party Number	O							
Called Party Subaddress	O							
Transit Network Selection								
Redirecting Number								O
Redirection Number				O	O			
Low-Layer Compatibility								
High-Layer Compatibility								
Non-Locking Shift to Code Set	O	O		O	O	O	O	O
Display Text	O	O		O	O	O	O	O
Operator System Access								
Call Appearance								

Note(s):

a. Mandatory if this is the first clearing message, optional otherwise (X.25).

b. Mandatory for X.25.

c. The maximum length of the Extended Facility IE (N) is 4720 if the call reference is 2 octets, or 4700 if the call reference is 3 octets.

Table 4.1.1-4 — Cross-Reference of Information Elements to Message Types (Network → User) (Notify through Status Inq) (2 of 2)

Information Element	Message				Appl	Section	Length
	SETUP	SETUP ACK	STATUS	STATUS INQ			
Protocol Discriminator	M	M	M	M	All	4.1.3.1.1	1
Call Reference	M	M	M	M	All	4.1.3.1.2	2-3
Message Type	M	M	M	M	All	4.1.3.1.3	1
Segmented Message					NCA	4.1.3.5.3	4
Bearer Capability	M				All	4.1.3.2.3	4-6
Cause			M		All	4.1.3.2.9	4-10
Extended Facility					NCA	4.1.3.5.1	5-N
Call State			M		All	4.1.3.2.4	3
Channel Identification	O	M			All	4.1.3.2.10	3
Facility					NCA,CA	4.1.3.5.2	4-239
Progress Indicator	O	O			V,SV,C,SC	4.1.3.2.20	4
Notification Indication					SV,SC	4.1.3.2.19	3
Information Request		O			All	4.1.3.2.16	3
Keypad					V,SV,C,SC	4.1.3.2.17	3-34
Signal	O	O			V,SV,C,SC	4.1.3.2.24	3
Feature Activation					SV,SC	4.1.3.2.13	3-4
Feature Indication		O			SV	4.1.3.2.14	4-5
Service Profile Identifier					All	4.1.3.2.23	2-22
Endpoint Identifier	O				All	4.1.3.2.12	3-4
Calling Party Number	O				V,SV,C,SC	4.1.3.2.7	4-19
Calling Party Subaddress	O				V,SV,C,SC	4.1.3.2.8	4-23
Called Party Number	O				All	4.1.3.2.5	10
Called Party Subaddress	O				All	4.1.3.2.6	4-23
Transit Network Selection	O				V,SV,C,SC	4.1.3.2.25	4-8
Redirecting Number					V,SV,C,SC	4.1.3.2.21	5-20
Redirection Number					SV,SC	4.1.3.2.22	6-13
Low-Layer Compatibility	O				V,SV,C,SC	4.1.3.2.18	4-16
High-Layer Compatibility	O				V,SV,C,SC	4.1.3.2.15	4-5
Non-Locking Shift to Code Set	O	O	O	O	V,SV,C,SC	4.1.3.2.1	11
Display Text	O	O	O	O	V,SC,C,SC	4.1.3.3.1	5-128
Operator System Access					V,SC,C,SC	4.1.3.3.2	3
Call Appearance	O				SV,SC	4.1.3.4.1	3-4

Note(s):

a. Mandatory if this is the first clearing message, optional otherwise (X.25).

b. Mandatory for X.25.

c. The maximum length of the Extended Facility IE (N) is 4720 if the call reference is 2 octets, or 4700 if the call reference is 3 octets.

Table 4.1.1-5 — Cross-Reference of Information Elements to Message Types (User → Network) (Alert through Info) (1 of 2)

Information Element	Message									
	ALERT	CALL PRO	CONN	CONN ACK	DISCONN	FACILITY	HOLD	HOLD ACK	HOLD REJ	INFO
Protocol Discriminator	M	M	M	M	M	M	M	M	M	M
Call Reference	M	M	M	M	M	M	M	M	M	M
Message Type	M	M	M	M	M	M	M	M	M	M
Bearer Capability										
Cause					M				M	
Extended Facility										
Call State										
Channel Identification	O[a]	O[a]	O[a]							
Facility					O	M				
Progress Indicator			O							
Notification Indication										
Information Request										
Keypad										O
Signal										
Feature Activation										O
Feature Indicator										
Service Profile Identifier										O
Endpoint Identifier										
Calling Party Number										
Calling Party Subaddress										
Called Party Number										O
Called Party Subaddress										
Transit Network Selection										
Redirecting Number										
Redirection Number										
Low-Layer Compatibility										
High-Layer Compatibility										
Non-Locking Shift Code Set										
Display Text										
Operator System Access										
Call Appearance										

Note(s):

a. Mandatory if this is the first response to SETUP (X.25).

Table 4.1.1-6 — Cross-Reference of Information Elements to Message Types (User → Network) (Alert through Info) (2 of 2)

Information Element	Appl	Section	Length
Protocol Discriminator	All	4.1.3.1.1	1
Call Reference	All	4.1.3.1.2	2-3
Message Type	All	4.1.3.1.3	1
Bearer Capability	All	4.1.3.2.3	4-6
Cause	All	4.1.3.2.9	4-10
Extended Facility	NCA	4.1.3.5.1	5-68
Call State	All	4.1.3.2.4	3
Channel Identification	All	4.1.3.2.10	3
Facility	NCA,CA	4.1.3.5.2	4-239
Progress Indicator	V,SV,C,SC,CA	4.1.3.2.20	4
Notification Indication	SV	4.1.3.2.19	3
Information Request	V,SV,C,SC	4.1.3.2.16	3
Keypad	V,SV,C,SC	4.1.3.2.17	3-34
Signal	V,SV,C,SC	4.1.3.2.24	3
Feature Activation	SV,SC	4.1.3.2.13	3-4
Feature Indicator	SV,SC	4.1.3.2.14	4-5
Service Profile Identifier	All	4.1.3.2.23	11-22
Endpoint Identifier	All	4.1.3.2.12	3-4
Calling Party Number	V.SV,C,SC	4.1.3.2.7	4-19
Calling Party Subaddress	V,SV,C,SC	4.1.3.2.8	4-23
Called Party Number	V,SV,C,SC	4.1.3.2.5	6-35
Called Party Subaddress	V,SV,C,SC	4.1.3.2.6	4-23
Transit Network Selection	V,SV,C,SC	4.1.3.2.25	4-8
Redirecting Number	V,SV,C,SC	4.1.3.2.21	5-20
Redirection Number	SV,SC	4.1.3.2.22	6-13
Low-Layer Compatibility	V,SV,C,SC	4.1.3.2.18	4-16
High-Layer Compatibility	V,SV,C,SC	4.1.3.2.15	4-5
Non-Locking Shift Code Set	V,SV,C,SC	4.1.3.2.1	1
Display Text	V,SV,C,SC	4.1.3.3.1	5-128
Operator System Access	V,SV,C,SC	4.1.3.3.2	3
Call Appearance	SV,SC	4.1.3.4.1	3-4

Note(s):

a. Mandatory if this is the first response to SETUP (X.25).

Table 4.1.1-7 — Cross-Reference of Information Elements to Message Types (User → Network) (Key Setup Ack through Info) (1 of 2)

Information Element	Message						
	KEY SETUP ACK	REGISTER	RELEASE	RELEASE COM	RETRIEVE	SETUP	STATUS
Protocol Discriminator	M	M	M	M	M	M	M
Call Reference	M	M	M	M	M	M	M
Message Type	M	M	M	M	M	M	M
Bearer Capability						M	
Cause			O	O			M
Extended Facility		O		O			
Call State							M
Channel Identification					O	O	
Facility		O				O	
Progress Indicator						O	
Notification Indication							
Information Request							
Keypad						O	
Signal							
Feature Activation						O	
Feature Indication							
Service Profile Identifier							
Endpoint Identifier							
Calling Party Number						O	
Calling Party Subaddress						O	
Called Party Number						O	
Called Party Subaddress						O	
Transit Network Selection						O	
Redirecting Number							
Redirection Number							
Low-Layer Compatibility						O	
High-Layer Compatibility						O	
Non-Locking Shift to							
Code Set						O	
Display Text							
Operator System							
Access						O	
Call Appearance						O	

Note(s):

a. Mandatory if this is the first clearing message (X.25).

b. Mandatory for packet non-initializing terminal if no default DN is provisioned for the interface.

c. REGister message must contain either Facility or Extended Facility.

Table 4.1.1-8 — Cross-Reference of Information Elements to Message Types (User → Network) (Key Setup Ack through Info) (2 of 2)

Information Element	Appl	Section	Length
Protocol Discriminator	All	4.1.3.1.1	1
Call Reference	All	4.1.3.1.2	2-3
Message Type	All	4.1.3.1.3	1
Bearer Capability	All	4.1.3.2.3	4-6
Cause	All	4.1.3.2.9	4-10
Extended Facility	NCA	4.1.3.5.1	5-68
Call State	All	4.1.3.2.4	3
Channel Identification	All	4.1.3.2.10	3
Facility	NCA,CA	4.1.3.5.2	4-239
Progress Indicator	SV,CA	4.1.3.2.20	4
Notification Indication	SV	4.1.3.2.19	3
Information Request	V,SV,C,SC	4.1.3.2.16	3
Keypad	V,SV,C,SC	4.1.3.2.17	3-34
Signal	V,SV,C,SC	4.1.3.2.24	3
Feature Activation	SV	4.1.3.2.13	3-4
Feature Indication	SV	4.1.3.2.14	4-5
Service Profile Identifier	All	4.1.3.2.23	11-22
Endpoint Identifier	All	4.1.3.2.12	3-4
Calling Party Number	All	4.1.3.2.7	4-19
Calling Party Subaddress	V,SV	4.1.3.2.8	4-23
Called Party Number	V,SV,C,SC	4.1.3.2.5	6-35
Called Party Subaddress	V,SV	4.1.3.2.6	4-23
Transit Network Selection	V,SV,C,SC	4.1.3.2.25	4-8
Redirecting Number	V,SV	4.1.3.2.21	5-20
Redirection Number	SV,SC	4.1.3.2.22	6-13
Low-Layer Compatibility	V,SV,C,SC	4.1.3.2.18	4-16
High-Layer Compatibility	V,SV,C,SC	4.1.3.2.15	4-5
Non-Locking Shift to Code Set	V,SV,C,SC	4.1.3.2.1	1
Display Text	V,SV,C,SC	4.1.3.3.1	5-128
Operator System Access	V,SV,C,SC	4.1.3.3.2	3
Call Appearance	SV,SC	4.1.3.4.1	3-4

Note(s):

a. Mandatory if this is the first clearing message (X.25).

b. Mandatory for packet non-initializing terminal if no default DN is provisioned for the interface.

c. REGister message must contain either Facility or Extended Facility.

4.1.2 MESSAGE CONTENT DEFINITIONS

4.1.2.1 Overview

Each definition contained in this section includes:

a. A brief description of the message direction and use.

b. A figure listing the IE contained in the message. For each IE, the figure indicates:

   1. Which applications have implemented the IE, where the applications abbreviations defined in "Call Control Definitions," Section 4.1.1.3, apply.

   2. *Section* of this specification describing the IE

   3. *Direction* in which the element may be sent; that is, user to network (u $\rightarrow$ n), network to user (n $\rightarrow$ u), or both

   4. Whether *inclusion* is:

      - Mandatory (M)
      - Optional (O)
      - Dependent on other circumstances, as indicated and explained by notes.

   5. Allowable *length(s)*, in octets, where "?" (if shown) means the maximum length is undefined (subject to the overall Layer 3 message maximum length restriction; see "Message Content Definitions," Section 4.1.2).

      The IEs are listed in order of appearance in the message. The relative order of IEs, specified in "Message Element (Structure) Definitions," Section 4.1.3, is the same for all message types.

c. Further explanatory notes, as necessary.

This section gives definitions for all messages supported by the basic rate interface (BRI). Note that not all applications implement each message appearing here. Refer to "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, "Packet Services," Section 4.3, "Common Protocols and Procedures for Voice and Data Services," Section 5.1, "Supplementary Voice Services," Section 5.2, and "Terminal Initialization," Section 6), for information on which messages are applicable for basic voice services, data services, supplementary voice services, and terminal initialization, respectively.

4.1.2.2 ALERTing

For all circuit and packet transport mode calls, this message may be sent from the called user to the network and, in turn, from the network to the calling user to indicate that called-user alerting has been initiated. The ALERTing message content is shown in Table 4.1.2-1.

Message Type: ALERTing
Direction: Both

Table 4.1.2-1 — ALERTing Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Channel Identification	ALL	4.1.3.2.10	u → n	[a]	3
Progress Indicator	V, SV, C, SC	4.1.3.2.20	n → u	[b]	4
Signal	V, SV, C, SC	4.1.3.2.24	n → u	M	3
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[c]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This IE must be included if this message is the first response to an incoming SETUP message in the basic call offering; Not included if SETUP message contained a "No channel" indication; not included for Electronic Key Telephone Set (EKTS).

b. Present if inband tones are provided or the call has returned to ISDN. This IE is included with Progress Indicator 8 when in-band audible ringing is being applied. Included for speech and 3.1 kHz audio calls.

c. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

4.1.2.3 CALL PROCeeding

The network sends this message to the calling user to indicate that it has initiated the call establishment requested and that it will not accept any more call establishment information. The called user may send this message to inform the network of terminal capabilities and/or to verify the selected channel. The CALL PROCeeding message content is shown in Table 4.1.2-2.

Message Type: CALL PROCeeding
Direction: Both

Table 4.1.2-2 — CALL PROCeeding Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Channel Identification	ALL	4.1.3.2.10	both	[a]	3
Progress Indicator	V, SV, C, SC	4.1.3.2.20	n → u	O	4
Information Request	V, SV, C, SC	4.1.3.2.16	n → u	O	3
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV	4.1.3.2.14	n → u	O[d]	4-5
Redirection Number	SV, SC	4.1.3.2.22	n → u	[b]	6-13
Called Party Number	V, SV, C, SC	4.1.3.2.5	n → u	O	10
Called Party Subaddress	V, SV, C, SC	4.1.3.2.6	n → u	O	4-23
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[c]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This element is mandatory only if the customer premises equipment (CPE) originated an en-bloc in the CALL PROCeeding message.

b. This information element is optional during Call Forwarding to indicate the remote DN.

c. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

d. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.4 CONNect

For voice, circuit transport mode and packet mode data applications, the called user sends this message to the network to indicate acceptance of a call, and the network sends this message to the calling user to indicate both: (1) call acceptance by the called user, and (2) establishment of an end-to-end circuit mode connection to the called user. The CONNect message content is shown in Table 4.1.2-3.

Message Type: CONNect
Direction: Both

Table 4.1.2-3 — CONNect Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Channel Identification	ALL	4.1.3.2.10	u → n	[a]	3
Facility	CA	4.1.3.5.2	n → u	O	4-214
Progress Indicator	SV,CA	4.1.3.2.20	both	[b]	4
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV	4.1.3.2.14	n → u	O[a]	4-5
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[c]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This IE is optional. Exclusive B-channel or exclusively D indication included if this is the first message in response to the SETUP message in basic call offering, except for EKTS. Refer to Section 5.2.1.5.5 for use of channel identification IE by additional call offering (ACO). Refer to Section 5.2.1.21 for further information on use of channel identification by EKTS.

b. Present if the call is not end-to-end ISDN or the call has returned to ISDN network.

c. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

d. Feature Indication is not sent to Non-Initializing Terminals.

4.1.2.5 CONNect ACKnowledge

For voice, circuit transport mode and packet mode data applications, the network sends this message to the called user to indicate completion of the circuit-switched connection. The terminal will not connect to the B-channel until after receipt of this message. Optionally, the calling user may send this message to the network to acknowledge receipt of the network CONNect message. However, the network will ignore such a message from the calling user. The CONNect ACKnowledge message content is shown in Table 4.1.2-4.

Message Type: CONNect ACKnowledge
Direction: Both

Table 4.1.2-4 — CONNect ACKnowledge Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Channel Identification	SV	4.1.3.2.10	n → u	[a]	3
Notification Indicator	SV, SC	4.1.3.2.19	n → u	O	3
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[b]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This element is included only if the call was originally offered during the all channel busy case; otherwise, it is not included (that is, flexible call offering). An EKTS is the exception.

b. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

4.1.2.6 DISConnect

Either the user or the network sends this message as an invitation to release the B-channel. However, the channel and call reference are retained at this time. The DISConnect message content is shown in Table 4.1.2-5.

Message Type: DISConnect
Direction: Both

Table 4.1.2-5 — DISConnect Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Cause	ALL	4.1.3.2.9	both	M	4-5
Facility	CA	4.1.3.5.2	n → u	O	4-17
Information Request	V, SV, C, SC	4.1.3.2.16	n → u	O	3
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV	4.1.3.2.14	n → u	O[c]	4-5
Redirection Number	SV, SC	4.1.3.2.22	n → u	[a]	6-13
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[b]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This information element is optional during Call Forwarding to indicate the remote DN.

b. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

c. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.7 FACility

The network sends this message to a terminal to transmit download data or an end-of-data indication. The FACility message content is shown in Table 4.1.2-6.

Message Type: FACility
Direction: Both

Table 4.1.2-6 — FACility Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	NCA	4.1.3.1.1	both	M	1
Call Reference	NCA	4.1.3.1.2	both	M	2 - 3
Message Type	NCA	4.1.3.1.3	both	M	1
Extended Facility	NCA	4.1.3.5.1	n -> u	O	5 - N[a]
Facility	NCA,CA	4.1.3.5.2	both	O	4-212

Note(s):

a. The maximum length of the Extended Facility IE (N) is 4720 if the call reference is 2 octets, or 4700 if the call reference is 3 octets.

4.1.2.8 HOLD

The user sends this message to request that a call be placed on hold by the network. The network sends this message to indicate that it is going to place a call on hold. The HOLD message content is shown in Table 4.1.2-7.

Message Type: HOLD
Direction: Both

Table 4.1.2-7 — HOLD Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV, SC	4.1.3.1.1	both	M	1
Call Reference	SV, SC	4.1.3.1.2	both	M	2-3
Message Type	SV, SC	4.1.3.1.3	both	M	1
Signal	SV, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV	4.1.3.2.14	n → u	O[a]	4-5
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[b]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. Feature Indication not sent to Non-Initializing Terminals.

b. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

4.1.2.9 HOLD ACKnowledge

The network sends this message to the user to indicate that a call has been put on hold for the user by the network. The user sends this message to the network to acknowledge the network's intention to place a call on hold. The user and the network retain the call reference of that call, and the B-channel is released by the user and the network. The HOLD ACKnowledge message content is shown in Table 4.1.2-8.

Message Type: HOLD ACKnowledge
Direction: Both

Table 4.1.2-8 — HOLD ACKnowledge Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV, SC	4.1.3.1.1	both	M	1
Call Reference	SV, SC	4.1.3.1.2	both	M	2-3
Message Type	SV, SC	4.1.3.1.3	both	M	1
Notification Indicator	SV, SC	4.1.3.2.19	n $\rightarrow$ u	O	3
Signal	SV, SC	4.1.3.2.24	n $\rightarrow$ u	O	3
Feature Indication	SV	4.1.3.2.14	n $\rightarrow$ u	O[b]	4-5
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n $\rightarrow$ u	[a]	1
Display Text	SV, SC	4.1.3.3.1	n $\rightarrow$ u	O	5-128

Note(s):

a. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

b. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.10 HOLD REJect

The network sends this message to the user to indicate that a call has not been placed on hold by the network. The user sends this message to the network to reject the network's intention to place a call on hold. The HOLD REJect message content is shown in Table 4.1.2-9.

Message Type: HOLD REJect
Direction: Both

Table 4.1.2-9 — HOLD REJect Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV, SC	4.1.3.1.1	both	M	1
Call Reference	SV, SC	4.1.3.1.2	both	M	2-3
Message Type	SV, SC	4.1.3.1.3	both	M	1
Cause	SV, SC	4.1.3.2.9	both	M	4-5
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	$n \rightarrow u$	[a]	1
Display Text	SV, SC	4.1.3.3.1	$n \rightarrow u$	O	5-128

Note(s):
a. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.

4.1.2.11 INFOrmation

Either the user or the network sends this message to provide additional information. The INFO message content is shown in Table 4.1.2-10.

Message Type: INFOrmation
Direction: Both

Table 4.1.2-10 — INFO Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	1-3
Message Type	ALL	4.1.3.1.3	both	M	1
Bearer Capability	ALL	4.1.3.2.3	n -> u	[a]	4-6
Cause	ALL	4.1.3.2.9	n -> u	O	4-5
Keypad	V, SV, C, SC	4.1.3.2.17	u -> n	[b]	3-34
Feature Activation	SV, SC	4.1.3.2.13	u -> n	[b]	3-4
Called Party Number	ALL	4.1.3.2.5	both	[c]	4-35
Signal	V, SV, C, SC	4.1.3.2.24	n -> u	[d]	3
Feature Indication	SV, SC	4.1.3.2.14	n -> u	4-5	
Redirection Number	SV, SC	4.1.3.2.22	n -> u	6-13	
Service Profile Indication	ALL	4.1.3.2.23	both	O	2-22
Progress Indicator	S, SV, C, SC	4.1.3.2.20	n -> u	O	4
Information Request	ALL	4.1.3.2.16	n -> u	O	3
Endpoint Identifier	ALL	4.1.3.2.12	n -> u	O	3-4
Locking Shift to Codeset 5	S, SV, C, SC	4.1.3.2.1	n -> u	1	
Display Text	S, SV, C, SC	4.1.3.3.1	n -> u	[h]	5-128

Note(s):

a. This IE is included only during Automated SPID Selection procedures during terminal initialization. It may appear a maximum of three times in the same INFO message.

b. Keypad and feature activation IEs are allowed within the same message. Feature Activation is accepted from only Fully Initializing Terminals.

c. This IE is included in the network-to-user direction only during Automated SPID Selection procedures during terminal initialization, to provide the Primary DN to the terminal.

d. This IE is mandatory only if the SETUP does not contain a keypad IE; otherwise, it is not included. The signal IE instructs the terminal to turn off the tones that were initiated earlier. In addition, this IE may be present in INFORMATION messages sent to the user while the network is returning certain in-band tones. In such cases, this IE instructs the terminal to begin providing the specified tone itself, if the terminal is able to.

Table 4.1.2-10 — INFO Message Content (Contd)

Note(s): (Contd)
e. Feature Indication is not sent to Non-Initializing Terminals.
f. This IE is optional to indicate the remote DN during Call Forwarding.
g. This IE is mandatory only if any Codeset 5 IEs are included in the message; otherwise, it is not included.
h. This IE is optional.

4.1.2.12 KEY HOLD

When an EKTS terminal answers an incoming call, the network sends this message to the other EKTS terminal(s) receiving terminating treatment for the call. The network also sends a KEY HOLD message in response to a CONNect message when no B-channel is available to establish a connection, and other EKTS terminals are still receiving terminating treatment for the call. The KEY HOLD message content is shown in Table 4.1.2-11.

Message Type: KEY HOLD
Direction: Network to User

Table 4.1.2-11 — KEY HOLD Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV	4.1.3.1.1	n → u	M	1
Call Reference	SV	4.1.3.1.2	n → u	M	2-3
Message Type	SV	4.1.3.1.3	n → u	M	2
Cause	SV	4.1.3.2.9	n → u	O	4-5
Notification Indicator	SV	4.1.3.2.19	n → u	O	3
Signal	SV	4.1.3.2.24	n → u	O	3
Locking Shift to Codeset 5	SV	4.1.3.2.1	n → u	O	1
Display Text	SV	4.1.3.3.1	n → u	O	5-128

4.1.2.13 KEY RELease

The network sends this message in response to a DISConnect or RELease message sent by an EKTS terminal when other EKTS terminals remain connected to the call. The KEY RELease message content is shown in Table 4.1.2-12.

Message Type: KEY RELease
Direction: Network to User

Table 4.1.2-12 — KEY RELease Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV	4.1.3.1.1	$n \rightarrow u$	M	1
Call Reference	SV	4.1.3.1.2	$n \rightarrow u$	M	2-3
Message Type	SV	4.1.3.1.3	$n \rightarrow u$	M	2
Notification Indicator	SV	4.1.3.2.19	$n \rightarrow u$	O	3
Feature Indication	SV	4.1.3.2.14	$n \rightarrow u$	O[a]	4-5
Locking Shift to Codeset 5	SV	4.1.3.2.1	$n \rightarrow u$	O	1
Display Text	SV	4.1.3.3.1	$n \rightarrow u$	O	5-128

Note(s):
a. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.14 KEY SETUP

When an EKTS terminal originates a call, the network sends this message to notify other EKTS terminal(s) sharing a call appearance of the directory number (DN) used for the call or sharing the same DN. It is also used for ICOM call at the terminating end. The KEY SETUP message content is shown in Table 4.1.2-13.

Message Type: KEY SETUP
Direction: Network to User

Table 4.1.2-13 — KEY SETUP Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV	4.1.3.1.1	n → u	M	1
Call Reference	SV	4.1.3.1.2	n → u	M	2-3
Message Type	SV	4.1.3.1.3	n → u	M	2
Bearer Capability	SV	4.1.3.2.3	n → u	M	4-5
Notification Indicator	SV	4.1.3.2.19	n → u	O	3
Endpoint Identifier	SV	4.1.3.2.12	n → u	O	3-4
Called Party Number	SV	4.1.3.2.5	n → u	O	10
Locking Shift to Codeset 5	SV	4.1.3.2.1	n → u	O	1
Display Text	SV	4.1.3.3.1	n → u	O	5-128
Locking Shift to Codeset 6	SV	4.1.3.2.1	n → u	O	1
Call Appearance	SV	4.1.3.4.1	n → u	O	3-4

4.1.2.15 KEY SETUP ACKnowledge

The terminal sends this message to the network in response to a KEY SETUP message. The KEY SETUP ACKnowledge message content is shown in Table 4.1.2-14.

Message Type: KEY SETUP ACKnowledge
Direction: User to Network

Table 4.1.2-14 — KEY SETUP ACKnowledge Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV	4.1.3.1.1	u → n	M	1
Call Reference	SV	4.1.3.1.2	u → n	M	2-3
Message Type	SV	4.1.3.1.3	u → n	M	2

4.1.2.16 NOTIFY

The network sends this message to a terminal to transmit information about certain events related to a service. The NOTIFY message content is shown in Table 4.1.2-15.

Message Type: NOTIFY
Direction: Network to User

Table 4.1.2-15 — NOTIFY Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	SV, SC	4.1.3.1.1	n → u	M	1
Call Reference	SV, SC	4.1.3.1.2	n → u	M	1-3
Message Type	SV, SC	4.1.3.1.3	n → u	M	1
Bearer Capability	SV, SC	4.1.3.2.3	n → u	O	4-6
Notification Indicator	SV, SC	4.1.3.2.19	n → u	[a]	3
Signal	SV, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV, SC	4.1.3.2.14	n → u	O[b]	4-5
Calling Party Number	SV, SC	4.1.3.2.7	n → u	O	4-19
Calling Party Subaddress	SV, SC	4.1.3.2.8	n → u	O	4-23
Called Party Number	SV, SC	4.1.3.2.5	n → u	O	10
Called Party Subaddress	SV, SC	4.1.3.2.6	n → u	O	4-23
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	O	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):
a. This element is mandatory; this element may appear twice in this message.
b. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.17 PROGress

The network sends this message to provide call progress information to the user. In particular, the progress indicator IE may inform the user of an interworking call. The cause IE may inform the user that the called party has rejected, or is not responding to, the call. The network may also send this message to facilitate tones or announcements. Receipt of this message indicates that the B-channel may contain call progress information. The PROGress message content is shown in Table 4.1.2-16.

Message Type: PROGress
Direction: Network to User

Table 4.1.2-16 — PROGress Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	V, SV, C, SC	4.1.3.1.1	n → u	M	1
Call Reference	V, SV, C, SC	4.1.3.1.2	n → u	M	2-3
Message Type	V, SV, C, SC	4.1.3.1.3	n → u	M	1
Cause	V, SV, C, SC	4.1.3.2.9	n → u	O	4-5
Progress Indicator	V, SV, C, SC	4.1.3.2.20	n → u	[a]	4
Signal	V, SV, C, SC	4.1.3.2.24	n → u	[b]	3
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[c]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This element is mandatory, this element may appear twice in this message (that is, in the case of excess call delay).

b. This element is optional; it is used to instruct terminals that choose to provide their own call progress (and other) tones when to turn such tones on and off.

c. This element is mandatory only if any Codeset 5 IEs are included in the message; otherwise it is not included.

4.1.2.18 REGister

This message is sent to establish a non-call-associated call reference value for the exchange of components. The REGister message content is shown in Table 4.1.2-17.

Message Type: REGister
Direction: User to Network

Table 4.1.2-17 — REGister Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	NCA	4.1.3.1.1	both	M	1
Call Reference	NCA	4.1.3.1.2	both	M	2 - 3
Message Type	NCA	4.1.3.1.3	both	M	1
Extended Facility	NCA	4.1.3.5.1	u -> n	O[a]	5 - 68
Facility	NCA	4.1.3.5.2	both	O[a]	7-239
Note(s): a. REGister message must contain either the Facility IE or Extended Facility IE.					

4.1.2.19 RELease

For all voice and data services, this message is sent by either the user or the network to indicate that the entity sending the message has disconnected the B-channel and intends to release the channel and call reference, and that the receiving entity will release the B-channel and call reference. The RELease message content is shown in Table 4.1.2-18.

Message Type: RELease
Direction: Both

Table 4.1.2-18 — RELease Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Cause	ALL	4.1.3.2.9	both	O	4-5
Channel Identification	ALL	4.1.3.2.10	n → u	O	3
Information Request	V, SV, C, SC	4.1.3.2.16	n → u	O	3
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV	4.1.3.2.14	n → u	O[c]	4-5
Redirection Number	SV, SC	4.1.3.2.22	n → u	[a]	6-13
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n −> u	[b]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This information element is optional during Call Forwarding to indicate the remote DN.

b. This element is mandatory only if any Codeset 5 IE is included in the message; otherwise, it is not included.

c. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.20 RELease COMplete

Either the network or user sends this message to indicate that the entity sending the message has released the channel (if any) and call reference, and that the receiving entity will do the same. The channel and call reference will then be available for reuse. The RELease COMplete message content is shown in Table 4.1.2-19.

Message Type: RELease COMplete
Direction: Both

Table 4.1.2-19 — RELease COMplete Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Cause	ALL	4.1.3.2.9	both	O	4-5
Extended Facility	NCA	4.1.3.5.1	both	O	5-?[c]
Facility	NCA,CA	4.1.3.5.2	n → u	O	4-?
Information Request	V, SV, C, SC	4.1.3.2.16	n → u	O	3
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Feature Indication	SV	4.1.3.2.14	n → u	O [d]	4-5
Redirection Number	SV, SC	4.1.3.2.22	n → u	[a]	6-13
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[b]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. This information element is optional during Call Forwarding to indicate the remote DN.

b. This element is mandatory only if any Codeset 5 information elements are included in the message; otherwise, it is not included.

c. The REL COM message is never segmented, so the maximum length of the EFIE is the number of octets remaining in the message after coding the mandatory IEs and any optional IEs.

d. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.21 RETrieve

The terminal sends this message to the network to request a held call be reconnected, or to bridge or merge calls. The RETrieve message content is shown in Table 4.1.2-20.

Message Type: RETrieve
Direction: User to Network

Table 4.1.2-20 — RETrieve Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	V,SV,C,SC	4.1.3.1.1	u → n	M	1
Call Reference	V,SV,C,SC	4.1.3.1.2	u → n	M	2-3
Message Type	V,SV,C,SC	4.1.3.1.3	u → n	M	1
Channel Identification	V,SV,C,SC	4.1.3.2.10	u → n	O	3

4.1.2.22 RETrieve ACKnowledge

The network sends this message to indicate that a held call has been reconnected to a B-channel, or a bridging or merging request has been completed. The RETrieve ACKnowledge message content is shown in Table 4.1.2-21.

Message Type: RETrieve ACKnowledge
Direction: Network to User

Table 4.1.2-21 — RETrieve ACKnowledge Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	V,SV,C,SC	4.1.3.1.1	$n \rightarrow u$	M	1
Call Reference	V,SV,C,SC	4.1.3.1.2	$n \rightarrow u$	M	2-3
Message Type	V,SV,C,SC	4.1.3.1.3	$n \rightarrow u$	M	1
Channel Identification	V,SV,C,SC	4.1.3.2.10	$n \rightarrow u$	[a]	3
Notification Indicator	SV	4.1.3.2.19	$n \rightarrow u$	O	3
Signal	V,SV,C,SC	4.1.3.2.24	$n \rightarrow u$	O	3
Feature Indication	SV	4.1.3.2.14	$n \rightarrow u$	O[b]	4-5
Locking Shift to Codeset 5	SV,SC	4.1.3.2.1	$n \rightarrow u$	O	1
Display Text	SV,SC	4.1.3.3.1	$n \rightarrow u$	O	5-128

Note(s):
a. This is mandatory if the CPE did not include channel identification in the RETrieve message.
b. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.23 RETrieve REJect

The network sends this message to a terminal to reject a request to reconnect a held call to a B-channel, or to reject a bridging or merging request. The RETrieve REJect message content is shown in Table 4.1.2-22.

Message Type: RETrieve REJect
Direction: Network to User

Table 4.1.2-22 — RETrieve REJect Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	V,SV,C,SC	4.1.3.1.1	n → u	M	1
Call Reference	V,SV,C,SC	4.1.3.1.2	n → u	M	2-3
Message Type	V,SV,C,SC	4.1.3.1.3	n → u	M	1
Cause	V,SV,C,SC	4.1.3.2.9	n → u	M	4-5
Locking Shift to Codeset 5	SV,SC	4.1.3.2.1	n → u	O	1
Display Text	SV,SC	4.1.3.3.1	n → u	O	5-128

4.1.2.24 SEGment

The network sends this message to the terminal when the download data size is larger than the allowed maximum length of the Layer 3 message. The SEGment message content is shown in Table 4.1.2-23.

Message type: SEGment
Direction: Network to User

Table 4.1.2-23 — SEGment Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	NCA	4.1.3.1.1	n -> u	M	1
Call Reference	NCA	4.1.3.1.2	n -> u	M	2 - 3
Message Type	NCA	4.1.3.1.3	n -> u	M	1
Segmented Message	NCA	4.1.3.5.3	n -> u	M	4
Extended Facility	NCA	4.1.3.5.1	n -> u	M	[a]
Note(s): a. Beginning of Extended Facility Information Element (EFIE) or the continuation of the EFIE from previous SEGment message.					

4.1.2.25 SETUP

For voice and circuit mode data applications, the user or the network sends this message to request call establishment. The SETUP message content is shown in Table 4.1.2-24.

Message Type: SETUP
Direction: Both

Table 4.1.2-24 — SETUP Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Bearer Capability	ALL	4.1.3.2.3 4.2.1.1.1	both	M	4-6
Channel Identification	ALL	4.1.3.2.10	both	[a]	3
Facility	CA	4.1.3.5.2	u → n	O	4-17
Progress Indicator	V, SV, C, SC	4.1.3.2.20	both	[b]	4
Keypad	V, SV, C, SC	4.1.3.2.17	u → n	[c]	3-34
Signal	V, SV, C, SC	4.1.3.2.24	n → u	O	3
Feature Activation	SV, SC	4.1.3.2.13	u → n	[d]	3-4
Endpoint Identifier	V, SV, C, SC	4.1.3.2.12	n → u	[e]	3-4
Calling Party Number	V, SV, C, SC	4.1.3.2.7	both	[f]	[f]
Calling Party Subaddress	V, SV, C, SC	4.1.3.2.8	both	O	4-23
Called Party Number	ALL	4.1.3.2.5	both	[g]	[g]
Called Party Subaddress	ALL	4.1.3.2.6	both	O	4-23
Redirecting Number	V, SV, C, SC	4.1.3.2.21	n->u	O	5-20
Transit Network Selection	V, SV, C, SC	4.1.3.2.25	u->n	O	4-8
Low Layer Compatibility	V, SV, C, SC	4.1.3.2.18	both	O	4-16
High Layer Compatibility	V, SV, C, SC	4.1.3.2.15	both	O	4-5

See note(s) at end of table.

Table 4.1.2-24 — SETUP Message Content (Contd)

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	both	[h]	1
Operator System Access	SV, SC	4.1.3.3.2	u → n	O	3
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128
Locking Shift to Codeset 6	SV	4.1.3.2.1	both	[h]	1
Call Appearance	SV	4.1.3.4.1	both	[i]	3-4

Note(s):

a. If absent from a SETUP message from the user, the network shall select a channel and notify the user in its first response to the SETUP message; that is, it is equivalent to the user having coded the element to the "any channel" option. This IE is mandatory in the n → u direction.

b. Present if the incoming call has originated from a non-ISDN line or trunk.

c. This IE element is used to send address digits to the network, if any are available at the time of transmission of the SETUP message. The balance of the address digits will be assumed to follow in keypad IEs contained in subsequent INFOrmation messages. In particular, if an addressing information element is absent from the SETUP message, all address digits will arrive at the network via INFOrmation messages. Also see.

d. Keypad and feature activation IEs are allowed to be contained within the same message. Feature Activation accepted from only Fully Initializing Terminals.

e. This IE is mandatory if the terminal is an EKTS or MLHG terminal.

f. The calling party number is mandatory in the u → n direction for Basic EKTS, and for Non-Initializing Terminals when no Default DN is provisioned for the interface. The network may provide it if the user subscribes to CPN/BN Delivery. The length is 10-14 from user-to-network, and 4-19 from network-to-user.

g. The called party number is mandatory in the network to user direction. The called party number may be used for functional addressing and not be used for dialing. The length is 6-35 from user-to-network, 10 for circuit mode from network-to-user, and 7 for packet mode from network-to-user.

h. This element is mandatory only if any Codeset 5 or 6 information elements are included in the message; otherwise, it is not included.

i. Origination call appearance and destination call appearance are mandatory for CACH EKTS terminals; otherwise, they are not included.

4.1.2.26 SETUP ACKnowledge

The network sends this message to the calling user to signal that the network has begun call establishment but needs additional information to proceed. The SETUP ACKnowledge message content is shown in Table 4.1.2-25.

Message Type: SETUP ACKnowledge
Direction: Network to User

Table 4.1.2-25 — SETUP ACKnowledge Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	n → u	M	1
Call Reference	ALL	4.1.3.1.2	n → u	M	2-3
Message Type	ALL	4.1.3.1.3	n → u	M	1
Channel Identification	ALL	4.1.3.2.10	n → u	M	3
Progress Indicator	SV	4.1.3.2.20	n → u	O	4
Information Request	V, SV, C, SC	4.1.3.2.16	n → u	O	3
Signal	V, SV, C, SC	4.1.3.2.24	n → u	[a]	3
Feature Indication	SV	4.1.3.2.14	n → u	O[c]	4-5
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	[b]	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

Note(s):

a. Present if the SETUP message did not contain address digits; otherwise, not included.

b. This element is mandatory only if any Codeset 6 IEs are included in the message; otherwise it is not included.

c. Feature Indication not sent to Non-Initializing Terminals.

4.1.2.27 STATUS

The user sends this message to the network, in response to a STATUS ENQuiry, to inform the network of the current call state of the user. In addition, the user may send this message at any time other than in response to a STATUS ENQuiry. However, the network will take no action upon receipt of this message. The STATUS message content is shown in Table 4.1.2-26.

Message Type: STATUS
Direction: User to Network

Table 4.1.2-26 — STATUS Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	both	M	1
Call Reference	ALL	4.1.3.1.2	both	M	2-3
Message Type	ALL	4.1.3.1.3	both	M	1
Cause	ALL	4.1.3.2.9	both	M	4-5
Call State	ALL	4.1.3.2.4	both	M	3
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	O	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

4.1.2.28 STATUS ENQuiry

The network sends this message to the user, both periodically and on-demand, to verify the terminal/network consistency of the current state of the call. In particular, the network may use this message to check against the potential of lost DISConnect messages. Sending a STATUS message in response to a STATUS ENQuiry message is mandatory. The STATUS ENQuiry message content is shown in Table 4.1.2-27.

Message Type: STATUS ENQuiry
Direction: Network to User

Table 4.1.2-27 — STATUS ENQuiry Message Content

INFORMATION ELEMENT	APPLICATION	SECTION	DIRECTION	TYPE	LENGTH
Protocol Discriminator	ALL	4.1.3.1.1	n → u	M	1
Call Reference	ALL	4.1.3.1.2	n → u	M	2-3
Message Type	ALL	4.1.3.1.3	n → u	M	1
Locking Shift to Codeset 5	SV, SC	4.1.3.2.1	n → u	O	1
Display Text	SV, SC	4.1.3.3.1	n → u	O	5-128

4.1.3 MESSAGE ELEMENT (STRUCTURE) DEFINITIONS

4.1.3.1 First Three Information Elements of Every Message

4.1.3.1.1 Protocol Discriminator

The protocol discriminator identifies the messages for user-network call control as Q.931 messages and is the first information element of every message. See Table 4.1.3-1.

Table 4.1.3-1 — Protocol Discriminator

8	7	6	5	4	3	2	1	
Q.931 user-network call control messages								
0	0	0	0	1	0	0	0	Octet 1
Protocol Discriminator								

4.1.3.1.2 Call Reference

The call reference identifies a call at the local user-network interface to which the particular message applies and is the second information element of every message. The call reference IE comprises two fields: the call reference value and the call reference flag. See Table 4.1.3-2.

Table 4.1.3-2 — Call Reference

8	7	6	5	4	3	2	1	
0	0	0	0	Length of call reference value (in octets)				Octet 1
flag	call reference value							2
call reference value continued								3*

* Included if length of call reference value is 2 octets.
0 = message sent by side that allocated call reference value.
1 = message sent by side that did not allocate call reference value.

- Call Reference Value: The call reference values are assigned by the originating side of the interface for a call. These values are unique to the originating side only within a particular D-channel, Layer 2 logical link connection, as identified by a service access point identifier (SAPI) and a terminal endpoint identifier (TEI).

  The terminal shall assign a single-octet call reference value within the range 1 to 127. The terminal shall assign a 2-octet call reference value when no call reference values are available within the range 1 to 127.

- Call Reference Flag: The call reference flag can have the value "0" or "1" and identifies which end of the Layer 2 logical link allocated the call reference. The side that allocates the call reference sets the call reference flag to "0"; the other side sets the call reference flag to "1".

The null call reference is coded as shown in Table 4.1.3-3.

Table 4.1.3-3 — Null Call Reference

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Octet 1
				Length				

4.1.3.1.3 Message Type

The message type identifies the function of the message being sent and is the third information element of every message. When a 2-octet information element is used, the first octet is coded as "0000 0000." See Table 4.1.3-4.

Table 4.1.3-4 — Message Type

8	7	6	5	4	3	2	1	
0	Message Type							Octet 1

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Octet 1
1	Network-specific message type							2

Table 4.1.3-5 shows the codings of the message types.

Table 4.1.3-5 — Message Types

8	7	6	5	4	3	2	1	(Octet 1)
0	0	0	-	-	-	-	-	Call establishment messages:
			0	0	0	0	1	- ALERTing
			0	0	0	1	0	- CALL PROCeeding
			0	0	1	1	1	- CONNect
			0	1	1	1	1	- CONNect ACKnowledge
			0	0	0	1	1	- PROGress
			0	0	1	0	1	- SETUP
			0	1	1	0	1	- SETUP ACKnowledge
0	0	1	-	-	-	-	-	Call information phase messages:
			0	0	1	0	0	- HOLD
			0	1	0	0	0	- HOLD ACKnowledge
			1	0	0	0	0	- HOLD REJect
			1	0	0	0	1	- RETrieve
			1	0	0	1	1	- RETrieve ACKnowledge
			1	0	1	1	1	- RETrieve REJect
0	1	0	-	-	-	-	-	Call disengagement messages:
			0	0	1	0	1	- DISConnect
			0	1	1	0	1	- RELease
			1	1	0	1	0	- RELease COMplete
0	1	1	-	-	-	-	-	Miscellaneous messages:
			0	0	0	1	0	- FACility
			1	1	0	1	1	- INFOrmation
			0	1	1	1	0	- NOTIFY
			0	0	1	0	0	- REGister
			0	0	0	0	0	- SEGment
			1	1	1	0	1	- STATus
			1	0	1	0	1	- STATus ENQuiry
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**(Octet 2)**
1	-	-	-	-	-	-	-	Network-specific messages:
	1	1	1	1	0	1	1	- KEY HOLD
	1	1	1	1	1	0	0	- KEY RELease
	1	1	1	1	1	0	1	- KEY SETUP
	1	1	1	1	1	1	0	- KEY SETUP ACKnowledge
All other values are reserved								

4.1.3.2 Subsequent Information Elements

Other IEs follow the coding rules described in Tables 4.1.3-6 and 4.1.3-7. These rules are formulated to allow the terminal that processes a message to find IEs important to it, and yet remain ignorant of IEs that are not important to it.

Two categories of IEs are defined:

- Single octet information elements are defined in Table 4.1.3-6
- Variable-length information elements are defined in Table 4.1.3-7.

Table 4.1.3-6 — Information Element Format - Single Octet

8	7 6 5	4 3 2 1	
1	Information element identifier	Contents of information element	Octet 1

Table 4.1.3-7 — Information Element Format - Variable-Length

8	7 6 5 4 3 2 1	
0	Information element identifier	Octet 1
Length of information element (octets)		2
Contents of information element		3, etc.

The IEs are described in the following sections. Each IE has a particular order of appearance in a message, as indicated in "Message Content Definitions," Section 4.1.2. This order allows the receiving equipment to detect the presence or absence of a particular IE without scanning through an entire message.

In a message, the variable-length IEs, defined within ITU-T Recommendation Q.931 and Q.932, appear in ascending numerical order of the IE identifier value. If any network-specific IEs are included, the locking shift IE appears after the variable-length IEs defined within ITU-T Recommendation Q.931 and Q.932; the variable-length network-specific IEs then appear in ascending numerical order.

In the description of IEs, spare bits are set to "0." In the description of IEs having an extension bit (Ext), a "0" indicates the octet continues to the next octet, and a "1" indicates the octet is the last one in the extension domain.

A variable length information element's second octet indicates the total length of its contents. It represents the binary encoding of the number of octets (that is, the number of octets after Octet 2), with bit "1" as the least significant (2^0).

Table 4.1.3-8 summarizes the coding of the IE identifier bits for IEs defined in Codeset 0 (ITU-T Recommendation Q.931 and Q.932). Codeset 0 is the active codeset at the start of message-content analysis.

Table 4.1.3-8 — ITU-T Recommendation Q.931- and Q.932-Defined Information Element Identifier Coding (Codeset 0)

8	7	6	5	4	3	2	1	Information Element
1	:	:	:	-	-	-	-	***Single-octet information element***
1	0	0	1	0	X	X	X	Locking shift
1	0	0	1	1	X	X	X	Nonlocking shift
0	:	:	:	:	:	:	:	***Variable-length information elements***
	0	0	0	0	0	0	0	Segmented Message
	0	0	0	0	1	0	0	Bearer Capability
	0	0	0	1	0	0	0	Cause
	0	0	0	1	1	0	1	Extended Facility
	0	0	1	0	1	0	0	Call State
	0	0	1	1	0	0	0	Channel Identification
	0	0	1	1	1	0	0	Facility
	0	0	1	1	1	1	0	Progress Indicator
	0	1	0	0	1	1	1	Notification Indicator
	0	1	0	1	1	0	0	Keypad
	0	1	1	0	0	1	0	Information Request
	0	1	1	0	1	0	0	Signal
	0	1	1	1	0	0	0	Feature Activation
	0	1	1	1	0	0	1	Feature Indication
	0	1	1	1	0	1	0	Service Profile Identification
	0	1	1	1	0	1	1	Endpoint Identifier
	1	1	0	1	1	0	0	Calling Party Number
	1	1	0	1	1	0	1	Calling Party Subaddress
	1	1	1	0	0	0	0	Called Party Number
	1	1	1	0	0	0	1	Called Party Subaddress
	1	1	1	0	1	0	0	Redirecting Number
	1	1	1	0	1	1	0	Redirection Number
	1	1	1	1	0	0	0	Transit Network Selection
	1	1	1	1	1	0	0	Low-layer Compatibility
	1	1	1	1	1	0	1	High-layer Compatibility
All other values are reserved.								

4.1.3.2.1 Locking Shift

The locking shift information element, shown in Table 4.1.3-9, is used to shift to two codesets: the national-specific codeset (Codeset 5) or the network-specific codeset (Codeset 6). The locking shift procedure employs this information element to indicate the new active codeset. The specified codeset remains active until another locking shift information element is encountered.

Table 4.1.3-9 — Locking Shift Information Element

8	7	6	5	4	3	2	1	
1	0	0	1	0	Codeset			Octet 1
	Locking shift identifier							

- Codeset (Octet 1):

Bits 3	2	1	Meaning
1	0	1	National-specific codeset (Codeset 5)
1	1	0	Network-specific codeset (Codeset 6)

- National-specific codeset (Codeset 5):

Bits 8	7	6	5	4	3	2	1	Information Element
0	0	0	1	1	1	0	1	Operator system access
0	0	1	0	1	0	1	0	Display text

- Network-specific codeset (Codeset 6):

Bits 8	7	6	5	4	3	2	1	Information Element
0	1	1	1	1	0	1	1	Call appearance

4.1.3.2.2 Nonlocking Shift

The nonlocking shift information element, shown in Table 4.1.3-10, is used to shift to two codesets: the national-specific codeset (Codeset 5) or the network-specific codeset (Codeset 6). This nonlocking shift procedure is used to indicate the codeset to be used to interpret the next single IE. After the interpretation of the next single IE, the active codeset is again used.

Table 4.1.3-10 — Nonlocking Shift Information Element

8	7	6	5	4	3	2	1	
1	0	0	0	0	0	0	0	Octet 1
	Nonlocking shift identifier				Codeset			

- Codeset (Octet 1):

Bits 3	2	1	Meaning
1	0	1	National-specific codeset (Codeset 5)
1	1	0	Network-specific codeset (Codeset 6)

- National-specific codeset (Codeset 5):

8	7	6	5	4	3	2	1	Information Element
0	0	0	1	1	1	0	1	Operator System Access
0	0	1	0	1	0	1	0	Display Text

- Network-specific codeset (Codeset 6):

8	7	6	5	4	3	2	1	Information Element
0	1	1	1	1	0	1	1	Call appearance

4.1.3.2.3 Bearer Capability

The bearer capability information element, shown in Table 4.1.3-11, allows the calling terminal to request one of the bearer capabilities offered by the network and also allows the network to indicate to the called terminal the bearer capability of the incoming call.

Table 4.1.3-11 — Bearer Capability Information Element

8	7	6	5	4	3	2	1	
0	Bearer Capability 0	0	0	0	1	0	0 Information element identifier	Octet 1
Length of the bearer capability information element								2
1 Ext	0	0 Q.931 Standard	Information transfer capability					3
1 Ext	Transfer mode and rate							4
0/1 Ext	User information Layer 1 protocol							5[a]
1 Ext	0	0	Rate					5a[a]
1 Ext	User information Layer 2 protocol							6[b]
1 Ext	User information Layer 3 protocol							7[b]

Note(s):

a. Octets 5 and 5a may both be omitted. Octet 5a should be included under only certain circumstances when Octet 5 is included.

b. Octets 6 and 7 are included for only the packet mode.

- Information-transfer capability (Octet 3):

Bits 5	4	3	2	1	Meaning
0	0	0	0	0	Speech
0	1	0	0	0	unrestricted digital information
1	0	0	0	0	3.1 kHz audio

All other values are reserved.

- Transfer mode and rate (Octet 4):

Bits 7	6	5	4	3	2	1	Meaning
0	0	1	0	0	0	0	64 kbps, circuit mode
1	0	0	0	0	0	0	Packet mode

All other values are reserved.

- User information Layer 1 protocol (Octet 5):

Bits 7	6	5	4	3	2	1	Meaning
0	1	0	0	0	0	1	User Information Layer 1 - rate adaption
0	1	0	0	0	1	0	User Information Layer 1 - μ-law (Rec. G.711)

All other values are reserved.

- Rate (Octet 5a):

Bits 7	6	5	4	3	2	1	Meaning
0	0	0	1	1	1	1	Rate adaption from 56 kbps (Rec. I.463)

All other values are reserved.

When the encoding of the user information Layer 1 protocol in Octet 5 indicates rate adaption, Octet 5a is also included and communicates the rate. This rate adaption applies to circuit-mode transfer only.

- User information Layer 2 protocol (Octet 6):

Bits 7	6	5	4	3	2	1	Meaning
1	0	0	0	0	1	0	LAPD (Recommendation Q.921/I.441)
1	0	0	0	1	1	0	LAPB (Recommendation X.25, link level)

- User information Layer 3 protocol (Octet 7):

Bits 7	6	5	4	3	2	1	Meaning
1	1	0	0	1	1	0	Recommendation X.25, packet level

A. *Codings at the Originating Interface*

The bearer capability information element is coded for each bearer capability:

- Speech, circuit-mode
  - — Information transfer capability = speech
  - — Transfer mode and rate = 64-kbps, circuit-mode
  - — User information layer protocol = μ-law
  - — Octets 5a, 6, and 7 not present.
- 3.1-kHz audio, circuit-mode
  - — Information transfer capability = 3.1-kHz audio
  - — Transfer mode and rate = 64-kbps, circuit-mode
  - — User information Layer 1 protocol = μ-law
  - — Octets 5a, 6, and 7 not present.
- 64-kbps, unrestricted digital information, circuit-mode
  - — Information transfer capability = unrestricted digital information
  - — Transfer mode and rate = 64-kbps, circuit-mode
  - — Octets 5, 5a, 6, and 7 not present.
- 64-kbps, unrestricted digital information, circuit-mode, rate adapted from 56-kbps
  - — Information transfer capability = unrestricted digital information
  - — Transfer mode and rate = 64-kbps, circuit-mode
  - — User information Layer 1 protocol = user information layer 1 - rate adaption
  - — Rate = 56 kbps
  - — Octets 6 and 7 not present.
- Unrestricted digital information, packet-mode
  - — Information transfer capability = unrestricted digital information
  - — Transfer mode and rate = packet-mode
  - — User information Layer 2 protocol = [link access procedures on the D-channel (LAPD), if channel indicated is D-channel] or [link access procedures - balanced (LAPB), if channel indicated is B-channel]
  - — User information Layer 3 protocol = X.25, packet level
  - — Octet 5 and 5a not present.

B. *Codings at the Destination Interface*

The coding of the bearer capability IE at the terminating interface is identical to those described previously for originating interfaces.

4.1.3.2.4 Call State

The call state information element, shown in Table 4.1.3-12, describes the current status of a call and is included only in the STATus message. See SDLs for more information.

Table 4.1.3-12 — Call State Information Element

8	7	6	5	4	3	2	1	
Call State								
0	0	0	1	0	1	0	0	Octet 1
Information element identifier								
0	0	0	0	0	0	0	1	
Length of Call State Contents								2
0	0	Call State Value						3

- Call State Value (Octet 3): The call state values are shown in Table 4.1.3-13.

Table 4.1.3-13 — Call State Values

BITS 6 5 4 3 2 1	VALUE	MEANING
0 0 0 0 0 0	0.	Null
0 0 0 0 0 1	1.	Call Initiated
0 0 0 0 1 0	2.	Overlap Sending
0 0 0 0 1 1	3.	Outgoing Call Proceeding
0 0 0 1 0 0	4.	Call Delivered
0 0 0 1 1 0	6.	Call Present
0 0 0 1 1 1	7.	Call Received
0 0 1 0 0 0	8.	Connect Request
0 0 1 0 0 1	9.	Incoming Call Proceeding
0 0 1 0 1 0	10.	Active
0 0 1 0 1 1	11.	Disconnect Request
0 0 1 1 0 0	12.	Disconnect Indication
0 1 0 0 1 1	19.	Release Request

4.1.3.2.5 Called Party Number

The called party number information element, shown in Table 4.1.3-14, identifies the destination of a call for routing.

Table 4.1.3-14 — Called Party Number Information Element

8	7	6	5	4	3	2	1	
0	Called Party Number 1 1 1 0 0 0 0 Information element identifier							Octet 1
Length of called party number information								2
1 Ext	Type of number and numbering plan identification							3
0 Spare	Digits (IA5 Characters)							4, etc.

- Type of number and numbering plan (Octet 3):

Bits 7	6	5	4	3	2	1	Meaning
0	0	0	0	0	0	0	Unknown number in Unknown numbering plan (see Note)
0	0	1	0	0	0	1	International number in ISDN numbering plan (Rec. E.164)
0	1	0	0	0	0	1	National number in ISDN numbering plan (Rec. E.164)
0	1	1	1	0	0	1	Network-specific number in private numbering plan
1	0	0	0	0	0	1	Local (directory) number in ISDN numbering plan (Rec. E.164)
1	1	0	1	0	0	1	Abbreviated number in private numbering plan

All other values are reserved.

Note: When this codepoint is used:

— The number digits beginning in Octet 4 can provide the same information as is supported in the keypad information element.

— The called party number is provided enbloc.

— This information element is not to be used in combination with the keypad, operator system access or transit network selection information elements.

— This information is always considered to be complete and unambiguous; for example, if the information is not a valid dial access code or DN, the switch will provide the appropriate error treatment.

- Digits (Octets 4, etc.):

Bits 7 6 5 4 3 2 1	Meaning
0 1 0 0 0 1 1	#
0 1 0 1 0 1 0	*
0 1 1 0 0 0 0	0
0 1 1 0 0 0 1	1
0 1 1 0 0 1 0	2
0 1 1 0 0 1 1	3
0 1 1 0 1 0 0	4
0 1 1 0 1 0 1	5
0 1 1 0 1 1 0	6
0 1 1 0 1 1 1	7
0 1 1 1 0 0 0	8
0 1 1 1 0 0 1	9

All other values are reserved.

The "*" and "#" can be used with only the "Unknown Number in unknown numbering plan" codepoint.

A. *Codings at the Originating Interface*

When the terminal uses the "International number in ISDN numbering plan" codepoint, the terminal shall include no fewer than 6 digits and no more than 15 digits in the digits field.

When the terminal uses the "National number in ISDN numbering plan" codepoint, the terminal shall include 10 digits in the digits field, unless an N11 code is included.

When the terminal uses the "Local (directory) number in the ISDN numbering plan" codepoint, the terminal shall include 7 digits in the digits field, unless an N11 code is included.

4.1.3.2.6 Called Party Subaddress

The called party subaddress information element, shown in Table 4.1.3-15, identifies a subaddress associated with the called terminal.

Table 4.1.3-15 — Called Party Subaddress Information Element

8	7	6	5	4	3	2	1		
0	Called Party Subaddress 1	1	1	0	0	0	1 Information element identifier	Octet	1
Length of called party subaddress information									2
1 Ext	Type of Subaddress			odd/even indicator	0	0	0 Spare		3
Subaddress information									4, etc.

- Type of subaddress (Octet 3):

Bits			
7	**6**	**5**	**Meaning**
0	0	0	NSAP (X.213/ISO 8348 AD2)
0	1	0	User Specified
0	0	1	Reserved
0	1	1	Reserved

- Odd/even indicator (Octet 3):

Bit	
4	**Meaning**
0	Even number of digits in subaddress
1	Odd number of digits in subaddress

A. *Codings at the Originating Interface*

The called party subaddress IE can be included in a SETUP message.

B. *Codings at the Destination Interface*

The called party subaddress IE may be included in a SETUP message.

4.1.3.2.7 Calling Party Number

The calling party number information element, shown in Table 4.1.3-16, identifies the origin of a call.

Table 4.1.3-16 — Calling Party Number Information Element

8	7	6	5	4	3	2	1		
0	Calling Party Number 1	1	0	1	1	0	0 Information element identifier	Octet	1
Length of calling party number information									2
0/1 Ext	Type of number and numbering plan identification								3
1 Ext	Origin of number and presentation status								3a*
0 Spare	Digits (IA5 Characters)								4, etc.*

* This octet may be omitted in some cases.

- Type of number and numbering plan (Octet 3):

Bits 7	6	5	4	3	2	1	Meaning
0	0	0	0	0	0	0	Unknown number in unknown numbering plan
0	0	1	0	0	0	1	International number in ISDN numbering plan (Rec. E.164)
0	1	0	0	0	0	1	National number in ISDN numbering plan (Rec. E.164)
1	0	0	0	0	0	1	Local (directory) number in ISDN numbering plan (Rec. E.164)
1	0	0	1	0	0	1	Local number in private numbering plan
1	1	0	1	0	0	1	Abbreviated number in private numbering plan

All other values are reserved.

- Origin of number and presentation status (Octet 3a):

Bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
0	0	0	0	0	0	0	Presentation allowed of user-provided number, number not screened.
0	0	0	0	0	0	1	Presentation allowed of user-provided number, number passed network screening.
0	0	0	0	0	1	0	Presentation allowed of user-provided number, number failed network screening
0	0	0	0	0	1	1	Presentation allowed of network-provided number
0	1	0	0	0	0	0	Presentation prohibited of user-provided number, number not screened
0	1	0	0	0	0	1	Presentation prohibited of user-provided number, number passed network screening
0	1	0	0	0	1	0	Presentation prohibited of user-provided number, number failed network screening
0	1	0	0	0	1	1	Presentation prohibited of network-provided number
1	0	0	0	0	1	1	Number not available due to interworking

All other values are reserved.

- Digits (Octets 4, etc.):

  Digits are represented by IA5 characters, whose encoding is shown as follows:

Bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
0	1	1	0	0	0	0	0
0	1	1	0	0	0	1	1
0	1	1	0	0	1	0	2
0	1	1	0	0	1	1	3
0	1	1	0	1	0	0	4
0	1	1	0	1	0	1	5
0	1	1	0	1	1	0	6
0	1	1	0	1	1	1	7
0	1	1	1	0	0	0	8
0	1	1	1	0	0	1	9

All other values are reserved.

A. *Codings at the Originating Interface*

The type of number and numbering plan is coded as either "local (directory) number in the ISDN numbering plan," with the digits field containing a 7-digit local number or "national number in the ISDN numbering plan" with the digits field containing a 10-digit national number. If Octet 3a is included, Octet 3a is coded as "presentation allowed of user provided number, number not screened" or "presentation prohibited of user provided number, number not screened."

B. *Codings at the Destination Interface*

The type of number and numbering plan is one of the following:

- "Unknown number in unknown numbering plan"
- "International number in ISDN numbering plan"
- "International number in data numbering plan (ITU-T Recommendation X.121)"
- "National number in ISDN numbering plan"
- "National number in data numbering plan"
- "Network-specific number in data numbering plan."

The Stored Program Control System (SPCS) will include the origin of number and presentation status (Octet 3a).

The SPCS will not include digits if the presentation of the number is prohibited or if the number is not available due to interworking.

4.1.3.2.8 Calling Party Subaddress

The calling party subaddress information element, shown in Table 4.1.3-17, identifies a subaddress associated with the origin of a call.

Table 4.1.3-17 — Calling Party Subaddress Information Element

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th><th></th></tr>
<tr><td rowspan="3">0</td><td colspan="7">Calling Party Subaddress</td><td rowspan="3">Octet</td><td rowspan="3">1</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td colspan="7">Information element identifier</td></tr>
<tr><td colspan="8">Length of called party subaddress information</td><td></td><td>2</td></tr>
<tr><td>1Ext</td><td colspan="2">Type of
Subaddress</td><td colspan="2">odd/even
indicator</td><td>0</td><td>0</td><td>0</td><td></td><td>3</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="3">Spare</td><td></td><td></td></tr>
<tr><td colspan="8">Subaddress information</td><td></td><td>4, etc.</td></tr>
</table>

- Type of subaddress (Octet 3):

Bits

7	6	5	Meaning
0	0	0	NSAP (X.213/ISO 8348 AD2)
0	1	0	User Specified

All other values are reserved.

- Odd/even indicator (Octet 3):

Bit 4	Meaning
0	Even number of digits in subaddress
1	Odd number of digits in subaddress

4.1.3.2.9 Cause

The cause information element, shown in Table 4.1.3-18, describes the reason for generating certain messages, provides diagnostic information in the event of procedural errors, and indicates the location of the cause originator. Diagnostic information is not available for every cause. The cause IE and diagnostic may be repeated in a message to report multiple errors associated with a single call.

Table 4.1.3-18 — Cause Information Element

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td rowspan="3">0</td><td colspan="7">Cause</td><td rowspan="3">Octet 1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="7">Information element identifier</td></tr>
<tr><td colspan="8">Length of cause information element</td><td>2</td></tr>
<tr><td>1 Ext</td><td colspan="2">Coding standard</td><td>0</td><td colspan="4">General location</td><td>3</td></tr>
<tr><td rowspan="2">1 Ext</td><td colspan="7">Cause value</td><td rowspan="2">4</td></tr>
<tr><td colspan="3">(class)</td><td colspan="4">(Value in class)</td></tr>
<tr><td colspan="8">Diagnostics</td><td>5, etc.*</td></tr>
</table>

* This octet may be omitted.

- Coding standard (Octet 3):

Bits 7	6	Meaning
0	0	ITU-TS-standard
1	0	National-Specific
1	1	Network-specific

All other values are reserved.

- General location (Octet 3):

Bits				
4	**3**	**2**	**1**	**Meaning**
0	0	0	0	user
0	0	0	1	private network serving local user
0	0	1	0	public network serving local user
0	0	1	1	transit network
0	1	0	0	public network serving remote user
0	1	0	1	private network serving remote user
0	1	1	1	international network
1	0	1	0	network beyond interworking point

All other values are reserved.

- Cause value (Octet 4):

  The cause value consists of two fields: a class (Bits 5 through 7), indicating the general nature of the event, and a value within the class (Bits 1 through 4).

  — Cause Classes

Bits			
7	**6**	**5**	**Meaning**
0	0	0	normal event
0	0	1	normal event
0	1	0	network congestion
0	1	1	service or option not available
1	0	0	service or option not implemented
1	0	1	invalid message (for example, parameter out of range)
1	1	0	protocol error (for example, unknown message)
1	1	1	interworking

The ITU-TS-standardized and network-specific cause values are shown in Tables 4.1.3-19 and 4.1.3-20.

Table 4.1.3-19 — ITU-TS-Standardized Cause Values

CAUSE VALUE BITS 7 6 5	4 3 2 1	CAUSE #	CAUSE	DIAGNOSTIC
0 0 0	0 0 0 1	1.	Unallocated (unassigned) number	None
0 0 0	0 0 1 0	2.	No route to specified transit network	None
0 0 0	0 0 1 1	3.	No route to dest.	None
0 0 0	0 1 1 0	6.	Channel unacceptable	None
0 0 0	0 1 1 1	7.	Call awarded and being delivered in an established channel	None
0 0 1	0 0 0 0	16.	Normal clearing	None
0 0 1	0 0 0 1	17.	User busy	None
0 0 1	0 0 1 0	18.	No user responding	None
0 0 1	0 0 1 1	19.	User alerting, no answer	None
0 0 1	0 1 0 1	21.	Call Rejected	None
0 0 1	1 0 1 1	27.	Destination out of order	None
0 0 1	1 1 0 0	28.	Invalid number format (incomplete address)	None
0 0 1	1 1 0 1	29.	Facility rejected	None
0 0 1	1 1 1 0	30.	Response to STATus ENQuiry	None
0 1 0	0 0 1 0	34.	Circuit/Channel Congestion	None
0 1 0	1 0 0 1	41.	Temporary failure	None
0 1 0	1 0 1 0	42.	Switching equipment congestion	None
0 1 0	1 0 1 1	43.	Access information discarded	Info element identifier
0 1 0	1 1 0 0	44.	Requested channel not available	None
0 1 1	0 0 1 0	50.	Requested facility not subscribed	None
0 1 1	1 0 0 1	57.	Bearer capability not authorized	None
0 1 1	1 1 1 1	63.	Service or option not available, unspecified	None
1 0 0	0 0 0 1	65.	Bearer capability not implemented	None
1 0 0	0 1 0 1	69.	Requested facility not implemented	None
1 0 1	0 0 0 1	81.	Invalid call reference value	None
1 0 1	1 0 0 0	88.	Incompatible destination	None
1 1 0	0 0 0 0	96.	Mandatory information element is missing	Identifier
1 1 0	0 0 0 1	97.	Message type nonexistent or not implemented	None
1 1 0	0 0 1 1	99.	Information element nonexistent or not implemented	Info element identifier
1 1 0	0 1 0 0	100.	Invalid information element contents	Info element identifier
1 1 0	0 1 0 1	101.	Message not compatible with call state	None

Table 4.1.3-19 — ITU-TS-Standardized Cause Values (Contd)

CAUSE VALUE BITS 7 6 5	4 3 2 1	CAUSE #	CAUSE	DIAGNOSTIC
1 1 0	0 1 1 0	102.	Recovery of timer expiry	None
1 1 0	1 1 1 1	111.	Protocol error, unspecified	None
1 1 1	1 1 1 1	127.	Interworking, unspecified	None

Table 4.1.3-20 — Network-Specific Cause Values

CAUSE VALUE BITS 7 6 5	4 3 2 1	CAUSE #	CAUSE	DIAGNOSTIC
0 0 0	1 0 0 0	8.	Call is proceeding	None
0 0 0	1 1 0 1	13.	Service denied	None
0 0 1	1 1 0 0	28.	Special intercept announcement	None
0 0 1	1 1 0 1	29.	Special intercept announcement undefined code	None
0 0 1	1 1 1 0	30.	Special intercept announcement number unassigned	None
0 0 1	1 1 1 1	31.	Special intercept announcement call blocked due to group restriction	None
0 1 0	0 0 1 1	35.[a]	Call is queued	None
0 1 1	0 0 1 1	51.	Call type incompatible with service request	None
0 1 1	0 1 0 1	53.	Service operation violated	Long-term denial, short-term denial

Note(s):

a. Although the Cause class for this Cause value is "Resource unavailable," this value does not imply that the call should be cleared. See "Queuing Treatment," Section 4.2.1.6.3.5.

- Diagnostics (Octet 5):

  Where the diagnostic indicates an "information element identifier" (or "identifier" as given for Cause 96), the diagnostic contains the information element identifier value. Where the diagnostic indicates "Long-term denial" or "short-term denial," the following codings are used:

Bits 8 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 0 0	Short-term denial
0 0 0 0 0 0 0 1	Long-term denial

All other values are reserved

4.1.3.2.10 Channel Identification

The channel identifier information element, shown in Table 4.1.3-21, identifies a channel within an ISDN interface.

Table 4.1.3-21 — Channel Identification Information Element

8	7	6	5	4	3	2	1	
0	Channel identification 0	0	1	1	0	0	0 Information element identifier	Octet 1
0	0	0	0	0	0	0	1 Length of channel identification	2
1	Int ID	Int Type	0 Spare	Pref/ Excl	D chan Ind	Channel Selection Information		3

- Extension bit (Octet 3):

Bit 8	Meaning
1	Last octet.

- Interface identifier present (Octet 3):

Bit 7	Meaning
0	Interface is implicitly identified as the interface that includes the D-channel carrying the information element.

- Interface type (Octet 3):

Bit 6	Meaning
0	Basic Access Interface

- Preferred/Exclusive (Octet 3):

Bit 4	Meaning
0	Indicated channel is preferred
1	Exclusive B-channel is indicated; D-channel may be used if indicated by Bit 3.

- D-channel indicator (Octet 3):

Bit 3	Meaning
0	D-channel not indicated
1	D-channel indicated

The D-channel indicator is set to "0" for circuit-mode calls and set to either "0" or "1" for packet-mode calls.

- Channel-selection information (Octet 3):

Bit 2	1	Meaning
0	0	No B-channel indicated
0	1	B1 on Basic Access interface
1	0	B2 on Basic Access interface
1	1	Any channel

4.1.3.2.11 Display Text

This section defines display tags that are not supported on multiple vendor switches for NI-1.

"Display Text," Section 4.1.3.3.1, defines the coding of the display text IE that is supported as part of NI-1.

A. Display Text Tags (F)

Bits								
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
1	0	0	0	1	1	0	1	Calling party name
1	0	0	0	1	1	1	0	Called party name
1	0	0	0	1	1	1	1	Original call name
1	0	0	1	0	0	0	0	Redirecting name
1	0	0	1	0	0	0	1	Connected name
1	0	0	1	0	0	1	0	Originating restrictions
1	0	0	1	0	0	1	1	Date & Time of day
1	0	0	1	0	1	1	0	Redirection name
1	0	0	1	1	0	0	0	Redirecting number
1	0	0	1	1	0	0	1	Original called number
1	0	0	1	1	0	1	0	Connected number
1	0	0	1	1	1	1	0	Text

All other values are reserved.

The following list contains definitions for each of the display text tags listed.

1. Calling party name: This tag indicates ASCII text regarding the calling party's name.
2. Called party name: This tag indicates ASCII text regarding the called party's name.
3. Original called name: This tag indicates ASCII text regarding the original called party's name (that is, first redirecting name).
4. Redirecting name: This tag indicates ASCII text regarding the last redirecting name.
5. Connected name: This tag indicates ASCII information regarding the name of the connected to party.
6. Originating restrictions: This tag indicates ASCII text regarding restricting conditions that may apply to the calling party.
7. Date & time of day: This tag indicates ASCII text in form mm-dd-hh:mm am (or pm).
8. Redirection name: This tag indicates ASCII text regarding the redirection party's name.
9. Redirecting number: This tag indicates ASCII text regarding the redirecting number.
10. Original called number: This tag indicates ASCII text regarding the original call number.
11. Connected number: This tag indicates ASCII text regarding the connected number.
12. Text: This tag indicates ASCII text that does not have a specific display text tag.

B. Optional Control Tags (F)

The general coding of optional control tags is shown in Table 4.1.3-22.

Table 4.1.3-22 — General Coding of Optional Control Tags (F)

8	7	6	5	4	3	2	1
1	0	0/1	1	1	1	1	1
1/0	1	X	X	X	X	X	X
Extension bit	Optional Control Tag Identifier						

Bit 7 of the second octet of the optional control tag identifier is set to 1 to indicate that this tag is an optional control tag. Bit 7 of any following octets in an optional control tag is assignable to a particular optional control tag. The 0 or 1 value in Bit 6 of the first octet of the optional control tag identifier allowed in optional control tags refers to a primitive or constructor data structure as described in Section III.2.3 of Appendix III of *ANSI*[1] T1.610-1990. For example, a 3-octet optional control tag would appear as shown in Table 4.1.3-23.

Table 4.1.3-23 — 3-Octet Optional Control Tag

8	7	6	5	4	3	2	1
1	0	0/1	1	1	1	1	1
0	1	X	X	X	X	X	X
	Optional Control Tag Identifier						
1	X	X	X	X	X	X	X
	Optional Control Tag Identifier (continued)						

The *reverse video, blink, and normal rendition* optional control tags are coded as shown in Table 4.1.3-24.

1. Registered trademark of American National Standards Institute.

Table 4.1.3-24 — Coding of Reverse Video, Blink, and Normal Rendition Optional Control Tags

OPTIONAL CONTROL TAGS	BITS 8 7 6 5 4 3 2 1
Reverse Video	1 0 0 1 1 1 1 1
	0 1 0 0 0 0 0 1
Length	0 0 0 0 0 0 0 0
Blink	1 0 0 1 1 1 1 1
	0 1 0 0 0 0 1 0
Length	0 0 0 0 0 0 0 0
Normal Rendition	1 0 0 1 1 1 1 1
	0 1 0 0 0 0 1 1
Length	0 0 0 0 0 0 0 0

4.1.3.2.12 Endpoint Identifier

The SPCS sends this information element to the terminal to support terminal selection on call termination for some services and to provide terminal selection parameters as part of terminal initialization. No EID is generated for or sent to a Non-Initializing Terminal. See Table 4.1.3-25.

Table 4.1.3-25 — Endpoint Identifier Information Element

8	7	6	5	4	3	2	1	
Endpoint identifier 0 0 1 1 1 0 1 1 Information element identifier								Octet 1
Length of endpoint identifier contents								2
1 Ext	User Service IDentifier							3
1 Ext	Interpreter		Terminal IDentifier					4[a]

Note(s):
a. This octet is optional.

- User Service Identifier: The user service identifier (USID) is a selection parameter that identifies all terminals on an interface that have been initialized, that are associated with a user service order profile (USOP), and that may be addressed together. This parameter may have values from 0 to 127. The value 127 is a reserved value, coded as all "1"s (=127), to select all initialized terminals on a standard interface. When used in the initialization procedure, this parameter should contain a value from 0 to 126, which is assigned by the switch on a given interface and is uniquely associated with the identified USOP. When used in message broadcast (at Layer 2) on the standard interface to select the terminals that are associated with a specified USOP, this parameter should be coded with the USID value that corresponds to that USOP on the interface. When the USID is coded as 127, Octet 4 is not used and may be omitted. A USID will be unique per terminal per interface (that is, terminals cannot share USOPs). For successfully initialized terminals, the USID will have a value from 0 to 7.

- Terminal Identifier: The terminal identifier (TID) is a selection parameter that identifies a single terminal. It may have values from 0 to 62 that differ from the prestandard range of 0-127. The TID value, to be in the range of 00-62, is assigned by the user and forms the last two digits of the SPID entered into the terminal. This same TID value is sent by the switch to the terminal as part of the EID during initialization. The TID value of 63 is used to address all terminals on the interface that share the same USOP. To identify a particular terminal, the TID should be coded with the value assigned to that terminal at initialization.
- Interpreter: The interpreter bit indicates how the TID field is to be interpreted.

Bit 7	Meaning
0	Terminal is selected if it is assigned the indicated TID and USID value.
1	Terminal is selected if it is not assigned the indicated TID bit, but is assigned the indicated USID value.

4.1.3.2.13 Feature Activation

The feature activation information element, shown in Table 4.1.3-26, is used by an initialized terminal to request control of a feature. It will not be accepted from a Non-Initializing Terminal.

Table 4.1.3-26 — Feature Activation Information Element

8	7	6	5	4	3	2	1	
Feature activation								
0	0	1	1	1	0	0	0	Octet 1
Information element identifier								
Length of feature activation information								
0/1 Ext	Feature identifier							3
1 Ext	Feature identifier continuation, if needed							3a

* This octet may be omitted.

- The terminal shall code the feature identifier value as the binary coding of a decimal number in the range from 1 to 254. The values of 1 to 127 are coded in one octet, and the values 128 to 254 are coded in two octets.

4.1.3.2.14 Feature Indication

The feature indication information element, shown in Table 4.1.3-27, is used to inform an initialized terminal about the current status of the feature identified. This information element may be repeated in a message if the status changes for multiple features.

Table 4.1.3-27 — Feature Indication Information Element

8	7	6	5	4	3	2	1	
Feature indication								
0	0	1	1	1	0	0	1	Octet 1
Information element identifier								
Length of feature indication information								2
0/1 Ext.	Feature identifier							3
1 Ext.	Feature identifier continuation, if needed							3a[a]
0	0	0	0	Feature status				4
Spare								

Note(s):

a. This octet may be omitted

- The SPCS will (F) code the feature identifier value as the binary coding of a decimal number in the range from 1 to 254. The values of 1 to 127 are coded in one octet, and the values 128 to 254 are coded in two octets.
- Feature Status: The bit meaning for the feature status is shown as follows:

Bits 4	3	2	1	Meaning
0	0	0	0	Idle
0	0	0	1	Active
0	0	1	0	Prompt
0	0	1	1	Pending

All other values are reserved.

4.1.3.2.15 High-Layer Compatibility

The high-layer compatibility information element, shown in Table 4.1.3-28, provides a means to the called terminal for compatibility checking. This information is not interpreted by the network, but is carried transparently and delivered to the called terminal during call establishment.

The SPCS ensures that the maximum allowed length of the high-layer compatibility information element, 5 octets, is not exceeded.

The information on coding contained in this section has been replicated from Section 4.5.16 of ITU-T Recommendation Q.931, as amended by ITU-TS Study Group XI Temporary Document 641-E, *Proposed Amendments to Q.931*. This information is included here for the convenience of the reader.

The contents and structure of the high-layer compatibility information element are shown in Table 4.1.3-28.

Table 4.1.3-28 — High-Layer Compatibility Information Element

Bits 8	7	6	5	4	3	2	1	Octets
0	High-layer compatibility 1	1	1	1	1	0	1 Information element identifier	1
Length of high-layer compatibility contents								2
1 Ext	Coding standard		Interpretation			Presentation method of protocol profile		3
0/1 ext	High-layer characteristics identification							4
1 ext	Extended high-layer characteristics identification							4a

Note: This octet can be present when Octet 4 indicates maintenance or management.

- Coding standard (Octet 3)

Bits 7	6	Meaning
0	0	ITU-TS standardized coding, as described in the following paragraph
0	1	Reserved for other international standards (Note)
1	0	National standard (Note)
1	1	Standard defined for the network (either public or private) present at the network side of the interface (Note)

Note: These other coding standards are used when the desired high-layer compatibility cannot be represented with the ITU-TS standardized coding.

- Interpretation (Octet 3)

Bits 5	4	3	Meaning
1	0	0	First (primary or only) high layer characteristics identification (in Octet 4) to be used in the call.

All other values are reserved.

"Interpretation" indicates how the "High layer characteristic identification" (in Octet 4) is interpreted. Currently, "Interpretation" has only a single value. However, ITU-TS Study Group XI has noted that the following enhancements to the high-layer compatibility information element are for further study:

- Allowing the high-layer compatibility information element to contain multiple "high-layer characteristics identifications" and the procedures to handle multiple codings of this field (for example, sequential usage, alternative list, simultaneous usage)
- High-layer compatibility negotiation procedures

- Presentation method of protocol profile (Octet 3)

Bits		
2	**1**	**Meaning**
0	1	High-layer protocol profile (w/o specification of attributes)

All other values are reserved.

Currently, "Presentation method of protocol profile" has only a single value, that is, a "profile value" is used to indicate a service to be supported by high-layer protocols as required. ITU-TS Study Group XI has noted that the necessity of other presentations methods, for example, service indications in the form of layer-by-layer indication of protocols to be used in high-layers, is left for further study.

- High-Layer Characteristics Identification (Octet 4)

Bits 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 1	Telephony
0 0 0 0 1 0 0	Facsimile Group 2/3 (Recommendation F.182)
0 1 0 0 0 0 1	Facsimile Group 4 Class I (Recommendation F.184)
0 1 0 0 1 0 0	Teletex service, basic and mixed mode of operation (Recommendation F.230) and facsimile service Group 4, Classes II and III (Recommendation F.184)
0 1 0 1 0 0 0	Teletex service, basic and processable mode of operation (Recommendation F.220)
0 1 1 0 0 0 1	Teletex service, basic mode of operation (Recommendation F.200)
0 1 1 0 0 1 0	Syntax based Videotex (Recommendations F.300 and T.102) (Note 1)
0 1 1 0 0 1 1	International Videotex interworking through gateways or interworking units (Recommendations F.300 and T.101)
0 1 1 0 1 0 1	Teletex Service (Recommendation F.60)
0 1 1 1 0 0 0	Message Handling Systems (MHS) (Recommendation X.400 series)
1 0 0 0 0 0 1	OSI application (Note 2) (Recommendation X.200 series)
1 0 1 1 1 1 0	Reserved for maintenance (Note 3)
1 0 1 1 1 1 1	Reserved for management (Note 3)
1 1 0 0 0 0 0	Audio visual (Recommendation F.721)
1 1 0 0 0 0 1 through 1 1 0 1 1 1 1	Reserved for audio visual services (Recommendation F.700 series)
1 1 1 1 1 1 1	Reserved

All other values reserved.

Note 1: This is applicable to both terminal to videotex functions and videotex function communications (where a videotex function is either a videotex access point or a videotex data base or server).

Note 2: Further compatibility checking is executed by the OSI high-layer protocol.

Note 3: When this coding is included, Octet 4 may be followed by Octet 4a.

The coding in the high-layer characteristics identification (Octet 4) applies in the case of "Coding standard" = "ITU-TS standard" and "Presentation method of protocol profile" = "High layer protocol profile." Codepoints are added only for those services for which ITU-T Recommendations are available. See also Recommendation I.241. Extended high-layer characteristics identification (Octet 4a)

Bits 7	6	5	4	3	2	1	Meaning
0	0	0	0	0	0	1	Telephony
0	0	0	0	1	0	0	Facsimile Group 2/3 (Recomm. F.182)
0	1	0	0	0	0	1	Facsimile Group 4 Class I (Recomm. F.184)
0	1	0	0	1	0	0	Teletex service, basic and mixed mode of operation (Recomm. F.230) and facsimile service Group 4, Classes II and III (Recomm. F.184)
0	1	0	1	0	0	0	Teletex service, basic and processable mode of operation (Recomm. F.220)
0	1	1	0	0	0	1	Teletex service, basic mode of operation (Recomm. F.200)
0	1	1	0	0	1	0	Syntax based Videotex (Recomm. F.300 and T.102) (Note 1)
0	1	1	0	0	1	1	International Videotex interworking through gateways or interworking units (Recomm. F.300 and T.101)
0	1	1	0	1	0	1	Telex service (Recomm. F.60)
0	1	1	1	0	0	0	Message Handling Systems (MHS) (Recomm. X.400 series)
1	0	0	0	0	0	1	OSI application (Note 2) (Recomm. X.200 series)
1	0	1	1	1	1	0	Not available for assignment
1	0	1	1	1	1	1	Not available for assignment
1	1	0	0	0	0	0	Audio visual (Recomm. F.721)
1	1	0	0	0	0	1	
through							
1	1	0	1	1	1	1	Reserved for audio visual services (Recomm. F.700 series)
1	1	1	1	1	1	1	Reserved

All other values are reserved.

Note 1: This is applicable to both terminal to videotex functions and videotex function communications (where a videotex function is either a videotex access point or a videotex data base or server).

Note 2: Further compatibility checking is executed by the OSI high-layer protocol.

4.1.3.2.16 Information Request

The information request information element, shown in Table 4.1.3-29, is used to request additional information from the terminal and to indicate that the information has been received.

Table 4.1.3-29 — Information Request Information Element

8	7	6	5	4	3	2	1	
	Information request							
0	0	1	1	0	0	1	0	Octet 1
	Information element identifier							
0	0	0	0	0	0	0	1	2
Length of information request contents								
1	Info. Req. Ind.	Type of information						3

- Information Request Indicator (Octet 3, Bit 7):

Bit 7	Meaning
0	Information request completed
1	Prompt for additional information

- Type of Information (Octet 3, Bits 1-6):

6	5	4	3	2	1	Meaning
0	0	0	0	0	0	undefined
0	0	0	0	0	1	authorization code
0	0	0	0	1	0	address digits
0	0	0	0	1	1	terminal identification

All other values reserved.

4.1.3.2.17 Keypad

The keypad information element, shown in Table 4.1.3-30, conveys address information by means of IA5 characters.

Table 4.1.3-30 — Keypad Information Element

8	7	6	5	4	3	2	1	
Keypad								
0	0	1	0	1	1	0	0	Octet 1
Information element identifier								
Length of keypad information								2
0 Spare	Keypad information (IA5 Characters)							3, etc.

- Keypad information (Octet 3): Keypad information is coded as IA5 characters, which are coded as follows:

Bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
0	1	1	0	0	0	0	0
0	1	1	0	0	0	1	1
0	1	1	0	0	1	0	2
0	1	1	0	0	1	1	3
0	1	1	0	1	0	0	4
0	1	1	0	1	0	1	5
0	1	1	0	1	1	0	6
0	1	1	0	1	1	1	7
0	1	1	1	0	0	0	8
0	1	1	1	0	0	1	9
0	1	0	1	0	1	0	*
0	1	0	0	0	1	1	#

All other values are reserved.

4.1.3.2.18 Low-Layer Compatibility

The low-layer compatibility information element, shown in Table 4.1.3-31, provides a means to the called terminal for compatibility checking. This information is not interpreted by the network, but is carried transparently and delivered to the called terminal during call establishment.

The switch ensures that the maximum allowed length of the low-layer compatibility information element, 16 octets, is not exceeded.

The contents and structure of the low-layer compatibility information element are shown as follows. The switch does not inspect the contents of the low-layer compatibility information element; it accepts all codings of the following fields.

Note: The information on coding contained in this section has been replicated from Section 4.5.18 of ITU-T Recommendation Q.931, as amended by ITU-TS Study Group XI Temporary Document 641-E, *Proposed Amendments to Q.931*. This information is included here for the convenience of the reader.

Table 4.1.3-31 — Low-Layer Compatibility Information Element

<table>
<tr><td colspan="8">Bits</td><td></td></tr>
<tr><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td></td></tr>
<tr><td>0</td><td colspan="7">Low-layer compatibility
1 1 1 1 1 0 0
information element identifier</td><td>Octet
1</td></tr>
<tr><td colspan="8">Length of the low-layer compatibility contents</td><td>2</td></tr>
<tr><td>0/1 ext</td><td colspan="2">coding standard</td><td colspan="5">information transfer capability</td><td>3</td></tr>
<tr><td>1 ext.</td><td>Negot. indic.</td><td colspan="6">0 0 0 0 0 0
spare</td><td>3a</td></tr>
<tr><td>0/1 ext.</td><td colspan="2">transfer mode</td><td colspan="5">information transfer rate</td><td>4</td></tr>
<tr><td>1 ext</td><td colspan="7">rate multiplier</td><td>4.1[a]</td></tr>
<tr><td>0/1 ext</td><td>0 Layer 1</td><td>1 ident</td><td colspan="5">user information Layer 1 protocol</td><td>5</td></tr>
<tr><td>0/1 ext</td><td>synch/ async</td><td>negot.</td><td colspan="5">user rate</td><td>5a[b]</td></tr>
<tr><td>0/1 ext</td><td colspan="2">intermediate rate</td><td>NIC onRx</td><td>NIC on Rx</td><td>Flow contrl</td><td>Flow contrl</td><td>0 Spare</td><td>5b[c]</td></tr>
<tr><td>0/1 ext</td><td>Hdr/ no Hdr</td><td>multi frame</td><td>mode</td><td>LLI Neg.</td><td>assign or/ee</td><td>In-ban neg.</td><td>0 Spare</td><td>5b[d]</td></tr>
<tr><td>0/1</td><td colspan="2">number of stop bits</td><td colspan="2">number of data bits</td><td colspan="3">parity</td><td>5c[b]</td></tr>
<tr><td>1 ext</td><td>duplex mode</td><td colspan="6">modem type</td><td>5d[b]</td></tr>
<tr><td>0/1 ext</td><td>1 Layer 2</td><td>0 indent</td><td colspan="5">user information Layer 2 protocol</td><td>6</td></tr>
<tr><td>0/1 ext</td><td colspan="2">Mode</td><td>0 Spare</td><td>0</td><td>0[e]</td><td colspan="2">Q.933 use</td><td>6a</td></tr>
<tr><td>1 ext</td><td colspan="7">User-specified Layer 2 protocol information</td><td>6a[f]</td></tr>
<tr><td>1 ext</td><td colspan="7">Window size (k)</td><td>6b[e]</td></tr>
<tr><td>0/1 ext</td><td>1 Layer 3</td><td>1 ident</td><td colspan="5">user information Layer 3 protocol</td><td>7</td></tr>
<tr><td>0/1 ext</td><td>Mode</td><td>0 Spare</td><td colspan="5">0</td><td></td></tr>
<tr><td>1 ext</td><td colspan="7">Optional Layer 3 protocol information</td><td>7a[g]</td></tr>
<tr><td>0/1 ext</td><td>0 Spare</td><td>0</td><td>0</td><td colspan="4">Default packet size</td><td>7b[g]</td></tr>
<tr><td>1 ext</td><td colspan="7">packet window size</td><td>7c[g]</td></tr>
</table>

Note(s):

a. This octet is required if Octet 4 indicates multirate (64 kbps base rate). Otherwise, it shall not be present.

b. This octet may be present if Octet 3 indicates unrestricted digital information and Octet 5 indicates either of the ITU-TS standardized rate adaptions V.110 and X.30 or V.120. It may also be present if Octet 3 indicates 3.1 kHz audio and Octet 5 indicates G.711.

c. This octet may be present only if Octet 5 indicates ITU-TS standardized rate adaption Rec. V.110/X.30.

d. This octet is present only if Octet 5 indicates ITU-TS standardized rate adaption Rec. V.120.

e. This octet may be present only if Octet 6 indicates certain acknowledged mode HDLC elements of procedure.

f. This octet may be present only if Octet 6 indicates user-specified Layer 2 protocol.

g. This octet may be present only if Octet 7 indicates a Layer 3 protocol based on ITU-TS X.25 | ISO/IEC 8208 or ITU-TS Rec. X.223 | ISO 8878.

h. This octet may be present only if Octet 7 indicates user-specified Layer 3 protocol.

- Coding standard (Octet 3)

Bits 7	6	Meaning
0	0	ITU-TS standardized coding, as described previously
0	1	Reserved for other international standards (Note)
1	0	National standard (Note)
1	1	Standard defined for the network (either public or private) present on the network side of the interface (Note)

Note: These other coding standards are used when the desired low-layer compatibility cannot be represented with the ITU-TS-standardized coding.

- Information transfer capability (Octet 3)

Bits 5	4	3	2	1	Meaning
0	0	0	0	0	Speech
0	1	0	0	0	Unrestricted digital information
0	1	0	0	1	Restricted digital information
1	0	0	0	0	3.1 kHz audio
1	0	0	0	1	7 kHz audio
1	1	0	0	0	Video

All other values are reserved.

- Negotiation indicator (Octet 3a)

Bit 7	Meaning
0	Out-band negotiation not possible
1	Out-band negotiation possible

Annex J of ITU-T Recommendation Q.931 contains a description of low-layer compatibility negotiation. When Octet 3a is omitted, "out-band negotiation not possible" is assumed.

- Transfer mode - (Octet 4)

Bits 7	6	Meaning
0	0	Circuit-mode
1	0	Packet-mode

All other values are reserved.

- Information transfer rate (Octet 4)

Bits 5	 4	 3	 2	 1	Circuit mode	Packet-mode
0	0	0	0	0	-	This code is used for packet-mode calls
1	0	0	0	0	64 kbps	-
1	0	0	0	1	2x64 kbps	-
1	0	0	1	1	384 kbps	-
1	0	1	0	1	1536 kbps	-
1	0	1	1	1	1920 kbps	-
1	1	0	0	0	Multirate (64 kbps base rate)	-

All other values are reserved.

The low-layer compatibility is bidirectional symmetric at the information transfer rate specified in Octet 4. When the information transfer rate 2 x 64 kbps is used, the coding of Octets 3 and 4 refer to both 64 kbps channels.

- Rate multiplier (Octet 4.1)

This octet is coded as a binary representation of the multiplier to the base rate. The multiplier can take any value from 2 up to the maximum number of B-channels available on the interface.

- User information Layer 1 protocol (Octet 5)

Bits 5 4 3 2 1	Meaning
0 0 0 0 1	ITU-TS standardized rate adaption V.110/X.30. This implies the presence of Octet 5a and optionally Octets 5b, 5c, and 5d, defined as follows.
0 0 0 1 0	Recommendation G.711 μ-law
0 0 0 1 1	Recommendation G.711 A-law
0 0 1 0 0	Recommendation G.721 32 kbps ADPCM and Recommendation I.460
0 0 1 0 1	Recommendation G.722 and G.725 kHz audio
0 0 1 1 0	Recommendation H.261 for 384 kbps video
0 0 1 1 1	Non-ITU-TS standardized rate adaption. This implies the presence of Octet 5a and, optionally, Octets 5b, 5c and 5d. The use of this codepoint indicates that the user rate specified in Octet 5a is defined by the user. Additionally, Octet 5b, 5c, and 5d, if present, are defined consistent with the user specified rate adaption.
0 1 0 0 0	ITU-TS standardized rate adaption V.120 This implies the presence of Octets 5a and 5b, defined as follows, and optionally Octets 5c and 5d.
0 1 0 0 1	ITU-TS standardized rate adaption X.31 HDLC flag stuffing.

All other values are reserved.

If the following conditions apply:

- The transfer mode is "circuit-mode"
- The information transfer capability is "unrestricted digital information" or "restricted digital information"
- The user information Layer 1 protocol is not to be identified to the network

Then Octet 5 is omitted. If the transfer mode is packet-mode, Octet 5 can be omitted. Otherwise, Octet 5 is present.

- Synchronous/asynchronous (Octet 5a)

Bit 7	Meaning
0	Synchronous
1	Asynchronous

Octets 5b-5d can be omitted in case of synchronous user rates.

- Negotiation (Octet 5a)

Bit 6	Meaning
0	Inband negotiation not possible
1	Inband negotiation possible

See Recommendation V.110 and X.30.

- User rate (Octet 5a)

Bits 5	4	3	2	1	Meaning
0	0	0	0	0	Rate is indicated by E-bits specified in Recomm. I.460
0	0	0	0	1	0.6 kbps Recomm. V.6 and X.1
0	0	0	1	0	1.2 kbps Recomm. V.6
0	0	0	1	1	2.4 kbps Recomm. V.6 and X.1
0	0	1	0	0	3.6 kbps Recomm. V.6
0	0	1	0	1	4.8 kbps Recomm. V.6 and X.1
0	0	1	1	0	7.2 kbps Recomm. V.6
0	0	1	1	1	8 kbps Recomm. I.460
0	1	0	0	0	9.6 kbps Recomm. V.6 and X.1
0	1	0	0	1	14.4 kbps Recomm. V.6
0	1	0	1	0	16 kbps Recomm. I.460
0	1	0	1	1	19.2 kbps Recomm. V.6
0	1	1	0	0	32 kbps Recomm. I.460
0	1	1	1	0	48 kbps Recomm. V.6 and X.1
0	1	1	1	1	56 kbps Recomm. V.6
1	0	0	0	0	64 kbps Recomm. X.1
1	0	1	0	1	0.1345 kbps Recomm. X.1
1	0	1	1	0	0.100 kbps Recomm. X.1
1	0	1	1	1	0.075/1.2 kbps Recomm. V.6 and X.1 (Note)
1	1	0	0	0	1.2/0.075 kbps Recomm. V.6 and X.1 (Note)
1	1	0	0	1	0.050 kbps Recomm. V.6 and X.1
1	1	0	1	0	0.075 kbps Recomm. V.6 and X.1
1	1	0	1	1	0.110 kbps Recomm. V.6 and X.1
1	1	1	0	0	0.150 kbps Recomm. V.6 and X.1
1	1	1	0	1	0.200 kbps Recomm. V.6 and X.1
1	1	1	1	0	0.300 kbps Recomm. V.6 and X.1
1	1	1	1	1	12 kbps Recomm. V.6

All other values are reserved.

Note: The first rate is the transmit rate in the forward direction of the call. The second rate is the transmit rate in the backward direction of the call.

- Octet 5b for V.110/X.30 rate adaption
  - — Intermediate rate (Octet 5b)

Bits 7	6	Meaning
0	0	Not used
0	1	8 kbps
1	0	16 kbps
1	1	32 kbps

  - — Network independent clock (NIC) on transmission (Tx) (Octet 5b) (Note)

Bit 5	Meaning
0	Not required to send data with network independent clock
1	Required to send data with network independent clock

Note: Refers to transmission in the forward direction of the call.

See Recommendation V.110 and X.30.

  - — NIC on reception (Rx) (Octet 5b) (Note)

Bit 4	Meaning
0	Cannot accept data with Network Independent Clock (that is, sender does not support this optional procedure)
1	Can accept data with Network Independent Clock (that is, sender does support this optional procedure)

Note: Refers to transmission in the forward direction of the call.

See Recommendations V.110 and X.30.

  - — Flow control on transmission (Tx) (Octet 5b) (Note)

Bit 3	Meaning
0	Not required to send data with flow control mechanism
1	Required to send data with flow control mechanism

Note: Refers to transmission in the forward direction of the call.

See Recommendations V.110 and X.30.

— Flow control on reception (Rx) (Octet 5b) (Note)

Bit 2	Meaning
0	Cannot accept data with flow control mechanisms (that is, sender does not support this optional procedure)
1	Can accept data with flow control mechanism (that is, does support this optional procedure)

Note: Refers to transmission in the backward direction of the call.

See Recommendations V.110 and X.30.

- Octet 5b for V.120 rate adaption

— Rate adaption header/no header (Octet 5b)

Bit 7	Meaning
0	Rate adaption header not included
1	Rate adaption header included

— Multiple frame establishment support in data link (Octet 5b)

Bit 6	Meaning
0	Multiple frame establishment not supported; only UI frames allowed
1	Multiple frame establishment supported

— Mode of operation (Octet 5b)

Bit 5	Meaning
0	Bit transparent mode of operation
1	Protocol sensitive mode of operation

— Logical link identifier negotiation (Octet 5b)

Bit 4	Meaning
0	Default, LLI=256 only
1	Full protocol negotiation (Note)

Note: A connection over which protocol negotiation is executed is indicated in Bit 2 of Octet 5b.

— Assignor/assignee (Octet 5b)

Bit 3	Meaning
0	Message originator is "default assignee"
1	Message originator is "assignor only"

— Inband/out-band negotiation (Octet 5b)

Bit 2	Meaning
0	Negotiation is done with USER INFORMATION messages on a temporary signaling connection
1	Negotiation is done inband using logical link zero

- Number of stop bits (Octet 5c)

Bits 7	6	Meaning
0	0	Not used
0	1	1 bit
1	0	1.5 bits
1	1	2 bits

- Number of data bits excluding parity bit if present (Octet 5c)

Bits 5	4	Meaning
0	0	Not used
0	1	5 bits
1	0	7 bits
1	1	8 bits

- Parity information (Octet 5c)

Bits 3	2	1	Meaning
0	0	0	Odd
0	1	0	Even
0	1	1	None
1	0	0	Forced to 0
1	0	1	Forced to 1

All other values are reserved.

- Duplex mode (Octet 5d)

Bit 7	Meaning
0	Half duplex
1	Full duplex

- Modem type (Octet 5d)

  Bits 6-1 coded according to network-specific rules.

- User information Layer 2 protocol (Octet 6) (Note 1)

Bits 5	4	3	2	1	Meaning
0	0	0	0	1	Basic mode ISO 1745
0	0	0	1	0	ITU-T Recomm. Q.921 (I.441) (Note 4)
0	0	1	1	0	ITU-T Recomm. X.25, link layer (Notes 1, 4)
0	0	1	1	1	ITU-T Recomm. X.25 Multilink (Note 4)
0	1	0	0	0	Extended LAPB; for half duplex operation (T.71)
0	1	0	0	1	HDLC ARM (ISO 4335) (Note 4)
0	1	0	1	0	HDLC NRM (ISO 4335) (Note 4)
0	1	0	1	1	HDLC ABM (ISO 4335) (Note 4)
0	1	1	0	0	LAN logical control (ISO 8802/2)
0	1	1	0	1	ITU-T Recomm. X.75 Single Link Procedure (SLP) (Note 4)
0	1	1	1	0	ITU-T Recomm. Q.922 (Note 4)
0	1	1	1	1	Core aspects of ITU-T Recom. Q.922
1	0	0	0	0	User specified (Note 2)
1	0	0	0	1	ISO 7776 DTE-DTE operation (Notes 3, 4)

All other values are reserved.

Note 1: This Recommendation is compatible with ISO 7776 DTE-DCE operation.

Note 2: When this coding is included, Octet 6a will include user coding for the user specified Layer 2 protocol.

Note 3: This standard is compatible with Recommendation X.75 modified by the application rules defined in Recommendation T.90.

Note 4: When this coding is included, Octets 6a and 6b with ITU-TS encoding may be included.

- User information Layer 3 protocol (Octet 7)

Bits 5	4	3	2	1	Meaning
0	0	0	1	0	ITU-T Recomm. Q.931 (I.451)
0	0	1	1	0	ITU-T Recomm. X.25, packet layer (Note 2)
0	0	1	1	1	ISO 8208 (X.25 packet level protocol for data terminal equipment) (Note 2)
0	1	0	0	0	ITU-TS Recommendation X.223/ISO 8878 (use of ISO/IEC 8208 and ITU-TS Recommendation X.25 to provide the OSI-CONS) (Note 2)
0	1	0	0	1	ISO 8473 (OSI connectionless service)
0	1	0	1	0	ITU-T Recomm. T.70 minimum network layer
0	1	0	1	1	ISO/IEC TR 9577 (Protocol identification in the network layer)
1	0	0	0	0	User specified (Note 1)

All other values are reserved.

Note 1: When this coding is included, Octet 7a will include user coding for the user-specified Layer 3 protocol.

Note 2: When this coding is included, Octets 7a, 7b, and 7c with ITU-TS encoding may be included.

- Mode of operation (Octet 7a)

Bits 7	6	Meaning
0	1	Normal packet sequence numbering
1	0	Extended packet sequence numbering

All other values are reserved.

- User-specified Layer 3 protocol information (Octet 7a)

  The use and coding of Octet 7a depends on user defined requirements.

- Default packet size (Octet 7b)

Bits 4	3	2	1	Meaning
0	1	0	0	Default packet size 16 octets
0	1	0	1	Default packet size 32 octets
0	1	1	0	Default packet size 64 octets
0	1	1	1	Default packet size 128 octets
1	0	0	0	Default packet size 256 octets
1	0	0	1	Default packet size 512 octets
1	0	1	0	Default packet size 1024 octets
1	0	1	1	Default packet size 2048 octets
1	1	0	0	Default packet size 4096 octets

All other values are reserved.

- Packet window size (Octet 7c)

  Bits 7-1 binary coding of packet window size value in the range from 1 to 127.

4.1.3.2.19 Notification Indicator

The notification indicator information element, shown in Table 4.1.3-32, is used to indicate information pertaining to a call or service. The notification indicator IE can be repeated in a message if multiple notifications are to be provided.

Table 4.1.3-32 — Notification Indicator Information Element

8	7	6	5	4	3	2	1	
	Notification indicator							
0	0	1	0	0	1	1	1	Octet 1
	Information element identifier							
Length of notification indicator contents								2
1 Ext.	Notification Description							3

- Notification Description (Octet 3):

Bits 7 6 5 4 3 2 1	Meaning
	Network-specific notification descriptions
1 1 1 0 1 0 0	Service profile update
1 1 1 0 1 0 1	User bridged onto call
1 1 1 0 1 1 0	ACB monitoring discontinued
1 1 1 0 1 1 1	Call on hold
1 1 1 1 0 0 0	Monitored user idle
1 1 1 1 0 0 1	Remote-hold (F)
1 1 1 1 0 1 0	Remote-hold-released (F)
1 1 1 1 0 1 1	Call is forwarded
1 1 1 1 1 0 0	Privacy enabled
1 1 1 1 1 0 1	Privacy disabled
1 1 1 1 1 1 0	Call retrieved from hold
All other values reserved.	

4.1.3.2.20 Progress Indicator

The progress indicator information element, shown in Table 4.1.3-33, describes an event that has occurred during the life of a call.

Table 4.1.3-33 — Progress Indicator Information Element

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th></th></tr>
<tr><td>0</td><td colspan="7">Progress Indicator
0 0 1 1 1 1 0
Information element identifier</td><td>Octet 1</td></tr>
<tr><td colspan="8">0 0 0 0 0 0 1 0
Length of progress indicator</td><td>2</td></tr>
<tr><td>1 Ext</td><td colspan="2">Coding Standard</td><td>0</td><td colspan="4">General Location</td><td>3</td></tr>
<tr><td>1</td><td colspan="7">Progress Description</td><td>4</td></tr>
</table>

- Coding Standard (Octet 3):

Bits 7 6	Meaning
0 0	ITU-TS standard
1 0	National standard
1 1	Network-specific standard

- General Location (Octet 3):

Bits 4 3 2 1	Meaning
0 0 0 0	User
0 0 0 1	Private network serving local user
0 0 1 0	Public network serving local user
0 0 1 1	Transit network (Note 1)
0 1 0 0	Public network serving remote user
0 1 0 1	Private network serving remote user
0 1 1 1	International network (Note 2)
1 0 1 0	Network beyond interworking point

All other values are reserved.

Note 1: The "transit network" codepoint applies to the national coding standard.

Note 2: The "international network" codepoint applies to the network-specific coding standard.

- Progress Descriptor Values (Octet 4):

Bits 7 6 5 4 3 2 1	Ind. No.	Meaning
0 0 0 0 0 0 1	1	Call is not end-to-end ISDN; further call progress information may be available inband
0 0 0 0 0 1 0	2	Destination address is non-ISDN
0 0 0 0 0 1 1	3	Origination address is non-ISDN
0 0 0 1 0 0 0	8	Inband information or appropriate pattern now available
0 0 0 1 0 1 0	10	Delay in response at destination interface (Note)

Note: Progress Descriptor 10 applies under the national coding standard.

4.1.3.2.21 Redirecting Number

The redirecting number information element, shown in Table 4.1.3-34, is used to provide the number of the party that redirected the call.

Table 4.1.3-34 — Redirecting Number Information Element

8	7	6	5	4	3	2	1		
	Redirecting number								
0	1	1	1	0	1	0	0	Octet	1
	Information element identifier								
Length of redirecting number information									2
0 Ext	Type of number and numbering plan identification								3
0 Ext	Origin of number and presentation status								3a
1 Ext	0	0	0	Reason for redirection					3b
	Spare								
0 Spare	Digits (IA5 Characters)								4, etc.[a]

Note(s):
a. These octets may be omitted in some cases.

- Type of number and numbering plan (Octet 3):

Bits 7	6	5	4	3	2	1	Meaning
0	0	0	0	0	0	0	unknown
0	0	1	0	0	0	1	reserved for international number in ISDN numbering plan (Rec. E.164)
0	0	1	0	0	1	1	reserved for international number in data numbering plan (Rec. X.121)
0	1	0	0	0	0	1	national number in ISDN numbering plan (Rec. E.164)
1	1	0	1	0	0	1	abbreviated number in private numbering plan

All other values are reserved.

- Origin of number and presentation status (Octet 3a):

Bits 7	6	5	4	3	2	1	Meaning
0	0	0	0	0	1	1	Presentation allowed of network-provided number
0	1	0	0	0	1	1	Presentation prohibited of network-provided number
1	0	0	0	0	1	1	Number not available

All other values are reserved.

- Reason for redirection (Octet 3b):

Bits 4	3	2	1	Meaning
0	0	0	0	Unknown
0	0	0	1	Call forwarding busy
0	0	1	0	Call forwarding no reply
1	0	0	1	Call forwarding DTE out of order
1	0	1	0	Call forwarding by the called equipment
1	1	1	1	Call forwarding unconditional

All other values are reserved.

- Digits of the base directory number: (Octets 4, etc.):

  Digits are represented by IA5 characters whose encoding is shown:

Bits 7	6	5	4	3	2	1	Meaning
0	1	1	0	0	0	0	0
0	1	1	0	0	0	1	1
0	1	1	0	0	1	0	2
0	1	1	0	0	1	1	3
0	1	1	0	1	0	0	4
0	1	1	0	1	0	1	5
0	1	1	0	1	1	0	6
0	1	1	0	1	1	1	7
0	1	1	1	0	0	0	8
0	1	1	1	0	0	1	9

All other values are reserved.

A. *Codings at the Originating Interface*

The redirecting number IE is not included in any message at the originating interface.

B. *Codings at the Destination Interface*

The redirecting number IE is included in the SETUP message and may be repeated. The first redirecting number IE is the original user, and the second redirecting number IE is the most recent forwarding user.

4.1.3.2.22 Redirection Number

The Redirection Number information element, shown in Table 4.1.3-35, identifies the directory number to which calls are to be redirected by an activated Call Forwarding feature (for example, the remote directory number).

Table 4.1.3-35 — Redirection Number Information Element

8	7	6	5	4	3	2	1	
	Redirection Number							
0	1	1	1	0	1	1	0	Octet 1
	information element identifier							
Length								2
1	Type of number and numbering plan identification							3
0 Spare	Digits (IA5 Characters)							4, etc.

- The "Type of number and numbering plan identification" (Octet 3):

Bits 7 6 5 4 3 2 1	Meaning
1 0 0 0 0 0 1	Local (directory) number in ISDN numbering plan
0 1 0 0 0 0 1	National number in ISDN numbering plan
0 1 1 1 0 0 1	Network specific number in private numbering plan
1 1 0 1 0 0 1	Abbreviated number in private numbering plan

For the NI-3 Call Forwarding Over Private Facilities feature, the network specific number in private numbering plan is supported since this coding is used with private numbering plan digits that are used with private facility access (PFA)/automatic route selection (ARS), which is supported for CFPF remote DNs in NI-3.

The abbreviated number in private numbering plan, is often used to encode intercom (that is, individualized dialing plan dialing strings). In order to meet the 6-13 Redirection Number IE length specifications, it can be used only as long as that number is at least three digits long. If the abbreviated private numbering plan digit string (such as the speed call digit) is less than three digits long, it will be expanded to seven to 10 digits.

The numbering plan indicators, local number in ISDN numbering plan or national number in ISDN numbering plan, will be used only when no private information is provided. Prefix digits, such as "0", "1", or "escape to POTS" code ("*9") will not be included in the Redirection Number IE.

Since the *5ESS*® switch will also permit international direct distance dialing (IDDD) numbers as forward-to DNs, IDDD numbers will be encoded to fit the national number format, that is, only the last 10 digits of the IDDD digit string will be encoded in the Redirection Number IE. All additional digits will be truncated off to make the number fit the national number format and the maximum length of 13 octets (that is, 10 digits) for the Redirection Number IE.

The "Digits" of the base directory number values in Octet 4, etc. of the Redirection Number IE must be coded as follows:

Bits 7	6	5	4	3	2	1	Meaning
0	1	1	0	0	0	0	0
0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	2
0	1	1	0	0	1	1	3
0	1	1	0	1	0	0	4
0	1	1	0	1	0	1	5
0	1	1	0	1	1	0	6
0	1	1	0	1	1	1	7
0	1	1	1	0	0	0	8
0	1	1	1	0	0	1	9

4.1.3.2.23 Service Profile Identification

The service profile identification information element, shown in Table 4.1.3-36, is used to identify a user service order profile (USOP).

Table 4.1.3-36 — Service Profile Identification Information Element

8	7	6	5	4	3	2	1		
0	Service profile identification 0	1	1	1	0	1	0 Information element identifier	Octet	1
Length of service profile identification contents									2
0 Spare	Spare Profile IDentifier (SPID) (IA5 Characters)								3, etc.

- Service Profile Identifier:

  The SPID parameter is coded as IA5 characters.

4.1.3.2.24 Signal

The signal information element, shown in Table 4.1.3-37, conveys indications that allow the receiving terminal to generate tones and alerting signals.

Table 4.1.3-37 — Signal Information Element

8	7	6	5	4	3	2	1	
Signal								
0	0	1	1	0	1	0	0	Octet 1
Information element identifier								
0	0	0	0	0	0	0	1	
Length of signal information								2
Signal value								3

- Signal value (Octet 3):

Bits								
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
0	0	0	0	0	0	0	0	Dial tone on
0	0	0	0	0	0	0	1	Ringback/audible ringing tone on
0	0	0	0	0	0	1	1	Network congestion/reorder tone on
0	0	0	0	0	1	0	0	Busy tone on
0	0	0	0	0	1	0	1	Confirmation tone
0	0	0	0	0	1	1	1	Call waiting tone
0	0	1	1	1	1	1	1	Tones off
0	1	0	0	0	0	0	0	Alerting on - pattern 0, normal alerting
0	1	0	0	0	0	0	1	Alerting on - Pattern 1, distinctive alerting-intergroup
0	1	0	0	0	0	1	0	Alerting on - Pattern 2, distinctive alerting-special/priority
0	1	0	0	0	0	1	1	Alerting on - Pattern 3, EKTS intercom
0	1	0	0	0	1	0	0	Alerting on - Pattern 4, reminder ring
0	1	0	0	1	1	1	1	Alerting off
Network-specific signal value								
0	0	0	1	0	0	0	1	Recall dial tone on
0	0	0	1	0	0	1	0	Barge-in tone
1	1	1	1	1	0	1	0	Incoming additional call tone
1	1	1	1	1	0	1	1	Priority additional call tone
1	1	1	1	1	1	0	1	Expensive route warning tone (F)

All other values are reserved.

4.1.3.2.25 Transit Network Selection

The transit network selection information element, shown in Table 4.1.3-38, identifies a requested transit network.

Table 4.1.3-38 — Transit Network Selection Information Element

8	7	6	5	4	3	2	1	
0	Transit Network Selection 1	1	1	1	0	0	0 Information element identifier	Octet 1
Length of transit network identification								2
1 Ext.	Type of network identification			Network identification plan				3
0 Spare	Network identification (IA5 Characters)							4, etc.

- Type of network identification (Octet 3):

Bits 7 6 5	Meaning
0 0 0	User-specified (private) identification
0 1 0	Nationally-standardized identification

All other values are reserved.

- Network identification plan (Octet 3):

Bits 4 3 2 1	Meaning
0 0 0 0	Unknown
0 0 0 1	Inter-LATA carrier identification code
0 0 1 0	User-specified identification code

All other values are reserved.

- Network identification (Octets 4, etc.):

  These IA5 characters are organized according to the rules of the network identification plan specified in Octet 3. The identification of interexchange carrier (IC) networks is made with the 4-digit code assigned to ICs.

  User-specified identification codes are used for selection among the private leased circuits (or groups of leased circuits) available to a given user. A private leased circuit is a public network-provided circuit to which access is restricted to a given user or groups of users. The correspondence between user-specified identification codes and private leased circuits (or groups of circuits) is agreed between the user (or groups of users) and the network.

A. *Codings at the Originating Interface*

The transit network selection can be included in the SETUP message.

B. *Codings at the Destination Interface*

The transit network selection IE is not included in any message at the destination interface.

4.1.3.3 National-Specific Information Elements (Codeset 5)

4.1.3.3.1 Display Text

The display text information element, shown in Table 4.1.3-39, is used to supply switch-formatted display information that may be displayed by a terminal for a human user. Display text IE is optional in all network to user messages, but to receive display information it is mandatory to include the display text IE.

The maximum length of the display text IE is dependent on the maximum length of an INFOrmation message. If the display text IE does not fit in the appropriate message due to message length constraints, the entire display text IE is sent in a subsequent INFOrmation message.

Table 4.1.3-39 — Display Text Information Element

8	7	6	5	4	3	2	1		
0	Display text 0	1	0	1	0	1	0 Information element identifier	Octet	1
Length of display text information element									2
1	Display type								3
Display Information									4, etc.

- Display type (Octet 3, Bits 1-7):

Bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
0	0	0	0	0	0	0	Normal

  All other values are reserved.

  The display text information element for Display Type 0 (Normal) is not repeated in a message.

- Display information:

  One or more fields of display information may be included depending on specific service requirements.

  The display information is broken into fields of tag, length, and text as shown in Table 4.1.3-40

Table 4.1.3-40 — Display Information (Relative Order of Octets 4, etc.)

DISPLAY FIELD INFORMATION	MANDATORY INDICATION FOR DISPLAY FIELD
DisplayN tag DisplayN length DisplayN text	Optional

- Display tag:

A. Mandatory control tags:

Bits								
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Meaning**
1	0	0	0	0	0	0	0	Blank
1	0	0	0	0	0	0	1	Skip

The following list contains definitions for each of the mandatory control tags listed in the preceding display.

1. Blank: This tag always has a 1-octet length and a binary value from 1 to 255 that tells the terminal how many successive blank characters to append to any previous text.
2. Skip: This tag always has a 1-octet length and a binary value from 1 to 255 that tells the terminal how many ASCII characters to skip over before operating on the next display tag.

B. Display tag bit value:

Bits 8 7 6 5 4 3 2 1	Meaning
1 0 0 0 0 0 0 0	Blank[a]
1 0 0 0 0 0 0 1	Skip[a]
1 0 0 0 0 0 1 0	Continuation
1 0 0 0 0 0 1 1	Called address[a]
1 0 0 0 0 1 0 0	Cause
1 0 0 0 0 1 0 1	Progress indicator
1 0 0 0 0 1 1 0	Notification indicator
1 0 0 0 0 1 1 1	Prompt
1 0 0 0 1 0 0 0	Accumulated digits
1 0 0 0 1 0 0 1	Status
1 0 0 0 1 0 1 0	Inband
1 0 0 0 1 0 1 1	Calling address[a]
1 0 0 0 1 1 0 0	Reason[a]
1 0 0 0 1 1 0 1	Calling party name
1 0 0 0 1 1 1 0	Called party name
1 0 0 0 1 1 1 1	Original called name
1 0 0 1 0 0 0 0	Redirecting name
1 0 0 1 0 0 0 1	Connected name
1 0 0 1 0 0 1 0	Originating restrictions
1 0 0 1 0 0 1 1	Date & time of day[a]
1 0 0 1 0 1 0 0	Call appearance ID[a]
1 0 0 1 0 1 0 1	Feature address
1 0 0 1 0 1 1 0	Redirection name
1 0 0 1 1 1 1 0	Text[a]

All other values are reserved.

Note(s):

a. Tags that will be supported by the switch for NI-1.

The following list contains definitions for each of the display text tags listed under display tag bit value.

1. This tag indicates ASCII text that is associated with the previously tagged information (other than blank or skip).
2. Called address: This tag indicates ASCII text regarding the called number.
3. Cause: This tag indicates ASCII text related to the corresponding cause value.
4. Progress indicator: This tag indicates ASCII text related to the contents of the corresponding progress indicator IE.

5. Notification indicator: This tag indicates ASCII text related to the contents of the corresponding notification indicator information element.
6. Prompt: This tag indicates ASCII text to request the user to input additional information, for example, digits.
7. Accumulated digits: This tag indicates ASCII text describing digits input by the user.
8. Status: This tag indicates ASCII information describing a feature condition, for example, feature is active or feature has been deactivated.
9. Inband: This tag indicates ASCII information indicating that tones or other information are being provided inband.
10. Calling address: This tag indicates ASCII text related to the contents of the calling party number IE.
11. Reason: This display text tag indicates ASCII text that is associated with the redirecting reason in the redirecting number IE.
12. Call appearance ID: This display text tag indicates ASCII text (an alphabetical character followed by an equal sign) that is associated with a call appearance.
13. Feature address: This tag indicates ASCII information describing an address associated with a feature.

C. Display length: Bit 8 is set to zero and the remaining seven bits are a binary encoding of the length of the display text, with Bit 1• the least significant bit.

D. Display text: The display text (except for blank and skip information) is coded in ASCII characters whose encoding is shown. Blank and skip information are in binary form.

7 6 5 4 3 2 1	Meaning	7 6 5 4 3 2 1	Meaning	7 6 5 4 3 2 1	Meaning
0 1 0 0 0 0 0	Space	1 0 0 0 0 0 0	@	1 1 0 0 0 0 0	‘
0 1 0 0 0 0 1	!	1 0 0 0 0 0 1	A	1 1 0 0 0 0 1	a
0 1 0 0 0 1 0	"	1 0 0 0 0 1 0	B	1 1 0 0 0 1 0	b
0 1 0 0 0 1 1	#	1 0 0 0 0 1 1	C	1 1 0 0 0 1 1	c
0 1 0 0 1 0 0	$	1 0 0 0 1 0 0	D	1 1 0 0 1 0 0	d
0 1 0 0 1 0 1	%	1 0 0 0 1 0 1	E	0 0 1 1 1 0 1	e
0 1 0 0 1 1 0	&	1 0 0 0 1 1 0	F	1 1 0 0 1 1 0	f
0 1 0 0 1 1 1	’	1 0 0 0 1 1 1	G	1 1 0 0 1 1 1	g
0 1 0 1 0 0 0	(	1 0 0 1 0 0 0	H	1 1 0 1 0 0 0	h
0 1 0 1 0 0 1	)	1 0 0 1 0 0 1	I	1 1 0 1 0 0 1	i
0 1 0 1 0 1 0	*	1 0 0 1 0 1 0	J	1 1 0 1 0 1 0	j
0 1 0 1 0 1 1	+	1 0 0 1 0 1 1	K	1 1 0 1 0 1 1	k
0 1 0 1 1 0 0	,	1 0 0 1 1 0 0	L	1 1 0 1 1 0 0	l
0 1 0 1 1 0 1	-	1 0 0 1 1 0 1	M	1 1 0 1 1 0 1	m
0 1 0 1 1 1 0	.	1 0 0 1 1 1 0	N	1 1 0 1 1 1 0	n
0 1 0 1 1 1 1	/	1 0 0 1 1 1 1	O	1 1 0 1 1 1 1	o
0 1 1 0 0 0 0	0	1 0 1 0 0 0 0	P	1 1 1 0 0 0 0	p
0 1 1 0 0 0 1	1	1 0 1 0 0 0 1	Q	1 1 1 0 0 0 1	q
0 1 1 0 0 1 0	2	1 0 1 0 0 1 0	R	1 1 1 0 0 1 0	r
0 1 1 0 0 1 1	3	1 0 1 0 0 1 1	S	1 1 1 0 0 1 1	s
0 1 1 0 1 0 0	4	1 0 1 0 1 0 0	T	1 1 1 0 1 0 0	t
0 1 1 0 1 0 1	5	1 0 1 0 1 0 1	U	1 1 1 0 1 0 1	u
0 1 1 0 1 1 0	6	1 0 1 0 1 1 0	V	1 1 1 0 1 1 0	v
0 1 1 0 1 1 1	7	1 0 1 0 1 1 1	W	1 1 1 0 1 1 1	w
0 1 1 1 0 0 0	8	1 0 1 1 0 0 0	X	1 1 1 1 0 0 0	x
0 1 1 1 0 0 1	9	1 0 1 1 0 0 1	Y	1 1 1 1 0 0 1	y
0 1 1 1 0 1 0	:	1 0 1 1 0 1 0	Z	1 1 1 1 0 1 0	z
0 1 1 1 0 1 1	;	1 0 1 1 0 1 1	[	1 1 1 1 0 1 1	{
0 1 1 1 1 0 0	<	1 0 1 1 1 0 0	\	1 1 1 1 1 0 0	|
0 1 1 1 1 0 1	=	1 0 1 1 1 0 1	]	1 1 1 1 1 0 1	}
0 1 1 1 1 1 0	>	1 0 1 1 1 1 0	^	1 1 1 1 1 1 0	~
0 1 1 1 1 1 1	?	1 0 1 1 1 1 1	_		

4.1.3.3.2 Operator System Access

The operator system access information element, shown in Table 4.1.3-41, is used to request access to an operator services system.

Table 4.1.3-41 — Operator System Access Information Element

8	7	6	5	4	3	2	1	
0	Operator system access 0	0	1	1	1	0	1 Information element identifier	Octet 1
0	0	0	0	0	0	0	1	2
Length of operator system access								
1 Ext.	Type of service 0	0	0	0	0	Type of access		3

- Type of service (Octet 3):

Bits					
5	4	3	2	1	Meaning
0	0	0	0	0	Unspecified

All other values are reserved.

- Type of access (Octet 3):

Bits		
2	1	Meaning
0	0	Public/principal: default operator system
0	1	Public/alternate: operator system determined by user subscription

All other values are reserved.

A. *Codings at the Originating Interface*

The operator system access IE can be included in the SETUP message.

B. *Codings at the Destination Interface*

The operator system access IE is not included in any message at the destination interface.

4.1.3.4 Network-Specific Information Elements (Codeset 6)

4.1.3.4.1 Call Appearance

The call appearance information element is shown in Table 4.1.3-42.

Table 4.1.3-42 — Call Appearance Information Element

8	7	6	5	4	3	2	1	
Call appearance								
0	1	1	1	1	0	1	1	Octet 1
Information element identifier								
Length of call appearance information								2
0/1 Ext.	Call appearance identifier							3
1 Ext.	Call appearance identifier continuation, if needed							3a

- Call appearance identifier:

  The call appearance identifier is coded as the binary coding of a decimal number in the range from 0 to 16,383. The values of 0 to 127 are coded in one octet, and the values 128 to 16,383 are coded in two octets.

4.1.3.5 Information Elements Used in Non-Call-Associated Signaling for Common Element Procedures and Components

This section contains the additional Information Elements (IEs) used to support the ATS feature that are not contained in previous sections. This section also contains the components (also called Protocol Data Units - PDUs) within the EFIEs for the ATS feature.

4.1.3.5.1 Extended Facility

The extended facility information element, as shown in Table 4.1.3-43, is used for data transport in both terminal-to-switch and switch-to-terminal directions. The short or long form of length encoding may be used as appropriate, see "Length," Section 4.1.3.5.5.7.

Table 4.1.3-43 — Extended Facility Information Element

8	7	6	5	4	3	2	1	
Extended Facility IE ID								
0	0	0	0	1	1	0	1	Octet 1
0/1	Length of Ext. Fac. IE							2
continuation of length of IE								2a
1	0	0	service discrim.					3
ext.	spare		1	0	0	1	0	
PDU component								4, etc

- Service Discriminator (Protocol Profile) (Octet 3)

Bits 5 4 3 2 1	Meaning
1 0 0 1 0	CMIP protocol

- Component - PDU (Octet 4)

  The component is coded as defined in "Components," Section 4.1.3.5.4.

4.1.3.5.2 Facility

This section contains the additional Information Elements (IEs) used to support the ATS feature that are not contained in previous sections. See Table 4.1.3-44. The IE is used to carry a single component in both terminal-to-switch and switch-to-terminal directions.

Table 4.1.3-44 — Facility Information Element

8	7	6	5	4	3	2	1	
Facility IE ID								
0	0	0	1	1	1	0	0	Octet 1
Length of Facility IE								2
1	0	0	service discrim.					3
ext	spare		1	0	0	0	1	
PDU component								4, etc

- Length (Octet 2)

  Octet 2 must be a binary encoding of the length with Bit 1 as the least significant bit. The length is the number of octets after Octet 2.

- Service Discriminator (Octet 3)

Bits 5 4 3 2 1	Meaning
1 0 0 0 1	Supplementary services

- Component (Octet 4)

  The component is coded as defined in "Components," Section 4.1.3.5.4.

4.1.3.5.3 Segmented Message

The segmented message information element, shown in Table 4.1.3-45, is included in only a SEGment message. It identifies the type of message that is segmented.

Table 4.1.3-45 — Segmented Message Information Element

8	7	6	5	4	3	2	1	
Segmented Message Info Ele ID								
0	0	0	0	0	0	0	0	Octet 1
Length of Seg Msg Contents								
0	0	0	0	0	0	1	0	
first seg ind	number of segments remaining							
0	segmented message type							

- First Segment Indicator (Octet 3)

Bit 8	Meaning
0	Subsequent segment to first message
1	First segment of segmented message

- Number of Segments Remaining (Octet 3)

  Binary number indicating the number of remaining segments within the message to be sent.

- Segmented Message Type (Octet 4)

  Message type of message being segmented (FACILITY).

  Note: Bit 8 is reserved for use as an extension bit.

4.1.3.5.4 Components

An operation is specified by encoding a component in an Extended Facility Information Element (EFIE) or Facility Information Element (FIE). The following four components, also termed Protocol Data Units (PDUs), are used to send and receive ASN.1 encoded data: Invoke, Reject, Return Error and Return Result.

4.1.3.5.4.1 Invoke

This component is used to request an operation, or in some cases to report the success of or errors in an operation (for example, ATS). The contents of this component are shown in Table 4.1.3-46.

Table 4.1.3-46 — Invoke Component Content

DATA ELEMENT	VALUE	INCLUSION CONDITIONS
Component type	Invoke	mandatory
Invoke ID	any value in permitted range	mandatory
Linked ID	value of invoke ID in parent invoke	included if Invoke is a linked invoke
Operation value	value defined for supplementary service	mandatory
Argument(s)	defined by the operation	included if defined for the operation

4.1.3.5.4.2 Reject

This component is used to indicate that a received component was rejected by either the switch or the CPE. The contents of this component are shown in Table 4.1.3-47.

Table 4.1.3-47 — Reject Component Content

DATA ELEMENT	VALUE	INCLUSION CONDITIONS
Component type	Reject	mandatory
Invoke ID	value in invoke for this component exchange (note)	mandatory
Problem value	reason for component rejection	mandatory
Note(s): a. A null identifier must be used if the invoke identifier cannot be determined.		

4.1.3.5.4.3 Return Error

This component is used to indicate that an operation was either unsuccessfully performed or unable to be performed. The contents of this component are shown in Table 4.1.3-48.

Table 4.1.3-48 — Return Error Component Content

DATA ELEMENT	VALUE	INCLUSION CONDITIONS
Component type	Return Error	mandatory
Invoke ID Error value	value in invoke for this component exchange service-specific value indicating reason for failure	mandatory mandatory
Parameter(s)	any arguments defined by the error	included if defined for the error

4.1.3.5.4.4 Return Result

This component indicates that an operation was successfully performed. The contents of this component are shown in Table 4.1.3-49.

Table 4.1.3-49 — Return Result Component Content

DATA ELEMENT	VALUE	INCLUSION CONDITIONS
Component type	Return Result	mandatory
Invoke ID	value in invoke for this component exchange	mandatory
Sequence	Sequence	included if any results are returned
Operation value	value of operation value in the invoke	included if any results are returned
Results	any arguments defined by the operation	included if defined for the operation

4.1.3.5.5 Data Elements

The following data elements are used in the components shown in "Components," Section 4.1.3.5.4.

4.1.3.5.5.1 Component Type

The component type data elements are shown in Table 4.1.3-50.

Table 4.1.3-50 — Component Type Data Elements

8 7 6 5 4 3 2 1	
Component type	Octet 1
Length	2
Length continued	3a, 3b, ...

- Component type:

Bits 8 7 6 5 4 3 2 1	Meaning
1 0 1 0 0 0 0 1	Invoke
1 0 1 0 0 0 1 0	Return Result
1 0 1 0 0 0 1 1	Return Error
1 0 1 0 0 1 0 0	Reject

  All other values reserved.

- Length:

  The length indicates the length of the component excluding the component type and length fields. There are two methods of encoding the length: short form (up to and including 127 octets) and long form (greater than 127 octets). "Length," Section 4.1.3.5.5.7, specifies the two formats.

4.1.3.5.5.2 Invoke Identifier

The invoke identifier data elements are shown in Table 4.1.3-51.

Table 4.1.3-51 — Invoke Identifier Data Elements

8	7	6	5	4	3	2	1	
Invoke identifier tag								Octet 1
0	0	0	0	0	0	1	0	
Invoke ID length								2
Invoke Identifier								3
Invoke Identifier continued as needed								4

- Invoke Identifier length

  The switch supports a length of one or two octets for the Invoke ID.

- Invoke Identifier

  The invoke ID is an integer value that is coded as a 2's complement binary number in one or two octets. "Invoke Identifier Administration," Section 7.1.1.10, describes invoke ID administration.

4.1.3.5.5.3 Linked Identifier

The linked identifier data elements are shown in Table 4.1.3-52.

Table 4.1.3-52 — Linked Identifier Data Elements

8	7	6	5	4	3	2	1	
Linked Identifier tag								Octet 1
1	0	0	0	0	0	0	0	
Linked ID length								2
0	0	0	0	0	0	0	1	
Linked Identifier								3

- Linked Identifier length

  The Linked ID length for the ATS feature shall be one octet.

- Linked Identifier

  The Linked ID is an integer value that shall be encoded as a 2's complement binary number in 1 octet. "Invoke IDs Used in Components Sent by the Switch," Section 7.1.1.10.2, describes linked ID administration.

4.1.3.5.5.4 Operation Value

The operation value data elements are shown in Table 4.1.3-53.

Table 4.1.3-53 — Operation Value Data Elements

8 7 6 5 4 3 2 1		
Operation value	octet	1
Operation value length		2
Operation value		3, etc.

- Operation value tag

Bits 8	7	6	5	4	3	2	1	Meaning
0	0	0	0	0	0	0	0	Integer
0	0	0	0	0	0	0	0	Object Identifier

All other values reserved.

- Operation value length

The operation value length shall be coded using the short form length format described in "Length," Section 4.1.3.5.5.7.

- Operation value

When the Operation value tag is coded as "integer," the Operation value is encoded as a 2's complement binary number in one octet. Each operation value has an associated operation class (see "Operation Class," Section 7.1.1.9). The operation class is not contained in the protocol and is expected to be known to both the switch and the terminal.

For the case where the Operation Value is an object identifier see "Object Identifier Value," Section 4.1.3.5.5.8. Operation value must be coded as an object identifier if the object identifier tag is used.

4.1.3.5.5.5 Error Value

The error value data elements are shown in Table 4.1.3-54.

Table 4.1.3-54 — Error Value Data Elements

8 7 6 5 4 3 2 1		
Error value tag	octet	1
Error value length		2
Error value		3, etc.

- Error value tag

Bits 8 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 1 0	Integer
0 0 0 0 0 1 1 0	Object identifier

- Error value length

  The Error value length shall be coded using the short form length format described in "Length," Section 4.1.3.5.5.7.

- Error value

  The error value shall be encoded as a 2's complement binary number in the fewest number of octets if the integer tag is used. The error value must be encoded as an object identifier if the object identifier tag is used.

- Refer to "Object Identifier Value," Section 4.1.3.5.5.8, for "Object Identifier Value" format.

4.1.3.5.5.6 Problem Value

The problem value data elements are shown in Table 4.1.3-55.

Table 4.1.3-55 — Problem Value Data Elements

8 7 6 5 4 3 2 1	
Problem value tag	Octet 1
Problem value length	2
Problem value	3

- Problem value tag

  The Problem value tag indicates whether the detected problem is general in nature or is specific to a particular component. For each problem tag classification, problem values are defined. For example, General problem values are defined for use with the General problem tag.

Bits 8 7 6 5 4 3 2 1	Meaning
1 0 0 0 0 0 0 0	General problem tag
1 0 0 0 0 0 0 1	Invoke problem tag
1 0 0 0 0 0 1 0	Return Result problem tag
1 0 0 0 0 0 1 1	Return Error problem tag

  All other values reserved.

- Problem value length

  The problem value length shall be coded using the short form length format described in "Length," Section 4.1.3.5.5.7. The length of the problem value is one octet.

- Problem value
  - — General Problem

Bits 8 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 0 0	Unrecognized component
0 0 0 0 0 0 0 1	Mistyped component
0 0 0 0 0 0 1 0	Badly structured component

All other values reserved.

— Invoke Problem

Bits 8 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 0 0	Duplicate invocation
0 0 0 0 0 0 0 1	Unrecognized operation
0 0 0 0 0 0 1 0	Mistyped argument
0 0 0 0 0 0 1 1	Resource limitation
0 0 0 0 0 1 0 1	Unrecognized linked identifier
0 0 0 0 0 1 1 0	Linked response unexpected
0 0 0 0 0 1 1 1	Unexpected child operation

All other values reserved.

— Return Result Problem

Bits 8 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 0 0	Unrecognized invocation
0 0 0 0 0 0 1 0	Mistyped result

All other values reserved.

— Return Error Problem

Octet 1 8 7 6 5 4 3 2 1	Meaning
0 0 0 0 0 0 0 0	Unrecognized invocation
0 0 0 0 0 0 1 0	Unrecognized error
0 0 0 0 0 0 1 1	Unexpected error
0 0 0 0 0 1 0 0	Mistyped parameter

All other values reserved.

4.1.3.5.5.7 Length

The length element is used by Q.931 to specify the number of octets that follow in a data element. The intent is to encode the length using the fewest number of length octets possible. The exception to this rule is that the 3-octet length form may be used for ASN.1 constructed tags.

4.1.3.5.5.7.1 Short Form (lengths up to and including 127 octets)

The short form of the length is used to encode lengths up to and including 127 octets. Bit 8 is set to 0, and the remaining seven bits are a binary encoding of the length with Bit 1 being the least significant bit (see Table 4.1.3-56).

Table 4.1.3-56 — Short Form Length Element

8	7 6 5 4 3 2 1	
0	length of contents	Octet1

4.1.3.5.5.7.2 Long Form (lengths greater than 127 octets)

The long form of the length is used to encode lengths greater than 127 octets. Bit 8 is a flag bit and when set, it indicates that the low-order bits signify the length of the length (see Table 4.1.3-57).

Table 4.1.3-57 — Long Form Length Element

8	7 6 5 4 3 2 1	
flag1	length of length (number of length octets remaining)	Octet 1
length of contents		Octet 2
Length of contents[a]		Octet 3

Note(s):

a. Octet 3 is used if the length is greater than 255 octets

4.1.3.5.5.8 Object Identifier Value

An object identifier is a sequence of non-negative integer values, which are encoded as subidentifiers. The sequence of integers comes from the ASN.1 encoding of the object. The first two integer values (X,Y) of the sequence are used to form the first subidentifier (40*X+Y), and each subsequent integer value is the next subidentifier. Each subidentifier is coded separately as shown in Table 4.1.3-58, as an unsigned binary number of one or two octets, and then concatenated to form the object identifier value.

Table 4.1.3-58 — Object Identifier Value

8	7 6 5 4 3 2 1	
0	Subidentifier	octet 1

8	7 6 5 4 3 2 1	
1	Subidentifier	octet 1
0	Subidentifier continued	2

As an example, consider the ASN.1 sequence {1 3 17 105 2 2 2}, which is an object identifier used in the NESS service. The first two integer values form the first subidentifier, 43 (40*1+3). The second subidentifier is 17, the third is 105, and so on. Therefore, the actual Object Identifier value data element is the string of octets shown in Table 4.1.3-59

Table 4.1.3-59 — Object Identifier Value - Example

8	7 6 5 4 3 2 1	
0	0 1 0 1 0 1 1 Subidentifier 1	Octet 1
0	0 0 1 0 0 0 1 Subidentifier 2	2
0	1 1 0 1 0 0 1 Subidentifier 3	3
0	0 0 0 0 0 1 0 Subidentifier 4	4
0	0 0 0 0 0 1 0 Subidentifier 5	5
0	0 0 0 0 0 1 0 Subidentifier 6	

4.1.3.5.5.9 Sequence

The sequence length element is shown in Table 4.1.3-60.

Table 4.1.3-60 — Sequence Length Element

8	7	6	5	4	3	2	1	
Sequence tag								Octet 1
0	0	1	1	0	0	0	0	
Sequence length								2
Sequence length (continued)								3[a]

Note(s):
a. Included if long form encoding is used

- The sequence length must be coded using the short form or long form length format described in "Length," Section 4.1.3.5.5.7. The length indicates the total number of octets in the sequence excluding the octets used for the sequence tag and length.

4.1.3.5.5.10 Null Identifier

The null identifier data element, shown in Table 4.1.3-61, is used in the reject component when the switch is unable to determine the invoke identifier in the component that is being rejected.

Table 4.1.3-61 — Null Identifier Data Element

8	7	6	5	4	3	2	1	
Null identifier tag								Octet 1
0	0	0	0	0	1	0	1	
Null identifier length								2
0	0	0	0	0	0	0	0	

4.1.4 BRI MESSAGE SEGMENTATION FOR LONGER MESSAGES

Layer 3 messages that are longer than the data link layer frame length can support must be partitioned into segments that can fit into the data link layer frame.

The segmentation procedures apply to only a FACility message containing downloadable data for the Automatic Terminal Setup (ATS) feature. The segmentation procedures defined in this section are based on Q.931 Annex K as amended by TR-1281 to allow up to 20 SEGMENT messages resulting from one long Q.931 message.

Message segmentation shall be used only when the Q.931 message length exceeds 244 octets. It is a constraint of the *5ESS*® switch architecture that requires segmentation of Q.931 messages exceeding 244 octets. TR-1281 requires segmentation of Q.931 messages exceeding 256 (Layer 2 I-frame length of 260) octets.

Segmentation procedures apply within only a specific call reference value for a terminal and do not impact the procedures in operation on other call reference values for the same terminal or other terminals on the same interface. See Figure 4.1.4-1. The following rules apply when Q.931 messages are to be segmented for transmission:

a. The default maximum number of message segments is 20 for the ATS feature (8 is allowed by blue book Annex K). If the message is too long to be segmented into 20 SEGMENT messages, it shall be discarded. The segmentation procedures shall be aborted as per item g. A craft assert indicating the port, party, TEI and call reference associated with the terminal will be issued.

b. The first SEGMENT message shall consist of the following IEs in order; protocol discriminator, call reference, message type (indicating SEGMENT), segmented message, and octets starting with the first octet following the message type of the message being segmented, subject to the maximum length of the segment not exceeding the maximum size of the data link layer information field.

c. Each subsequent message shall begin with the protocol discriminator IE immediately followed by the call reference IE, the segment message type, the segmented message IE and one or more octets of the message being segmented, following directly from the octets transmitted in the previous segment, subject to the maximum length of the segment not exceeding the maximum size of the data link layer information field.

d. The first segment indicator field of the segmented message IE shall be set to indicate the first segment of a SEGMENT message, and not set in any following segment.

e. The number of segments remaining field of the segmented message IE shall be set to indicate how many more SEGMENT messages are to be sent.

f. The message type IE shall be coded to indicate a SEGMENT message and the segmented message IE shall indicate the message type of the original message being segmented.

g. The transmission of a segmented message may be aborted by: sending the terminal a RELease COMplete message with network-specific Cause 90, "segmentation error."

h. Once the first SEGMENT message has been transmitted for a given call reference, all remaining segments of the original message must be sent in

SEGMENT messages in the proper order before any other messages (with the exception of a RELease COMplete to abort segmentation), are sent for that call reference.

i. The octet order for the segmented message shall be preserved.

j. If the switch receives a RELease COMplete in State 31 during segmentation procedures, it shall follow the procedures in TR-1281, Section 7.2.3A.

It is possible that one or more SEGMENT messages will be sent to the terminal after the terminal has sent the switch a RELease COMplete.

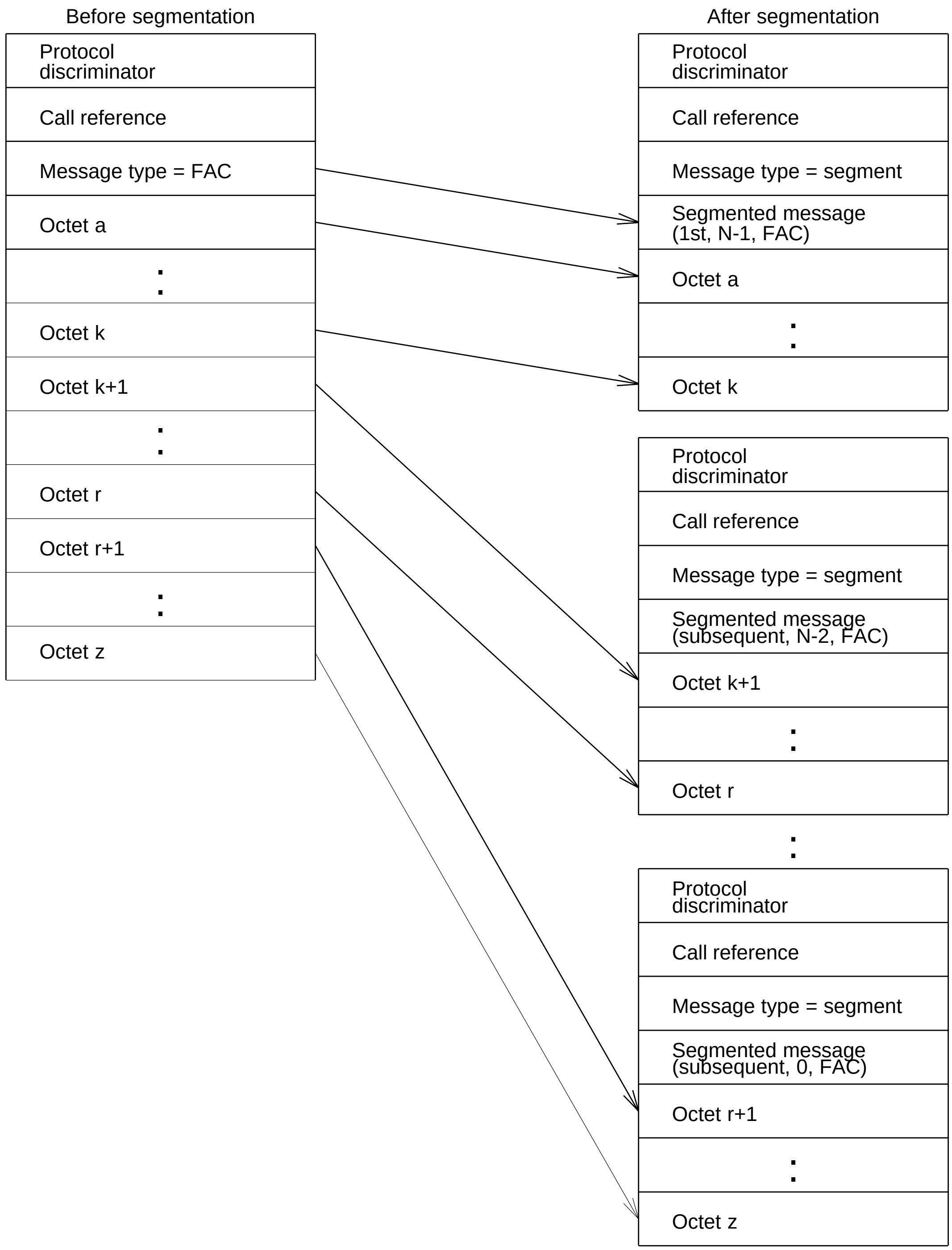


Figure 4.1.4-1 — Message Segmentation

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

4.2 BASIC CALL CONTROL FOR CIRCUIT MODE VOICE AND DATA SERVICES

This section defines the *procedures* required for establishing, maintaining, and clearing basic circuit mode voice and data services connections at the standard ISDN basic rate user-network interface. These procedures are defined in terms of *messages* exchanged over the D-channel of the standard basic rate interface (BRI) structure. The functions and procedures of this protocol, and the relationship with other layers, are described in general terms in International Telecommunications Union - Telecommunications Standardization Sector (ITU-TS) Recommendation Q.930.

User endpoints interconnecting to this interface are expected to comply with this specification, which is built upon the description provided in CCITT Recommendation Q.931, Bellcore SR-NWT-001953 and Bellcore SR-4620.

Beginning with the 5E11 software release, both B-channels can be configured for voice, allowing two active simultaneous voice calls from a single TEI. This added functionality meets National ISDN recommendations on channel configurations for voice.

Note: This capability is being introduced to the switch through a software update mechanism; it was not originally part of the 5E11 software release. Availability depends on the application of this software update in the switch. If this capability is not available in a particular switch, contact the service provider of the switch.

Prior to the 5E11 software release, both B-channels can be active for voice calls simultaneously, but only for separate terminals.

The information elements (IEs) and procedures described in this Section are used in the control of basic circuit-switched (circuit mode) voice and data service connections.

A terminal becomes associated with (bound to) a User Service Order Profile (USOP) by one of three means. The terminal initializes; the terminal does not initialize, or it fails to initialize, and receives service as a Non-Initializing Terminal (NIT); or the terminal sends a fixed TEI at Layer 2 establishment that identifies a particular USOP. This provisioning of a fixed TEI is possible only if the USOP also contains subscription parameters for a D-channel Permanent Virtual Circuit, described in "Packet Services," Section 4.3. Details of these three ways to establish service are covered in "Terminal Initialization," Section 6.

The important difference between these terminals is that, once a terminal has initialized, or has sent in the provisioned fixed TEI, the terminal is immediately associated with a service profile (USOP), and will lose that association only if the terminal goes out of service (for example, if the user unplugs the terminal from the interface). A NIT, in general, is bound to a USOP on the basis of the Calling Party Number it sends in a SETUP message. If the DN identifies a USOP that is not a fixed TEI USOP, and does not require an initializing terminal, the NIT is bound to that USOP, and is permitted to use any services provisioned in that USOP. As described in "Terminal Initialization," Section 6, the NIT may also send a SETUP with no Calling Party Number, in which case the terminal will be bound to a "Default DN USOP" or to a Default Service USOP, if one or the other is provisioned for the terminal's interface.

4.2.1 CALL CONTROL PROCEDURES

4.2.1.1 General Rules

This section describes the procedures across the standard interface between the network and an ISDN user for basic circuit mode (circuit-switched) voice and data service calls. To be compatible with this interface, ISDN terminals must be able to support at least one nonnull call reference value.

The standard ISDN BRI interface will support the operation of up to eight terminals on a single BRI.

The calls may be either interexchange or intra-exchange, or both. The calls are controlled by a series of standardized messages that flow across this interface. The messages and procedures described here are based upon ITU-TS Recommendation Q.931 and Bellcore TR-TSY-000268 issue 2. This section focuses on a description of the procedures, that is, the logical call processing control flow. For the main discussion, standard BRI user-network connections will be assumed, unless noted otherwise. "Interworking with Existing Services," Section 4.2.1.6, focuses on any special procedures needed for connections between a standard BRI and other non-BRI connections (such as analog lines, or analog or digital non-ISDN trunks).

Before these procedures are invoked, a reliable data link (Layer 2) connection must be established between the user and the network (see "Data Link Layer," Section 3). Note that broadcast links are considered immediately established upon the availability and proper stable operation of Layer 1.

4.2.1.1.1 Bearer Capability Supported on the Standard ISDN Interface

The standard ISDN interface will support only the following bearer capabilities for circuit-switched voice and data services in both directions:

- Circuit-Mode/Speech
- Circuit-Mode 3.1-kHz Audio
- Circuit-Mode Unrestricted Digital Information (64 kbps)
- Circuit-Mode Unrestricted Digital Information-Rate Adapted from 56 kbps to 64 kbps.

If the calling user originates a call by sending a SETUP message containing unimplemented bearer capability (for example, or 64 restricted bearer capability), the switch will reject the call, and send a RELease COMplete message to the calling user with Cause 65, "bearer capability not implemented (location = public network serving local user)."

If the bearer capability requested by the calling user does not indicate an authorized bearer capability as determined by the user's subscription parameters (the bearer capabilities are subscribed as voice and/or data calls, where voice calls include speech and 3.1-kHz audio, and data calls includes 56 and 64 kbps), the switch will reject the call request, and send a RELease COMplete message containing Cause 57 "bearer capability not authorized" (location = public network serving local user).

Furthermore, the following basic rules (listed in order of precedence) must be observed:

1. A message received consists of fewer than three octets or is larger than the maximum allowed Layer 3 message size (see "Message Definitions," Section 4.1) shall be treated as unexpected, and will be ignored.
2. A message received with a protocol discriminator not in accordance with "Protocol Discriminator," Section 4.1.3.1.1, shall be treated as unexpected, and will be ignored.
3. An endpoint will ignore all broadcast messages that do not address it. No action shall be taken and no state change shall occur.
4. A message received missing one or more mandatory IEs shall be treated as unexpected. The user may send a STATUS message with Cause 96. The network will send a RElease COMplete with Cause 96 when a SETUP is received missing one or more mandatory IEs. No other action shall be taken on it, and no state change will occur.
5. When the user or network receives a message containing "optional" IEs that it does not know how to act upon, it may act on the message as if those IEs were not received.
6. Unrecognized IEs within messages will be ignored by the receiving equipment.
7. When a locking shift IE is encountered, the receiving equipment must interpret the following IE(s) according to the codeset specified by the locking shift IE, if supported. Terminals designed to meet only this section (that is, not "Network Layer—Supplementary Services," Section 5) will ignore any IEs in a message located after the locking shift to Codeset 6 IE.
8. If the switch receives from the user equipment a correctly coded message that contains the nonlocking shift IE, the switch should recognize this IE. The switch will ignore this IE and the IE following it, and continue call processing according to the procedures applicable to the received message.

Note: Please refer to "Handling of Error Conditions," Section 4.2.1.5, for further detail.

4.2.1.2 Call Establishment at the Originating Interface

4.2.1.2.1 Overview of Call Establishment

The user initiates call establishment by transferring a SETUP message across the user-network interface. This message will be sent only by a user in response to an explicit end-user stimulus (or other higher-layer application control).

Upon sending the SETUP message, the call (as viewed from the user side of the interface) enters the *Call Init* state. This SETUP message will contain a call reference (whose value is allocated according to the procedures described in "Call Reference," Section 4.1.3.1.2) and bearer capability IE.

If the terminal has initialized, and if the terminal is either a Basic Call or Basic EKTS terminal, then the SETUP message must contain the Calling Party Number IE; if the terminal is a CACH EKTS terminal, then the SETUP message must contain the Call Appearance IE. If the terminal has not initialized, then the Calling Party Number is optional. If a Calling Party Number is present, then the switch will attempt to associate the terminal with the services identified by that DN. If no Calling

Party Number is present, and the interface has a Default DN assigned for the indicated call type (circuit or packet mode), then the non-initialized terminal will be associated with the Default DN USOP. If no Default DN is assigned, but a Default Service USOP has been identified for the interface, then the terminal will receive the services associated with the Default Service USOP.

If the terminal established Layer 2 by using a fixed TEI which was provisioned in the switch for use with a D-channel Permanent Virtual Circuit, then the Calling Party Number IE is optional, as long as the requested call type is provisioned in the Fixed TEI USOP.

The SETUP message may also optionally contain channel identification IEs, or other IEs specified for the SETUP message in the user-to-network direction (such as Low-Layer Compatibility, High Layer Compatibility, Called Party Subaddress, or Calling Party Subaddress). Note that use of the exclusive channel selection calling option is allowed. All channel assignments, however, are determined by the network; an incompatible exclusive channel request by a user would result in a RELease COMplete network response with Cause 44, "requested channel not available."

4.2.1.2.2 Passing Low-Layer Compatibility (LLC) IE, High-Layer Compatibility (HLC) IE, Called Party Subaddress (CdPS) IE, and Calling Party Subaddress (CgPS) IE

These optional IEs (LLC, HLC, CdPS, and/or CgPS) are sent by the calling user to the destination user or entity. These optional IEs will be transported in Q.931 SETUP messages during the call establishment phase. The minimum length of LLC, HLC, CdPS, or CgPS is 4 octets.

a. ***Low-Layer Compatibility Information Element:*** The LLC IE is used to provide information to the called user equipment for compatibility checking between end-user equipment.

   If the calling user initiates a call by sending a SETUP message containing the LLC IE across the ISDN standard interface, the switch will pass this IE transparently and signal it in the SETUP message delivered to the terminating side if the LLC IE consists of 16 or fewer octets.

   If the LLC exceeds the maximum length, the switch will discard this IE and send a STATUS message to the calling user with a Cause 43, "access information discarded (location = public network service the local user; diagnostic = LLC IE identifier)," and the call state IE coded as Call State 1, "call initiated." The coding of the LLC IE is provided in "Low-Layer Compatibility," Section 4.1.3.2.18.

b. ***High-Layer Compatibility Information Element:*** The HLC IE is used to provide information to the called user equipment for compatibility checking between end-user equipment.

   If the calling user initiates a call by sending a SETUP message containing the HLC IE across the ISDN standard interface, the switch will pass this IE transparently and signal it in the SETUP message delivered to the terminating side if the HLC IE consists of 5 or fewer octets.

   If the HLC exceeds the maximum length, the switch will discard this IE and send a STATUS message to the calling user with a Cause 43, "access information discarded (location = public network service the local user; diagnostic = HLC IE identifier)," and the call state IE coded as Call State 1, "call initiated." The coding of the HLC IE is provided in "High-Layer Compatibility," Section 4.1.3.2.15.

c. ***Called Party Subaddress Information Element:*** The called party subaddress IE identifies a subaddress to be associated with the call at the destination interface.

   If the calling user initiates a call by sending a SETUP message containing the CdPS IE across the ISDN standard interface, the switch will pass this IE transparently to the terminating side only if:

   - the Called party number IE is present in the SETUP message; and
   - CdPS IE consists of between 5 and 23 octets containing a maximum of 20 digits of information.

   If one of the previous conditions is not met, the switch will discard CdPS IE, and send a STATUS message to the calling user with a Cause 43, "access information discarded" (location = public network serving the local user; diagnostic = CdPS IE identifier), and the call state IE coded as Call State 1, "call initiated." The coding of the CdPS IE is provided in "Called Party Subaddress," Section 4.1.3.2.6.

d. ***Calling Party Subaddress Information Element:*** The calling party subaddress IE identifies a subaddress associated with the call at the origination interface.

   If the calling user initiates a call by sending a SETUP message containing the CgPS IE across the ISDN standard interface, the switch will pass this IE transparently to the terminating side only if:

   - Calling party number IE or the call appearance IE is present in the SETUP message
   - CgPS IE consists of not more than 23 octets
   - ISDN calling number identification services feature allow to transfer the CgPS IE, as described in the ISDN calling number identification services.

   If one of the previous conditions is not met, the switch will discard this IE, and send a STATUS message to the calling user with a Cause 43, "access information discarded" (location = public network serving the local user; diagnostic = CgPS IE identifier), and the call state IE coded as call State 1, "call initiated." The coding of the CgPS IE is provided in "Calling Party Subaddress," Section 4.1.3.2.8.

4.2.1.2.3 En-bloc Sending Mode

4.2.1.2.3.1 Overview of En-bloc Sending Mode

"En-bloc" sending mode occurs when the network receives sufficient address information in the SETUP message (described previously) to set up the call. All the necessary address information may be provided by the user in one of the following addressing procedures.

- Keypad signaling using the keypad IE
- Functional addressing using the combination of transit network selection, called party number, and/or operator system access IEs.

The customer premises equipment (CPE) shall not use the keypad IE in combination with called party number IE, TNS IE, and/or operator system access (OSA) IE. If the network receives the keypad IE with the called party number IE, TNS IE, and/or OSA IE in the SETUP message, in general the network will clear the call based on the call type.

- If the call is end-to-end ISDN voice call (speech or 3.1 kbps), the network will send to the originating CPE a CALL PROCeeding message to identify the B-channel over which the inband information will be provided. The network will then send a PROGress message containing Cause 28, "invalid number format," and Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."
- If the call is end-to-end ISDN data call (56- or 64-kbps unrestricted digital information), the network will send a RELease COMplete with Cause 28 and signal information "Network Congestion (Reorder) tone on."

The called party number IE shall contain only the destination address of the call, unless the CdPN IE is coded as "Unknown."

The TNS IE, if included, shall contain the identification of the network that will be routing the call to its destination.

The OSA IE, if included, shall contain information to request access to an operator system. The network will act on the OSA IE only when it is signaled after the locking shift IE where the codeset identification is set to Codeset 5. Otherwise, the network will treat the ID as an unimplemented IE.

Details on the content of the CdPN, TNS, and OSA IEs are given in "Message Definitions," Section 4.1.

4.2.1.2.3.2 Error Conditions

The error conditions that cause the network to reject the call are as follows:

- If the CdPN IE is coded with incomplete address information to determine the routing of the call, the switch will reject the call by sending a RELease COMplete message with Cause 28, "invalid number format (location = public network serving the local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message to identify the B-channel over which the inband information will be provided. The switch will then send a PROGress message containing Cause 28, "invalid number format," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on." The only exception to this is when CdPN is coded unknown and may have an access code.
- If the OSA IE is coded in an unacceptable code in association with the CdPN or the TNS IEs, the switch will reject the call by sending a RELease COMplete message with Cause 28, "invalid number format (location = public network serving the local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message to identify the B-channel over which the inband information will be provided. The switch will then send a PROGress message containing the Cause 28, "invalid number format," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."

- If the transit network selection IE contains in the network identification field, a network that is not recognized by the switch, the switch will reject the call by sending RELease COMplete with Cause 2, "no route to specified transit network (location = public network serving the local user)," and signal information "reorder tone on." However, if tones and announcements apply, the switch will send a CALL PROCeeding message then send a PROGress message containing the Cause 2, "no route to specified transit network," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."
- In the case of an intra-LATA call, if the TNS IE is specified for carrier that is not authorized to carry intra-LATA calls, the switch will reject the call by sending a RELease COMplete message to the calling user with Cause 3, "no route to destination" (location = public network serving local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message then send a PROGress message containing the Cause 3, "no route to destination," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."
- In the case of inter-LATA call, if the TNS IE is not available to the switch (for example, the TNS information is not present in the SETUP message and appropriate inter-LATA carrier presubscription information is not available), the switch will reject the call by sending a RELease COMplete message to the calling user with Cause 3, "no route to destination" (location = public network serving local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message then send a PROGress message containing the Cause 3, "no route to destination," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."
- If the CdPN/(TNS) IE is coded with an unimplemented type of number (network)/numbering (network) identification plan code, or if the OSA IE is coded with an unimplemented type of access, the switch will reject the call. The switch will send to the calling user equipment a RELease COMplete message containing Cause 100, "invalid IE contents (location = public network serving the local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message then send a PROGress message containing the Cause 100, "invalid IE contents," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."
- If the SETUP message contains the keypad IE and any of the functional addressing IEs: CdPN, TNS, or OSA, the switch will reject the call. The switch will send to the calling user equipment a RELease COMplete message containing Cause 28, "invalid number format (location = public network serving the local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message to identify the B-channel over which the inband information will be provided. The switch will then send a PROGress message containing the Cause 28, "invalid number format," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."

- If the calling number is not subscribed to any dialing or routing feature [individualized dialing plan (IDP), Speed Calling, automatic route selection (ARS), advanced services platform (ASP), private facilities access (PFA)], the switch will reject the call if the CdPN is coded private (network-specific or abbreviated) or the TNS is coded user-specific by sending a RELease COMplete message with Cause 28, "invalid number format (location = public network serving local user)." However, if tones and announcements apply, the switch will send CALL PROCeeding message to identify the B-channel over which the inband information will be provided. The switch will then send a PROGress message containing the Cause 28, "invalid number format," Progress Indicator 8, "inband treatment has been applied (location = public network serving the local user)," and the signal information "Network Congestion (Reorder) tone on."

4.2.1.2.3.3 B-Channel Selection

If the channel that has been requested by the user is appropriate (per the user's subscribed channel configuration, if applicable) and available, the network shall send the user a CALL PROCeeding message with that channel identification specified exclusive. This message will signify to the user that the network has received complete address information, and the network checked the availability of the destination interface or an out going trunk to route the call. Upon user receipt of this message, the call enters the *Outgoing Call Proceeding* state at the user side of the interface. No further address information will be accepted for the call.

If the user-requested channel is inappropriate or unavailable but the user had expressed only a preference in the SETUP message, then the network will allocate the other B-channel if appropriate and available. This channel's identity is indicated in the channel identification IE in the CALL PROCeeding message.

On the other hand, if no appropriate channel is available, the network will send the user a RELease COMplete message with Cause 34, "no channel available," and the call enters the *Null State*. If the user had expressed an "exclusive" preference for a channel that is not appropriate or not available, the network will send the user a RELease COMplete message with Cause 44, "requested channel not available," and the call enters the *Null State* (See "Message Definitions," Section 4.1, for more information regarding call states.)

The call reference value used in these messages (RELease COMplete and CALL PROCeeding) is the one the user allocated in the SETUP message, with the flag bit appropriately set. (See "Call Reference," Section 4.1.3.1.2)

4.2.1.2.4 Keypad Equivalent of Functional Addressing without Dialing/Routing Features

This section provides the translation of codes signaled in functional addressing IEs where the calling user does not have any supplementary dialing or routing features such as IDP, speed calling, PFA, ASP, and ARS.

To provide specific code interpretations, the following different combinations are identified in which the CdPN, TNS, and OSA can be signaled. Table 4.2.1-1, provides routing requirements for each possible combination of functional addressing IEs received from a calling DN that is not subscribed to any supplementary dialing or routing features. The switch will route the call as if it has received the address digits in the keypad equivalent corresponding to the functional addressing combination. The term XXXX in the keypad equivalent column represents the transit network identification digits that are present in the TNS IE. The term xxxx in the keypad equivalent column represents the line number contained in the address digits field of the CdPN IE. The term (1) means the prefix 1 which may or may not have to be signaled in the keypad method, which is an option controlled by the service provider.

4.2.1.2.5 Overlap Sending Mode

"Overlap" sending mode occurs if the SETUP message did not contain sufficient address information for call establishment. If the SETUP message did not contain any address information, the network will treat the call as follows:

- If the bearer capability is a speech or 3.1-kHz audio call (tones and announcements apply), the network will return to the user a SETUP ACKnowledge message containing the PI=8 "inband information or appropriate pattern now available" and a signal IE "dial tone on."
- If the bearer capability is a 56-kbps or 64-kbps unrestricted digital information (tones and announcements do not apply), the network will return to the user a SETUP ACKnowledge message containing a signal IE "dial tone on."

This SETUP ACKnowledge message will contain the call reference used in the SETUP message with the flag bit appropriately set, and a channel identification IE for the channel to be used in the call (determined per the previous procedure). The network shall also provide inband dial tone on the B-channel that has been selected. The network will start Timer T302. (For timer values, see Table 4.2.2-1.) The call enters the *Overlap Sending* state.

If, instead, incomplete address information was provided in the SETUP message, the network will send a SETUP ACKnowledge message as before, but without the signal IE. The network will not provide inband dial tone. The network will start Timer T302. The call enters the *Overlap Sending* state.

In either case, the user must now transmit to the network the balance of the address digits, either one at a time or in groups, by sending INFOrmation messages containing the address digits. These digits will be transmitted in keypad IEs.

If there had been no address information in the SETUP message, the network's response to the user's first INFOrmation message containing address information will be to transmit in return an INFOrmation message containing a Signal IE "tones off." The network will also cease providing inband dial tone.

The network will reinitialize Timer T302 upon the receipt of every such INFOrmation message (containing address information) from the user, until it determines that sufficient address information has been received. When outgoing facilities are determined, a CALL PROCeeding message is sent to the user, the call enters the *Outgoing Call Proceeding* state, Timer T302 is canceled, and call establishment is begun. No further address information will be accepted by the network for this call, that is, address information will be transmitted by the user in only SETUP messages and INFOrmation messages sent while the terminal is in the *Overlap Sending* state. Keypad elements received by the network that are related to the control of a connection that is in other than the *Null* or *Overlap Sending* states will be ignored by the network, and may be treated as unexpected as specified in "Unexpected or Unrecognized Messages with Valid Call References," Section 4.2.1.5.2. (Exceptions exist for certain supplementary services; see "Common Protocols and Procedures for Voice and Data Services," Section 5.1).

Table 4.2.1-1 — Keypad Equivalent of Functional Addressing without Dialing/Routing Features

CASE	OSA	TNS	CdPN	KEYPAD EQUIVALENT
1	Alternate	––	––	00
2	Alternate	––	International	00 (Ignore CdPN)
3	Alternate	––	National	00 (Ignore CdPN)
4	Alternate	––	Local	00 (Ignore CdPN)
5	Alternate	––	Unknown	Clear Call
6	Alternate	––	Private	00 (Ignore CdPN)
7	Alternate	IEC	International	101XXXX+00 (Ignore CdPN)
8	Alternate	IEC	National	101XXXX+00 (Ignore CdPN)
9	Alternate	IEC	Local	101XXXX+00 (Ignore CdPN)
10	Alternate	IEC	Unknown	Clear Call
11	Alternate	IEC	Private	00 (Ignore CdPN)
12	Alternate	User-Specific	Don’t Care	Clear Call
13	––	––	––	Keypad signaling
14	––	IEC	––	101XXXX (cut-thru to IEC)
15	––	User-Specific	Don’t Care	Clear Call
16	Principal	––	––	0
17	Principal	IEC	––	101XXXX+0
18	Principal	User-Specific	Don’t Care	Clear Call
19	––	––	International	011+CC+NN
20	––	––	National	(1)+NPA+CO+xxxx OR N11
21	––	––	Local	CO+xxxx OR N11
22	––	––	Unknown	Keypad signaling OR N11
23	––	––	Private	Clear Call
24	––	IEC	International	101XXXX+011+CC+NN
25	––	IEC	National	101XXXX+(1)+NPA+CO+xxxx
26	––	IEC	Local	101XXXX+CO+xxxx
27	––	IEC	Unknown	Clear Call
28	––	IEC	Private	Clear Call
29	Principal	––	International	01+CC+NN
30	Principal	––	National	0+NPA+CO+xxxx OR N11
31	Principal	––	Local	0+CO+xxxx OR N11
32	Principal	––	Unknown	Clear Call
33	Principal	––	Private	Clear Call
34	Principal	IEC	International	101XXXX+01+CC+NN
35	Principal	IEC	National	101XXXX+0+NPA+CO+xxxx
36	Principal	IEC	Local	101XXXX+0+CO+xxxx
37	Principal	IEC	Unknown	Clear Call
38	Principal	IEC	Private	Clear Call

If Timer T302 expires before the network receives sufficient information, the network will treat the call as either a permanent signal or a partial dial condition. If the call is a voice (speech and 3.1 kbps) call, the calling user will receive a PROGress message with progress indicator = 8 (inband treatment has been applied) in conjunction with the appropriate inband tone or announcement (see "Call Failure Procedure," Section 4.2.1.2.6). When the user receives this message, the user will monitor the B-channel. No state transition takes place when the message is sent or received. When the tone or announcement times out, the network sends a DISConnect message to the user that will contain a signal IE indicating "tones off," if a tone had been provided to the user (see "Handling of Error Conditions," Section 4.2.1.5). The call would then enter the *Disconnect Indication* state and proceed as in "Call Clearing by the Network," Section 4.2.1.4.3.

4.2.1.2.6 Call Failure Procedure

In general, for end-to-end ISDN voice calls (speech or 3.1-kHz audio), if the network determines that a call not yet in the active state cannot be established, and if the network wishes to provide a tone over the B-channel, the network will send the user a PROGress message with Progress Indicator 8 and an appropriate signal IE. If instead the network wishes to play an announcement over the B-channel, the network will send the user a PROGress message containing Progress Indicator 8, but no signal IE. The network will then connect the user B-channel to the desired announcement or tone source. When the user receives one of the previous messages, the user will monitor the B-channel to receive such information as the network tone or announcement may provide. If possible, the terminal will inform its end-user of the contents of the cause IE, if present. No state transition takes place when the PROGress message is sent or received.

If and when the tone or announcement times out, the network will send a DISConnect message containing an appropriate cause and signal IE indicating "tones off," if appropriate. The call will then enter the *Disconnect Indication* state and proceed as in "Call Clearing by the Network," Section 4.2.1.4.3. Otherwise, the call will remain in its current state until the calling user issues a DISConnect message, moving the call into the *Disconnect Request* state (see "Clearing by the User," Section 4.2.1.4.2).

In the case of end-to-end data call (56- or 64-kbps unrestricted digital information), if the network determines that a call not yet in the *Active state cannot be established*, the network will send a DISConnect message containing an appropriate signal IE.

4.2.1.2.7 Call Confirmation

If the originating network-switch receives an indication that the remote user has been alerted, it will send the calling user an ALERTing message. Audible (inband) ring will also be provided by the network to the calling party at this time. When the ALERTing message is sent, the call enters the *Call Delivered* state. The calling user, upon receiving the ALERTing message, may choose to provide its own audible ring, or equivalent, indication.

In certain cases, the remote user may respond with a CONNect message without sending an ALERTing message. In that case, the originating user will not receive the ALERTing message, but instead will directly receive a CONNect message (see "Call Connected," Section 4.2.1.2.8). Upon receiving a CONNect message, the user will cease providing audible ring, if it is doing so.

If the network receives an indication that interworking has occurred, it will transmit a progress indicator IE to the calling user in an appropriate message (that is, ALERTing, CONNect, or PROGress). If the message used is a PROGress message, no state change will occur.

For end-to-end circuit-switched data calls, the switch will not return the audible ringing to the calling user.

4.2.1.2.8 Call Connected

When the originating network switch receives an indication that the call has been accepted and connected at the remote end, it will send the calling user a CONNect message. An end-to-end circuit connection exists at this point, and the call enters the *Active* state. The user-endpoint will cease providing audible ringing, if it is doing so, and it may choose to send a CONNect ACKnowledge message in response to the CONNect message. The CONNect ACKnowledge message, however, will not trigger any event (for example, state transition) in the network.

When a circuit-switched call originated from an ISDN interface terminates to a non-ISDN line, the ringing will be removed from the called line following off-hook detection. The network will then send the calling user equipment a CONNect message containing Progress Indicator 2, "Called equipment is non-ISDN."

If tones were previously turned on, a signal IE (tones off) is included in the CONNect message.

4.2.1.3 Call Establishment at Terminating Interface

For the purposes of this section, a called user is "busy" if all subscribed voice and data service B-channels are currently used, that is, active or already reserved for an incoming or outgoing call. (This definition is, in general, a function of the service being provided and the features that have been invoked for a given call. See also "Terminal Initialization," Section 6.)

If the network does not recognize the called user-network interface as "busy," the network will indicate the arrival of a call at the user-network interface by transferring a SETUP message across the interface through the broadcast capability at the data link layer. [Note that this procedure assumes that a point-to-point data link connection may not exist before the first Layer 3 message, for example, SETUP, is transferred across the interface to the user endpoint. However, a reliable point-to-point data link must be established by the user endpoint and the initialization procedures (if appropriate) must be invoked before responding to the SETUP message.] This SETUP message contains the call reference IE, bearer capability IE, called party number IE, and channel identification IE marked with the exclusive option (or "No channel available" for certain supplementary services; see "Common Protocols and Procedures for Voice and Data Services," Section 5.1). The SETUP message may also contain the progress indicator, and signal IE. After the SETUP message is sent, the call is in the *Call Present* state. The network initializes Timer T303 (see "Data Link Layer," Section 3).[1]

The network will not transmit SETUP messages to a busy called party. If the call is an interoffice call (that is, involves two or more switches), and out-of-band interoffice

1. From a terminal implementation viewpoint, the user may not have enough time, before this timer expires, to exercise certain terminal options. Therefore, the user may have to exercise these options earlier, in a predetermined fashion.

signaling is available, the network will take action to clear the interoffice connection back to the originating switch (that is, the switch serving the calling party). The originating switch continues to provide busy treatment to the calling party until such time as the calling party initiates call clearing procedures.

At the terminating ISDN BRI interface, only a single valid response will be expected for each SETUP message sent. The endpoint will satisfy the appropriate compatibility requirements for an incoming call before responding to a SETUP message. The following elements contained in the SETUP message may be used by the terminal to verify compatibility:

- ***Bearer Capability:*** The network will indicate the bearer service of the incoming call in the bearer capability IE. The terminal will respond to a SETUP message if the indicated bearer capability is supported by that endpoint and all other appropriate compatibility requirements are satisfied. All terminals must satisfy this compatibility requirement.
- ***Called Party Number:*** The network will always include the destination address of the incoming call in the called party number IE. The called party number will be coded as a local (directory) number in the ISDN numbering plan. Terminals will respond to a SETUP message if the indicated called number is assigned to that endpoint and all other appropriate compatibility requirements are satisfied.
- ***Called Party Subaddress:*** The called party subaddress IE that identifies subaddress associated with the called terminal can be used as compatibility check.

At a minimum, compatibility is determined by the terminal comparing the Bearer capability IE against its internal parameters.

If the terminal detects a mismatch in checking the compatibility information, then the terminal shall either ignore the call or reject the call by sending a RELease COMplete message with Cause 88, "incompatible destination," to the switch.

4.2.1.3.1 Call Confirmation

User equipment may respond to a SETUP message with a RELease COMplete with Cause 88, CALL PROCeeding, ALERTing, or CONNect message. Note that if a RELease or DISConnect is received with Cause 88, the switch will send RELease COMplete, but will continue to offer the call.

User equipment that satisfies the compatibility requirements indicated in the SETUP message and that wishes to accept the call responds with an ALERTing, a CALL PROCeeding, or a CONNect message.
If a CALL PROCeeding, ALERTing, or CONNect message is the first response from the called user to a SETUP message from the switch, the switch will accept the message as valid only if it contains the channel identification information marked as "Exclusive" B-channel indicating the channel on which the user equipment is prepared to accept the call. The channel ID must be the same as the channel that was sent by the ongoing setup.

If the channel identification IE is not included, the switch will initiate call clearing by sending to the called user a RELease message with Cause 96, "mandatory IE is missing (location = public network serving the local user; diagnostic = channel ID IE)."

If the channel identification IE is included and marked other than "Exclusive" B-channel (for example, marked as "Preferred" or "Any" B-channel) or the channel ID is not coded properly, the switch will initiate call clearing to the called user by sending a RELease message with Cause 100, "invalid IE contents (location = public network serving the local user; diagnostic = channel ID IE)."

If the channel identification in the CALL PROCeeding, ALERTing, or CONNect message is the first response from the called user equipment is different than the channel ID indicated in the SETUP message from the switch to the called user equipment, the switch will clear the call, and send a RELease message to the called user equipment containing Cause 6, "channel unacceptable," (location = public network serving local user)."

If the user equipment sends a CALL PROCeeding message first, the terminal subsequently sends an ALERTing and/or CONNect message. When the user equipment sends the network an ALERTing message, the terminal equipment is alerting the called user.

If the RELease COMplete message received from the called ISDN equipment contains Cause 88, "incompatible destination," the switch will ignore the message received from called user and continue to offer the call at the interface.

Multiple NITs may respond to the same SETUP message, since they are not permanently "bound" to a service profile. The switch will award the call to the NIT sending the first valid response. Any other responses, except for a RELease COMplete containing Cause 88, will be treated as an unexpected message.

4.2.1.3.2 Call Acceptance

To accept an incoming call, the user must send the network a CONNect message. The CONNect message will be sent by a terminal only in response to an explicit end-user (or other higher-layer application control) stimulus. If the user accepts a call using the B-channel indicated in the SETUP message and no user alerting is required, the called user may send a CONNect message without a previous ALERTing message. The user shall include the channel identification IE in the CONNect message, if the message is the first response to an incoming SETUP message. If this action is taken by the user, this element must be coded to reflect the same channel offered by the network in the incoming SETUP message.

When the switch receives a CONNect message, the switch will cancel Timers T301, T303, and T310 if any of them is running.

- If the call originated from a non-ISDN line, no indication of called party answer is sent to the calling user. The audible ringing tone, if being provided, will be removed.
- If the call originated from a non-ISDN trunk, the switch will return answer supervision over the trunk. The audible ringing tone, if being provided, will be removed from the trunk.

4.2.1.3.3 Active Indication

When the network receives a CONNect message, the call enters the *Connect Request* state. The network completes the circuit-switched path to the selected B-channel and subsequently sends a CONNect ACKnowledge message to the user that has accepted the call. The network also removes the audible ring, if present, to the calling party and initiates procedures to inform the originating exchange that the call has been connected. The CONNect ACKnowledge message indicates completion of the circuit-switched connection at the terminating exchange. The call enters the *Active* state at the terminating exchange at this time.

Upon receipt of the CONNect ACKnowledge message, the called terminal connects to the B-channel. (Note the called terminal must wait for the CONNect ACKnowledge message before connecting to the B-channel).

4.2.1.3.4 SETUP Collision

SETUP collision can occur when there is contention in the switch and/or the terminal for a limited resource. Two types of SETUP collisions have been identified: B-channel collisions and call appearance collisions (see "Setup Collision," Section 5.1.1.1.5).

SETUP collision can occur when there is contention in the switch and/or the terminal for the same B-channel resource. For example, SETUP collision can occur when the user transfers a SETUP message specifying a B-channel (for example, B1) with the exclusive option at the same time the switch transfers a SETUP message to the user specifying the same B-channel (that is, B1, in this example). The network will respond to the user's SETUP with a RELease COMplete message. Upon receipt of the network SETUP message, the user will assign the specified B-channel to the new incoming call, and proceed as in "Call Confirmation," Section 4.2.1.3.1.

Another example of a call collision is when the terminal is provisioned to have one voice call appearance and the user sends a SETUP (channel = any) at the same time as the network sends a SETUP (channel = B) where B stands for a particular B-channel. In this case, the terminal and the network are contending for the same call appearance (though not the same B-channel). This is an example of a call collision.

4.2.1.3.5 Excessive Call Delay Procedures

At the terminating interface, the switch will start Timer T303 after sending the SETUP message to the called user. The call enters the call present state. If the switch receives no response to the initial SETUP message sent to the called user equipment before Timer T303 expires, the call is considered to be encountering "excessive call setup delay."

If no response is received from the called user before the first expiration of T303, the switch will retransmit SETUP message and restart Timer T303. If a CALL PROCeeding message has been received from the called user equipment before the first expiration of Timer T303, the switch will not retransmit the first expiration of the SETUP message, and will not restart Timer T303. Note that Timer T303, if not expired, will not be canceled upon receipt of CALL PROCeeding message and T310 will be started.

The switch will also apply the following procedures:

A. **First Expiration of T303**

If no response has been received from the called user equipment or if a CALL PROCeeding message has been received, when Timer T303 expires the first time:

- For end-to-end ISDN speech or 3.1-kHz audio call, the switch will send the calling user equipment a PROGress message containing two progress indicator IEs: national standard Progress Descriptor 10, "delay in response at the called interface," and ITU-TS-standardized Progress Descriptor 8, "inband information for appropriate pattern now available," each with the location "public network serving the remote user." The PROGress message will also include the signal IE set to "ring-back/audible ringing tone on," and the switch will return inband audible ringing tone to the calling user in the associated B-channel.

- For end-to-end ISDN data call, the switch will send the calling user a Progress Descriptor 10, "delay in response at the called interface," and the signal "ring-back/audible ringing tone on."

For a circuit-switched call originating from a non-ISDN line or trunk, the switch will return audible ringing tone to the calling user.

B. **Second Expiration of T303**

If Timer T303 expires the second time and no response has been received from the called user equipment, the switch will release the B-channel and the call reference value:

- For an end-to-end ISDN speech or 3.1-kHz audio call, the switch will send the calling user equipment another PROGress message containing Cause 18, "no user responding," and Progress Indicator 8, "inband information or appropriate pattern now available." The PROGress message will also include the signal IE set to "ringback/audible tone on" and the Timer T306 will be initiated. The switch will remove the inband audible ringing tone when the calling user initiates clearing or when Timer T306 expires. If T306 expires, the switch will send the calling user a DISConnect message containing Cause 102, "recovery on timer expiry," and signal "tones off."
- For a circuit-switched call originating from a non-ISDN line or trunk, the switch will continue to provide audible ringing to the calling party until it disconnects.
- For an end-to-end ISDN data call, the network sends a DISConnect message to the calling user with Cause 18, "no user responding," and signal "ringback/audible ringing tone on."

4.2.1.3.6 Call Proceeding Indication

A. **Actions on Receipt of a Call Proceeding Indication**

The CALL PROCeeding message may be received by the switch when the called CPE cannot respond to a SETUP message with an ALERTing, CONNect, or a call clearing message before Timer T303 expires.

When a CALL PROCeeding message is received from the called user before the expiry of Timer T303 (first T303), the timer will continue to run and Timer T310 will also be started. However, if the CALL PROCeeding message is received when T303 is running for the second time, T303 is stopped and T310 is started.

B. **Action at Expiration of Timer T310**

If the switch does not receive an ALERTing or CONNect message from the called user equipment before Timer T310 expires, the switch will clear the call at the called interface. The switch will send a RELease message with Cause 102, "recovery on timer expiry," to the called user equipment.

When Timer T310 expires:

- For an end-to-end ISDN speech or 3.1-kHz audio call, the switch will send the calling user equipment a PROGress message containing Cause 18, "no user responding," Progress Indicator 8, "inband information or appropriate pattern now available," and signal "ringback/audible ringing tone on." Timer T306 will be initiated, and the switch will continue to provide audible ringing tone to the calling user until a release indication is received from the calling user equipment or Timer T306 expires. If T306 expires, the switch will send the calling user a DISConnect message containing Cause 102, "recovery on timer expiry," and signal "tones off."

- For an end-to-end ISDN data call, the network sends a DISConnect message to the calling user with Cause 18, "no user responding," and the signal "ring-back/audible ringing tone on."

If the call originated from a non-ISDN line or a trunk, the switch will continue to provide audible ringing tone to the calling user until an on-hook indication is received.

4.2.1.3.7 Call Received

When the switch receives an ALERTing message, it cancels Timer T303 or T310 (depending on which one is currently active), and moves the call into the call received state, and starts Timer T301. Receipt of an ALERTing message also causes the network to send the calling user a corresponding ALERTing message:

- For an end-to-end ISDN voice call, the network returns audible (inband) ring upon receipt of an ALERTing message (if it is not already doing so). When an ALERTing message is sent, the ALERTing message will include Progress Indicator 8, "inband information or appropriate pattern now available," and signal "ringback/audible ringing tone on." The switch will return audible ringing tone to the calling user.
- For end-to-end ISDN data, the network sends an ALERTing message to the calling user with the signal "ring-back/audible ringing tone on."

If audible ringing tone is already being provided because Timer T303 expired, the switch will continue to provide audible ringing. If Timer T301 expires, the switch will apply the following procedures:

A. **Called Party Treatment**

If the switch does not receive a valid CONNect message from the called user equipment before Timer T301 expires, the switch will send a RELease message with Cause 102, "recovery on timer expiry," to the called user equipment.

B. **Calling Party Treatment**

The treatment of the calling party depends on the bearer capability and the call type of the calling user equipment. For an end-to-end ISDN circuit-switched call, the switch will send the calling user equipment a DISConnect message containing Cause 19, "user alerting, no answer," and signal IE set to "tones off." The switch will remove audible ringing if the call is speech/3.1 kHz audio.

For the circuit-switched call originating from a non-ISDN line or trunk, the switch will continue to provide audible tones to the calling user until an on-hook indication is received.

4.2.1.3.8 Call Rejection

4.2.1.3.8.1 Call Rejection by the Called User

The called ISDN equipment may reject an incoming call in the call present or incoming call proceeding state by sending the appropriate clearing message to the network. The network will respond with normal call clearing procedures to the called party. Treatment to the calling party will be provided as follows:

- If the clearing message (DISConnect, RELease, or RELease COMplete) received from the called ISDN equipment contains Cause 88, "incompatible destination," the switch will respond by sending to the called user a RELease COMplete message (the switch will ignore a RELease COMplete message if it receives one) and continue to offer the call at the interface. If T303 expires for the first time, the procedures in "Excessive Call Delay Procedures," Section 4.2.1.3.5, are followed. If T303 expires for the second time and the switch has not received any message other than call clearing message with Cause 88, the switch will apply to the calling user the following treatment based on the call type:

  — In the case of end-to-end ISDN voice call (speech or 3.1 kHz audio), the switch will send to the calling user a PROGress message with Cause 18, "no user responding," signal "ringback/audible ring tone on," and Progress Indicator 8, "inband information or appropriate pattern now available." Inband audible ringing will be applied to the B-channel.

  — In the case of an end-to-end ISDN data call (56- or 64-kbps unrestricted digital information), the switch will send to the calling user a DISConnect message with Cause 18, "no user responding," and signal "ringback/audible ring tone on."

  — For a circuit-switched call originating from a non-ISDN line or trunk, the switch will return busy tone to the calling party unless audible ringing is already being returned. For the latter situation, the switch will continue returning audible ringing until the calling party disconnects.

- If the clearing message received from the called ISDN equipment contains Cause 17, "user busy," a treatment to the calling party will be provided as follows:

  — In the case of an end-to-end ISDN voice call (speech or 3.1-kHz audio), a PROGress message will be sent to the calling ISDN interface with Cause 17, "user busy." The PROGress message will also contain a signal IE coded to indicate "busy tone on" and busy tone will be applied to the B-channel unless an audible ringing tone was previously indicated. If audible ringing is already being applied, then the signal IE will indicate "ringback/audible ringing tone on" and the inband treatment will continue. The PROGress message will also include Progress Indicator 8, "inband information or appropriate pattern now available."

  — In the case of an end-to-end ISDN data call (56- or 64-kbps unrestricted digital information), the switch will send to the calling user a DISConnect message with Cause 17, "user busy," and signal "ringback/audible ring tone on."

  — For a circuit-switched call originating from a non-ISDN line or trunk, the switch will return audible ringing tone to the calling user.

- If the clearing message received from the called ISDN equipment contains a cause value other than Cause 88 or Cause 17, the switch will apply to the calling user the following treatment based on the call type.
  - In the case of an end-to-end ISDN voice call (speech or 3.1-kHz audio), a PROGress message will be sent to the calling ISDN interface with Cause 21, "call rejected," signal "ringback/audible ring tone on," and Progress Indicator 8, "inband information or appropriate pattern now available." Inband audible ringing will be applied to the B-channel.
  - In the case of an end-to-end ISDN data call (56- or 64-kbps unrestricted digital information), the switch will send to the calling user a DISConnect message with Cause 21, "call rejected," and signal "ringback/audible ring tone on."
  - For a circuit-switched call originating from a non-ISDN line or trunk, the switch will return audible ringing to the calling user.

In each of the previous cases, the network will start Timer T306 on sending the PROGress message to the calling user. The network will continue to provide the appropriate tone to the calling user until a clearing message is received from the calling user equipment or Timer T306 expires. If the calling user initiates clearing, the switch will complete normal call clearing procedures. If T306 expires, the switch will send a DISConnect message to the calling user equipment. The DISConnect message will contain Cause 102, "recovery on timer expiry," and signal "tones off."

If the user responds to the incoming SETUP message with a CALL PROCeeding message, and subsequently transmits a DISConnect message, the network will move the call to the *Disconnect Request* state. The network will respond to the called party with normal clearing procedures, but will return audible (inband) ring to the calling party. It will also return a PROGress message with Progress IE = 8 and the signal IE (audible ringing tone on) and the cause IE contained in the DISConnect message from the called user.

4.2.1.3.8.2 Call Rejection by the Network

In response to a SETUP message, if the switch receives any message other than a RELease COMplete message from a noninitialized terminal that or a fully-initialized terminal that is not associated with the offered call (user service profile), the switch will clear the responding CPE by sending a RELease COMplete message with Cause 21, "call rejected (location = public network serving local user)." If the switch receives a RELease COMplete message from a noninitialized terminal or a fully-initialized terminal not associated with a called user service profile in response to a SETUP message, the switch will ignore this message and continue call processing. The switch should continue to offer the call at the interface as if no user has responded.

4.2.1.4 Call Clearing

4.2.1.4.1 Overview of Call Clearing

Whenever the terminal moves into the *Null* state, the terminal will ensure that any tones, alerting, and other resources associated with the call reference being idled are also idled or released. Under normal conditions, the user or network usually initiates call clearing by sending a DISConnect message and following the procedures defined in this section. The only exceptions to this rule are as follows.

1. In response to a SETUP message, the user or the network will clear a rejected call (for example, because of incompatibility) by responding with a RELease

COMplete message, provided neither has previously sent any other response. This message, in turn, will result in the release of the call reference and in the renewed availability of the B-channel indicated by the SETUP message. (See "Call Confirmation," Section 4.2.1.3.1.)

2. The network may, under certain error conditions, issue a RELease COMplete message to clear a call. Therefore, a user-endpoint must be able to act upon a RELease COMplete in any state. As mentioned previously, this message will result in the release of the Call Reference and will make available the B-channel previously used.

4.2.1.4.2 Clearing by the User

Apart from the exception mentioned previously, the (terminating or originating) user initiates call clearing by generating a DISConnect message, with a cause IE indicating the reason for clearing across the interface to the network. When the network receives the DISConnect message, the call enters the *Disconnect Request* state. [For terminals that wish to protect against overbilling (due to loss of user DISConnect message) it is recommended that a clearing procedure with a timer scheme similar to that used by the network be implemented.]

The network responds to this message with a RELease message. (The RELease message has local significance only and does not imply an acknowledgment of clearing from the remote user.) Timer T308 is started, and the network enters the *Release Request* state. At this time the network also informs the remote network switch that the call has been terminated. Where possible, the network relays the same cause code to the far-end user. The B-channel is now unavailable for information transfer, but it is not yet available for use in other calls. If the user sends a RELease COMplete message before the expiry of T308, the network cancels the timer and makes the B-channel available for other calls. The call reference is also released at this time, and the call enters the *Null* state. If the user does not respond within the time period, the network retransmits a RELease message, as mentioned previously, to the user and restarts Timer T308. If the timer expires once again before the network receives a response from the user, the network considers the call completely terminated, makes the B-channel available for other calls, and releases the call reference; then the call enters the *Null* state.

4.2.1.4.3 Call Clearing by the Network

Apart from the exceptions mentioned previously, the network will initiate clearing by transferring a DISConnect message across the user-network interface, and the procedure described as follows will apply. When the network sends the DISConnect message, the B-channel used in the call is disconnected but is not yet available for further calls. The network starts Timer T305 and the call now enters the *Disconnect Indication* state. If the network initiates clearance in response to a far-end disconnection, the network will include the cause code from the far end in the DISConnect message. Otherwise, the network also initiates clearing toward the far end if necessary.

To clear the call, the user sends the network a RELease message. (Note, a Type II stimulus user-endpoint is permitted to send a DISConnect.) If the user generates the DISConnect message, the network follows the procedure described in "Clearing by the User," Section 4.2.1.4.2. If, instead, the user generates the RELease message, moving the call into the user *Release Request* state, the network will respond with a RELease COMplete message, and the call will move into the *Null* state.

If the network does not receive a DISConnect or RELease message from the user in a time interval T305 from the network's transmission of the DISConnect message, the network will cancel Timer T305 and send a RELease message to the user. The network will start Timer T308 and continue as described in paragraph two of "Clearing by the User," Section 4.2.1.4.2.

In some cases, the user may receive a RELease message from the network without having received a DISConnect message previously In these cases, the user must respond with a RELease COMplete message.

4.2.1.4.4 Clear Collision

Clear collision occurs when the user and the network simultaneously transfer a DISConnect message specifying the same call reference value. The network will regard the call as having entered the *Disconnect Request* state. In other words, the network will now send the user a RELease message. It may contain the same Cause value that the network received in the DISConnect message from the near-end user. The procedures described in paragraph two of "Clearing by the User," Section 4.2.1.4.2, now apply.

When collision occurs, the near-end user receives a DISConnect message after having sent a DISConnect message. In this case, the user will ignore the DISConnect message received from the network and follow the procedures described previously (that is, it will wait for a RELease message from the network).

4.2.1.5 Handling of Error Conditions

At a minimum, the following requirements are necessary for proper handling of error conditions occurring at this interface.

- The user terminal equipment must be capable of removing and/or retarding unnecessary/undesired tones or announcements provided by the network.
- The user must be capable of receiving a STATUS ENQuiry message and must respond to the STATUS ENQuiry with a STATUS message.
- The user must be capable of ignoring the receipt of a message that was received earlier (for example, SETUP, RELease).
- The user will ignore any messages received with an unrecognized message type.
- The user may, at any time, send an unsolicited STATUS message. The switch will discard these messages and take no further action.

On a demand basis, the network will issue STATUS ENQuiry messages to the user, as discussed in "Unexpected Messages with Improperly Coded Call Reference Information Elements," Section 4.2.1.5.3. This is largely to ensure that the network has not lost any user DISConnect messages.

Additional error-handling procedures used at this interface basically revolve around the receipt of "unexpected" messages, which fall into one of three possible classes:

1. Unexpected messages for which there is no associated call in progress (that is, for which the call reference is not recognized).
2. Unexpected messages for which there is an associated call in progress (that is, for which the call reference is recognized).
3. Unexpected messages for which the call reference IE is improperly encoded (for example, SETUP message with an Invalid Call Reference Flag).

With respect to the categories mentioned previously, Category 1 procedures are defined for both the user and the network. Category 2 procedures are defined for only the network; the user procedures are terminal equipment manufacturer options. Category 3 procedures are defined for the user.

An unrecognized message is a message with a message type that is either not defined by this interface specification or is not implemented by the user or network equipment because it is part of an optional procedure that is not supported.

Note: The network may remove from service a BRI or terminal that generates excessive unexpected messages.

Further detailed procedures for each case follow.

4.2.1.5.1 Unexpected or Unrecognized Messages with Nonexistent Call References

The network's response to the receipt of a message with a nonexistent (unrecognized), nonnull call reference (except for a SETUP message) will be to return a RELease COMplete message with that call reference (with the exception of RELease COMplete which is ignored). When the network receives a SETUP message specifying a call reference that it does not recognize as in use, the network shall respond according to the procedures in "Call Establishment at the Originating Interface," Section 4.2.1.2. (Note that this is not an error condition, but is merely included here for completeness and for the convenience of the reader.)

User actions upon receipt of a message with a nonexistent (unrecognized) call reference fall into six categories.

1. Whenever the user receives any message except SETUP, DISConnect, RELease, RELease COMplete, or STATUS ENQuiry that specifies a call reference it does not recognize as in use, the user will initiate clearing by sending a DISConnect, a RELease (preferred), or a RELease COMplete message, specifying the call reference used in the received message.
2. Whenever the user receives a DISConnect message that specifies a call reference not recognized as in use shall send a RELease message specifying the call reference used in the received message.
3. The receiver of a RELease message that specifies a call reference not recognized as in use shall send a RELease COMplete message specifying the call reference used in the received message.
4. The receiver of a RELease COMplete message that specifies a call reference not recognized as in use shall ignore the message.
5. When the user receives a STATUS ENQuiry message that specifies a call reference not recognized as in use, the user shall respond with a STATUS message containing the same call reference and containing a Call State IE indicating that the call reference is in the *Null Call* state at the user side of the interface.
6. When the user receives a SETUP message specifying a call reference that is not recognized as in use, the user shall respond according to the procedures given in "Call Establishment at the Originating Interface," Section 4.2.1.2, and "Keypad Equivalent of Functional Addressing without Dialing/Routing Features," Section 4.2.1.2.4. (Note that this is *not* an error condition, but it is merely included here for completeness and for the convenience of the reader.)

For all the previous clearing messages,[2] the cause IE shall specify the cause value 81 (that is, invalid call reference), with the location being the user or network (as is appropriate).

4.2.1.5.2 Unexpected or Unrecognized Messages with Valid Call References

When a message arrives at the network with an active call reference for which a normal (non-error condition) response is not prescribed in the current state of the call, the network considers it to be an unexpected message. As such, it may increment the network's error counter.

In particular, the following list summarizes network reactions to unexpected messages with valid (recognized) call references.

1. When the network receives an unexpected nonclearing or unrecognized message and the call is perceived to be in a *Nonclearing* state, the network may initiate clearing procedures. If, instead, the call is perceived to be in a *Clearing* state, the network shall ignore the receipt of the message.

   Note: If the message is late arriving or duplicated, the network shall consider it to be an unexpected message and ignore it.

2. When the network receives an unexpected DISConnect message in a clearing state, the network will ignore the receipt of the message. If, instead, the call is perceived to be in a nonclearing state, the network will initiate clearing procedures as specified in "Call Clearing," Section 4.2.1.4.

3. If the network receives a RELease message while in the *Disconnect Request* state, the switch should not ignore these messages, instead, the switch should act on the message and follow call clearing procedures. When the network unexpectedly receives a RELease message in a state other than the *Disconnect Request* state the network will release the B-channel and the call reference. Furthermore, the network will also send a RELease COMplete message to the user and move the call to the *Null* state.

4. When the network unexpectedly receives a RELease COMplete message, the network will release the B-channel and the call reference and move the call into the *Null* state.

   Note: Other services (described in "Packet Services," Section 4.3, and "Terminal Initialization," Section 6) may provide different treatments than those discussed here.

When an unexpected or unrecognized message arrives at the user side when in any nonnull state, the user side may return a STATUS message with Cause 98, "message not compatible with call state."

4.2.1.5.3 Unexpected Messages with Improperly Coded Call Reference Information Elements

Whenever the user receives a SETUP message where the call reference flag indicates the "destination side" (see "Call Reference," Section 4.1.3.1.2), the user should ignore this SETUP message and continue call processing as though the message was never sent.

2. Disconnect request, disconnect indication, and release request states are defined as clearing states, and DISConnect, RELease, and RELease COMplete messages are defined as clearing messages.

If the network will receive a SETUP message, as mentioned previously, the network will consider this an unexpected message and will increment the network's error counter. The network will take no further action with regard to the receipt of this message.

4.2.1.5.4 Call Activity Checks

To ensure that the *Network* state is consistent with the *User* state, and to particularly protect the network against lost DISConnect messages, the network will make periodic and on-demand call-activity checks. The procedure is summarized as follows:

A. Periodically, and upon certain on-demand stimuli, the network will send the user a STATUS ENQuiry message.

B. A STATUS message received from the user will indicate the *Call* state of the call at the user side of the interface and will contain the cause IE (recommended value of 30, "response to STATUS ENQuiry"). At a minimum, the terminal must know and appropriately relay *User* States U0 *(Null)*, and U10 *(Active)* to the network upon user receipt of a STATUS ENQuiry message (see "Specification Description Language Diagrams," Section 4.2.3). If the STATUS message indicates that the call is in progress, the network restores normal call processing. If the STATUS message indicates that the call is disconnected, the network initiates clearing procedures toward the far-end user. It also disconnects the B-channel and idles the call reference value of the near-end user.

C. If the network does not receive a STATUS response the first time, it will retransmit the STATUS ENQuiry message. If no response is received a second time, the network initiates clearing procedures.

4.2.1.5.5 Layer 2 Failure

The established links associated with the signaling service access point identifier (SAPI) (SAPI 0) will remain in multiple frame acknowledgment mode for the duration of any call. It is recommended that the terminal always maintain multiple frame mode for a nonbroadcast link while the terminal is activated, since this activity will prevent an increase in call setup delay on affected incoming/outgoing calls due to the link establishment procedures.

Upon Layer 2 failure (that is, due to Layer 1 failure or release of the link), Layer 3 will receive an internal indication that connectivity at Layer 2 has been lost for a given BRI, the network will clear all calls immediately. The network will move to the management state NOT_INIT or down (if Layer 2 loss due to Layer 1 loss) as defined in "Terminal Initialization," Section 6.

If the network receives a STATUS message containing Cause 41, the network will send a RELease COMplete with the call reference specified in the received STATUS message.

Note: The clearing of the calls upon loss of Layer 2 connectivity consists of returning all calls to the *null* (U0) call state. Since a communication path does not exist between the terminal and network, the calls cannot be cleared using normal call clearing procedures.

4.2.1.5.6 Treatment of Unrecognized Information Elements

The network and the user shall ignore all unrecognized IE received in any message whose IE identifier is not recognized. The receiver shall process that part of the message that it understands and otherwise continue normal operation as if the elements with unrecognized identifiers were not received.

4.2.1.6 Interworking with Existing Services

4.2.1.6.1 Assumptions

This section assumes three principles:

1. For an intraswitch call either originating or terminating to an non-ISDN line, or an interswitch call that exits the switch on non-ISDN facilities, the switch will inform the user prior to the call entering the *active* state.

2. For an interswitch call that exits the switch on ISDN facilities or an call incoming on ISDN facilities but originating on non-ISDN facilities, the remote switch connecting the ISDN and non-ISDN facilities for the call will inform the local switch that the call is a non-ISDN call. This shall occur prior to the call entering the *active* state.

3. The ISDN user may not know (without the switch informing the user to this effect) that the call is a non-ISDN call.

4.2.1.6.2 User Actions

The customer shall follow the same ISDN procedures described earlier to initiate and terminate calls to non-ISDN station sets or through non-ISDN networks. In some applications, for example, automated calling card services, the far-end customer premises equipment (CPE) or transit network may require the dual tone multifrequency (DTMF) be generated by the ISDN CPE. The network does not provide DTMF signaling for such applications: the signaling for such applications remain the responsibility of the user (that is, CPE). The user (CPE) is responsible for supplying DTMF generation at the appropriate times.

It is recommended that ISDN CPE generate DTMF signals and place those signals on the appropriate B-channel, whenever a B-channel is connected between the CPE and the local access network. If more than one B-channel is being used by the CPE, then it is the responsibility of the CPE to determine which B-channel, if any, will convey the DTMF signaling.

A B-channel can be connected between the CPE and the local access network in User States U2, U3, U4, and U10. In addition, the CPE will have a B-channel connected upon reception of a progress indicator IE that indicates inband tones may be applied to the B-channel (see "Call Failure Procedure," Section 4.2.1.2.6).

4.2.1.6.3 Network Actions

4.2.1.6.3.1 General

According to Principles 1 and 2 in "Interworking with Existing Services," Section 4.2.1.6, the ISDN exchange (both in the case of originating and terminating) will know when a call is a non-ISDN call. In such an event, the network shall monitor the inband signaling of the non-ISDN connection for on-hook and off-hook information. The ISDN user CONNect (DISConnect, respectively) message shall be mapped into inband off-hook (on-hook, respectively) information, and *vice versa*.

Note: The network may not always return a CONNect message for all calls, for example, operator calls.

The ISDN exchange may have to take additional actions, depending upon whether it is the originating or the terminating exchange.

Note: If the network is able to determine that the destination requested is incompatible with the service requested (per the bearer capability IE), the network will initiate call clearing procedures.

4.2.1.6.3.2 Notification of Interworking at the Origination Interface

When a call encounters non-ISDN facilities, the switch sends the following messages to the originating BRI interface with the appropriate progress indicator IE code point, as described in the following paragraphs:

a. In the case of end-to-end ISDN voice calls (speech or 3.1-kHz audio), if the call terminates to a non-ISDN line, the network will send to the originating CPE an ALERTing message. The progress descriptor in the progress indicator IE will be set to 8, "inband information or appropriate information available now" and the signal IE will be included with the signal value set to "ringback (audible ring) tone-on."

   In the case of end-to-end ISDN data calls (56- or 64-kbps unrestricted digital information), if the call terminates to a non-ISDN line, the network will send to the originating CPE an ALERTing message. The signal IE will be included with the signal value set to "ringback (audible ring) tone-on."

b. If the call terminates to a non-ISDN trunk, the network will send to the originating CPE a PROGress message. The progress descriptor in the progress indicator IE will be set to 1, "call is not end-to-end ISDN."

When the switch detects an off-hook from a called non-ISDN line, the switch will send a CONNect message to the calling user containing a signal IE set to "tones off." In addition, the progress indicator IE will be included with the progress descriptor set to 2, "called equipment is non-ISDN."

4.2.1.6.3.3 Notification of Interworking at the Terminating Interface

When a non-ISDN call terminates to the standard ISDN interface, the network will offer the call to the called ISDN user by sending a SETUP message containing 3.1-kHz audio bearer service and the progress indicator IE as follows:

- If the call arrived on an analog line on the same switch, the network will include progress indicator IE in the SETUP message with code point set to 3, "origination is non-ISDN."

  If the call arrived at the terminating switch on non-ISDN trunk, the network will not have any knowledge about the type of calling line interface. Therefore, the network will include the progress indicator IE in the outgoing SETUP message with code point set to 1, "call is not end-to-end ISDN," and/or "further call progress information may be available inband."

4.2.1.6.3.4 Busy Line Treatment

This section describes the treatment applied to a calling ISDN interface that reaches a busy ISDN interface or, for circuit-switched calls, a busy non-ISDN line. Also described is the treatment applied to a non-ISDN line or non-ISDN trunk that reaches a busy ISDN interface. Both network determined and user-determined interface busy are described.

A. **Network-Determined Busy**

For a circuit-switched speech or 3.1-kHz audio call, if a calling ISDN interface reaches a busy called ISDN interface or non-ISDN line that is marked busy, the switch will first send a CALL PROCeeding message (if no SETUP ACKnowledge or CALL PROCeeding message has previously been sent) to the calling user equipment to establish a B-channel over which to provide the tone. Then the switch will send the calling user equipment a PROGress message containing Cause 17, "user busy." The PROGress message will also include Progress Indicator 8, "inband information or appropriate pattern now available." The switch will return busy tone to the calling user equipment and initiate Timer T306. The switch will continue to provide busy tone to the calling user until a release indication is received from the calling user equipment or Timer T306 expires. If T306 expires, the switch will send the calling user a DISConnect message containing Cause 102, "recovery on timer expiry."

If the ISDN interface is marked busy and the calling user for a circuit-switched call is a non-ISDN line or the call was routed to the terminating switch over a non-ISDN trunk, busy tone will be returned over the calling line or incoming trunk, respectively. The switch will continue to provide busy tone until an on-hook or release indication is received.

For a circuit-switched data (56- or 64-kbps unrestricted digital information) call, if a calling ISDN interface reaches a busy called ISDN interface or non-ISDN line that is marked busy, the switch will send a DISConnect message or RELease COMplete message to the calling user equipment. A DISConnect message containing Cause 17, "user busy," and signal "busy tone on" will be sent if the SETUP ACKnowledge or CALL PROCeeding message that identified a channel for the call has already been returned to the calling user equipment; a RELease COMplete message containing Cause 17, "user busy," and signal "busy tone on" will be sent if the switch has sent no previous response identifying a channel for the call request to the calling user.

B. **User-Determined Busy/Reject**

When the called ISDN interface is not marked busy, a called user equipment may respond to the SETUP message from the switch by sending a call clearing message (DISConnect, RELease, or RELease COMplete) with Cause 17, "user busy," or with Cause 21, "call rejected." For actions taken by the switch on receipt of these call clearing message, refer to "Call Rejection," Section 4.2.1.3.8.

4.2.1.6.3.5 Queuing Treatment

When a circuit-switched ISDN call is queued for a line or trunk (this includes services that employ queuing, such as Multiline Hunt Group and Trunk Queuing), the switch will send to the terminal a PROGress message coded with Cause 35, "call queued."

Note that, although the class of this cause value is "Resource unavailable," the call remains in the same state. The CPE should not clear the call on the basis of this PROGress message.

4.2.1.7 Tones and Announcements

The switch has several ways to inform the user about the treatment applied to a call in an ISDN environment; one way is the return of tones and announcements to the user. The switch also employs the progress indicator and cause IEs to transmit information about a call. The progress indicator IE describes events that occur during the life of a call. For example, the progress indicator indicates interworking to a network with inband signaling, or informs an ISDN call originator when inband information (that is, a tone or an announcement) is available. This IE also includes information relating to the location of the progress descriptor (that is, source of inband information or place where interworking takes place). When the cause IE is included in a message, it identifies the reason that message was generated and the location of the cause originator. In addition, the signal IE is included in certain call control messages to aid user equipment in generating tones locally.

A. With the exception of audible ringing, tones may be returned to an ISDN user in two ways. A tone, such as dial tone, could be generated by the user equipment on receiving a message from the switch. The signal IE will be included in certain call control messages to aid the user equipment in generating tones locally. When an inband tone is returned to a user, the switch will send an appropriate message (for example, PROGress or SETUP ACKnowledge) to the call originator. The message will include Progress Indicator 8, "inband information or appropriate pattern now available" and the appropriate D-channel information describing the inband tone (that is, the signal IE and, when appropriate, the cause IE).

   As mentioned previously, audible ringing tone is an exception. When audible ringing applies, this tone will always be returned inband on speech and 3.1-kHz audio. To maintain consistency, the signal IE will be provided in the appropriate message (for example, ALERTing) when audible ringing is provided inband.

   Table 4.2.1-2 shows the signal information that will be sent when the corresponding inband tone is returned over the B-channel.

   Note: To return a tone or an announcement inband, a B-channel will be allocated for that purpose. For example, a CALL PROCeeding message will precede the PROGress message, thus allocating a channel over which inband information will be provided.

Table 4.2.1-2 — Inband Tones and the Corresponding Signal Information

INBAND TONE	SIGNAL INFORMATION
Dial Tone	Dial Tone On
Audible Ring	Audible Ringing Tone On
Reorder Tone	Network Congestion/Reorder Tone On
Busy Tone	Busy Tone On
	Tones Off

The switch will be able to return an inband tone on speech and 3.1-kHz audio calls, when the tone has no specific signal information code point assigned to it. In this case, the switch will send a PROGress message with Progress Indicator 8, "inband information or appropriate pattern now available," and then return the tone over the allocated channel. The signal IE will not be included in such a PROGress message.

A relationship exists between tones and cause values such that, when a certain cause is sent by the switch, a corresponding tone will also be returned [for example, a busy tone indication will be returned by the switch (whether as the signal information "busy tone on" or in combination with an inband busy tone) when the call termination treatment containing the cause information "user busy" is sent by the switch].

B. An inband announcement can convey the same information as the corresponding cause IE. When the switch returns an inband announcement, a PROGress message containing the suitable progress indicator, cause, and signal IEs is also transmitted.

When the inband tones and announcements feature does not apply, as in data calls, a combination of the cause and signal IEs will be used to provide the calling user with information that would otherwise have been provided inband.

For speech and 3.1-kHz audio calls, the switch will be able to return an inband announcement when that announcement has no specific cause information code point assigned to it. For example, the switch could return such announcements when equipment or facilities are unavailable in an IC-interconnection situation. In this case, the switch will send a PROGress message with Progress Indicator 8 and then return the announcement over the allocated channel. In addition, the signal IE is not included in the PROGress message.

C. If a call is terminated to a tone because it cannot be completed, the tone will be returned over the allocated B-channel after the switch has sent a PROGress message. The switch will use Timer T306 to limit the amount of time that such a tone is returned over the B-channel. Therefore, if T306 expires, the switch will remove the inband tone and disconnect the B-channel. If the user initiates call clearing once T306 has been initiated, the switch will stop the timer, remove the tone from the B-channel, and complete the call clearing procedure. If T306 expires, the switch will remove the tone and begin to clear the call. The network will send a DISConnect message with Cause 102 and will follow the clearing procedure as stated in "Call Clearing by the Network," Section 4.2.1.4.3.

D. As part of the call clearing treatment, the switch will send the calling party a cause IE that states the reason the call could not be completed.

If the switch has returned inband audible ringing tone as a result of the previously described situations and the call eventually cannot be completed, the switch will not replace inband audible ringing tone with another tone.

Table 4.2.1-3 indicates the application tone or announcement given the cause that is transmitted on voice/3.1-kHz audio calls.

If the call is terminated to a tone or an announcement, the switch will send a PROGress message with Progress Indicator 8 and then return the tone or announcement over the allocated channel. The PROGress message will also contain the cause IE that describes the call processing event and the corresponding signal IE.

Table 4.2.1-3 — Tones and Announcements Associated with Specific Cause Values

ITU-TS STANDARDIZED CAUSE VALUE	ASSOCIATED AUDIBLE INDICATION			
	ANNOUNCEMENT	REORDER	BUSY[a]	AUDIBLE RINGING
16. Normal clearing				
17. User busy			Ib/S[b]	
18. No user responding				Ib/S[b]
21. Call Rejected				Ib/S[b]
127. Interworking, unspecified[c]				

Note(s):

a. Busy tone applies only when the location is coded "user."

b. Ib: Inband information applied if network-provided tones and announcements apply.

S: Audible indication to be encoded in the signal IE.

c. Depending on the interworking situation, an announcement or a tone could be returned inband.

4.2.2 SYSTEM PARAMETERS

4.2.2.1 Timers Except T309

The following are the values of the critical network Layer 3 timers and parameters (see Table 4.2.2-1).

Timers T301, T303, T306, T310, and T-ALT perm are administerable by the local service provider on a per-office basis. Timers T302, 305, and T308 are fixed values.

Table 4.2.2-1 — List of System Parameters

NAME	CLASS	RANGE	DEFAULT VALUE	UNIT	FUNCTION
T301	timer	3 to 7 minutes in steps of 1 minute	5	min.	Duration of alerting ringing
T302	timer		10	sec.	Interdigit timeout; Overlap Addr.
T303	timer	1 to 4 seconds in steps of 0.5 second	2.5	sec.	Call setup timer
T305	timer		4	sec.	Delay from network DISC to userDISC or REL; Call Clearing
T306	timer	30 to 150 seconds in steps of 30 seconds	60	sec.	Tones/announcement timer
T308	timer		4	sec.	Delay from network REL to user REL COM; Call Clearing
T310	timer	3 to 10 seconds in steps of 1 seconds; with T310 > T303	5	sec.	Call proceeding timer
T-ALT perm	timer	0.5 to 5.0 seconds in steps of 0.5 seconds	1.0	sec.	Duration of automatic link transfer (ALT) request

4.2.2.2 Timer T309

Timer T309, which is associated with data link malfunction procedures, is required for an ISDN CPE connected to the switch. The upper bound for this timer must be programmable to at least 300 seconds. Also, the CPEs default value for Timer T309 should be at least 300 seconds. Note that failure to implement T309 with the appropriate value may result in the CPE, ***not the switch***, dropping stable circuit switched calls during retrofit.

4.2.3 SPECIFICATION DESCRIPTION LANGUAGE DIAGRAMS

This section contains specification description language (SDL) diagrams (Figures 4.2.3-1, 4.2.3-2, 4.2.3-3, 4.2.3-4, 4.2.3-5, 4.2.3-6, 4.2.3-7, 4.2.3-8, 4.2.3-9, 4.2.3-10, 4.2.3-11, 4.2.3-12, 4.2.3-13, 4.2.3-14, 4.2.3-15, 4.2.3-16, 4.2.3-17, 4.2.3-18, and 4.2.3-19) illustrating the call processing logic described in "Call Control Procedures," Section 4.2.1. Figures 4.2.3-2, 4.2.3-3, 4.2.3-4, 4.2.3-5, 4.2.3-6, 4.2.3-7, 4.2.3-8, 4.2.3-9, and 4.2.3-10 describe the originating end of a call. Figures 4.2.3-11, 4.2.3-12, 4.2.3-13, 4.2.3-14, 4.2.3-15, 4.2.3-16, 4.2.3-17, 4.2.3-18, and 4.2.3-19 describe the terminating end of a call. Potential message flows and interactions are portrayed as viewed from the user side of the interface.

These SDLs will be reviewed and considered with several points in mind:

1. Note that they represent this interface as viewed from the *user* (that is, terminal) side. This differs from the text, which is written largely from the network perspective. This will help terminal vendors understand how the network will expect them to perform and what actions the switch itself may take (that is, will clarify the text of "Call Control Procedures," Section 4.2.1).

   These SDLs are intended to be a complete depiction of this interface. In particular, the error-handling procedures of "Handling of Error Conditions," Section 4.2.1.5, are explicitly shown in conjunction with expected "normal" message flows.

2. *Most important,* note that these SDLs are not intended to impose design constraints upon CPE beyond those discussed in this section (that is, are not to be considered design blueprints). For example, the timing (that is, sequential location) of the task of connecting the B-channel to the end-user represents only a network recommendation, based on expected service interactions. In short, the SDLs will be viewed merely as a suggested interpretation of "Call Control Procedures," Section 4.2.1.

The SDLs are drawn from the perspective of a full-state terminal (one cognizant of all supported *User Call* states as defined in "Other Information Elements," Section 4.1.3.2) to provide a clear, detailed picture of the protocol interactions supporting this interface. The actual interface itself, however, supports terminals with less complicated perspectives. Moreover, the internal design of a terminal (for example, state machine design) is transparent to the interface. All that really affects the compatibility of a given terminal is whether the proper interface—the proper messages and IEs at the proper times—is presented to the switch.

As stated in the text, only recognition of States U0 (*Null*) and U10 (*Active*) are required of CPE as a minimum. The SDLs specifically drawn for such a terminal would likely be significantly different from those shown here. The only manifestation of this difference at the interface will be the *Call* state IE returned to the network in a STATUS message in response to a network STATUS ENQuiry. Hence, the SDLs given depict the minimally-acceptable mapping of *Call* state information that such a terminal must be able to perform. When in States U0, or U10, the terminal will so code the *Call* State IE when responding to a STATUS ENQuiry. Otherwise, the terminal will return the state it is in (if it recognizes any other states), or will return State U10 (*Active*) as a default response for all *Nonclearing* states. State U0 will be returned as the default for the *Clearing* states. The SDLs show this actual/default state response possibility by explicitly stating the IE content of the STATUS message to be returned.

By and large, these SDLs do not portray the content of message IEs. Two exceptions (in addition to the one previously mentioned) exist in the origination side SDL set: first, a terminal sending a SETUP message to the network with the channel identification IE coded to the no channel value is unacceptable; second, all address information sent by the terminal to the network must be coded in keypad IEs.

Note that the origination and termination side SDLs for each of States U10 (*Active*), U11 (*Disconnect Request*), U12 (*Disconnect Indication*), and U19 (*Release Request*) are identical. They are reproduced simply to give the reader an independent, complete view for each side.

Finally, note that the SDL diagrams assume that the initialization procedures described in "Terminal Initialization," Section 6, have been successfully completed. The SDL diagrams for endpoints that have not successfully completed endpoint initialization are provided in "Terminal Initialization," Section 6.

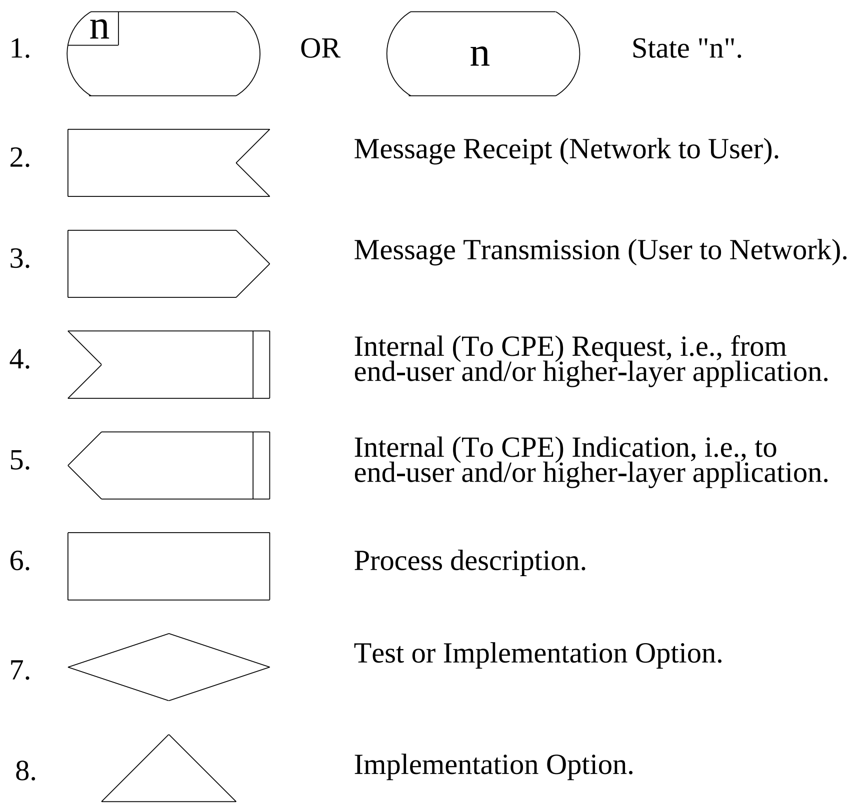


Figure 4.2.3-1 — SDL Symbol Key

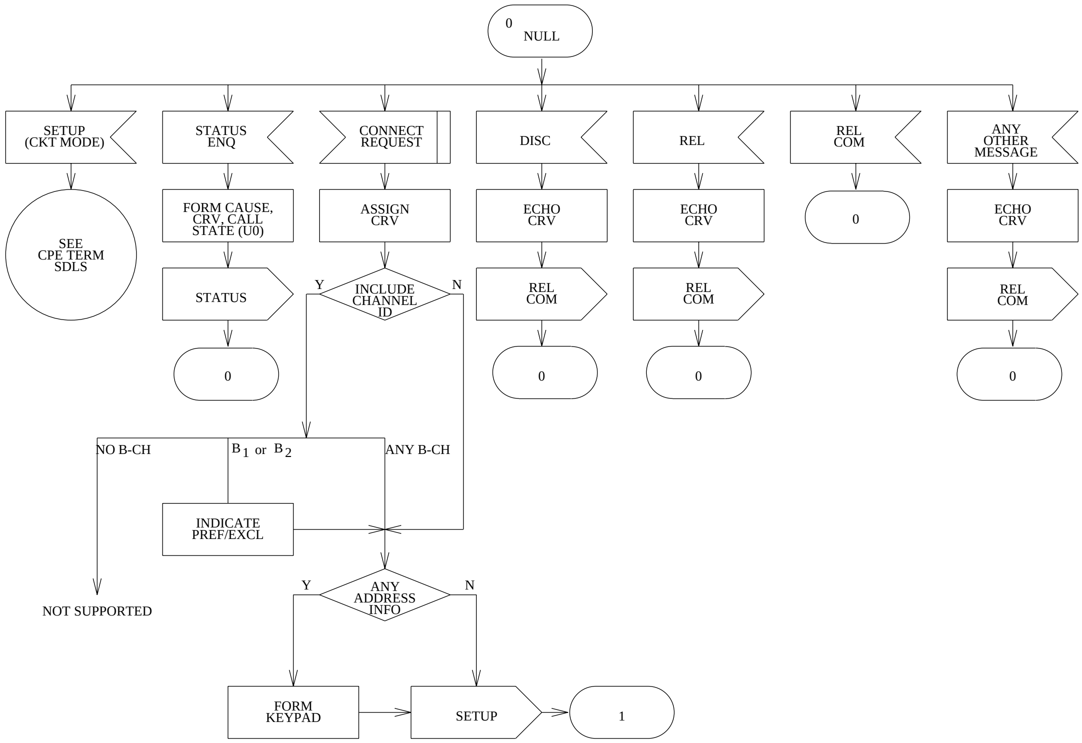


Figure 4.2.3-2 — Call Control—CPE Origination (NULL) (User Side)

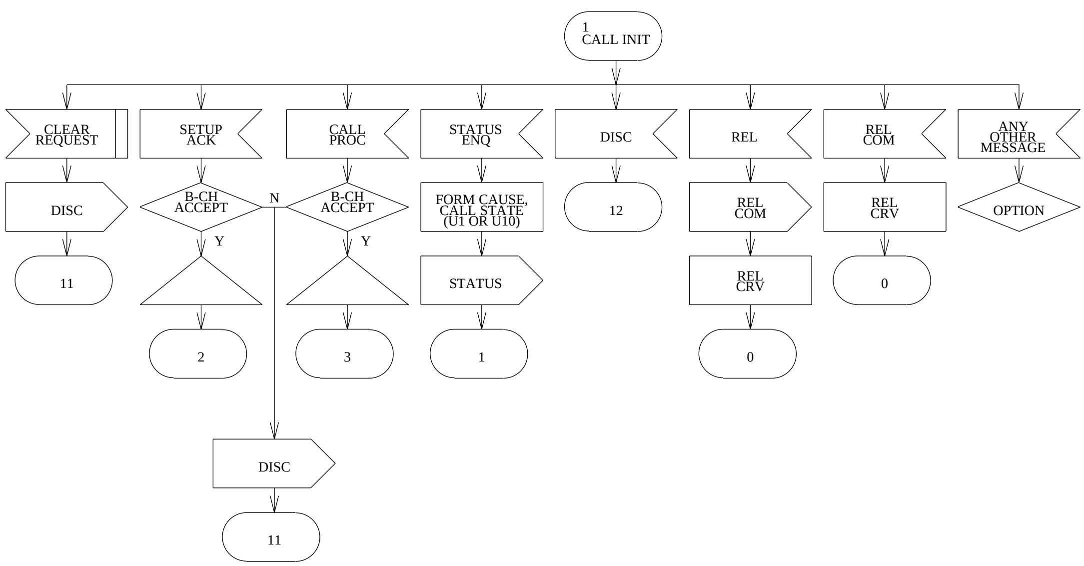


Figure 4.2.3-3 — Call Control—CPE Origination (CALL INIT) (User Side)

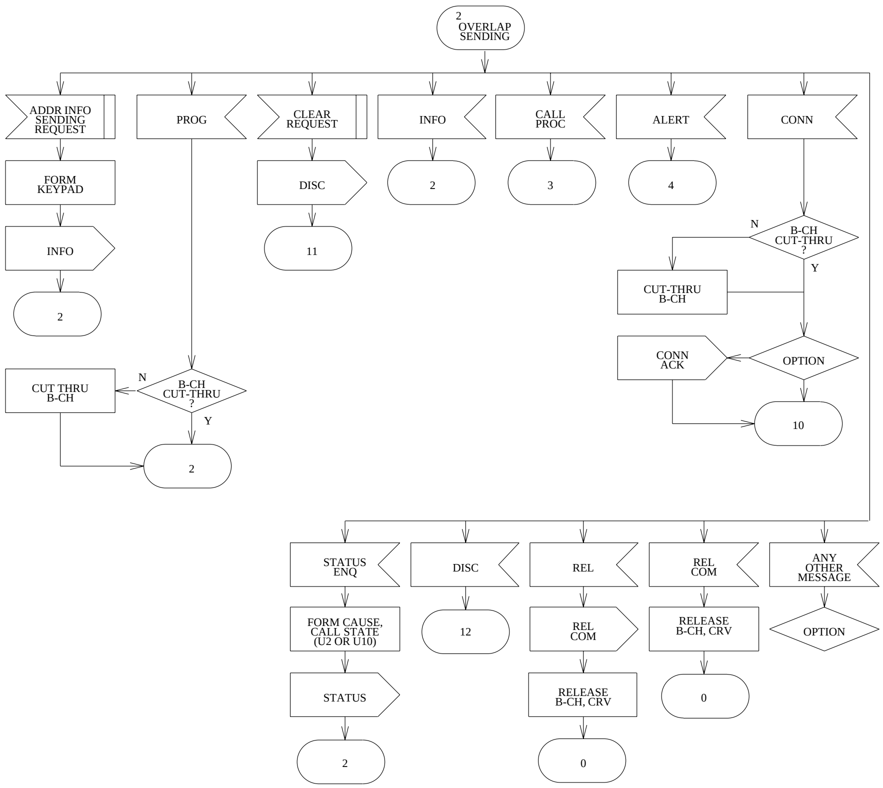


Figure 4.2.3-4 — Call Control—CPE Origination (OVERLAP SENDING) (User Side)

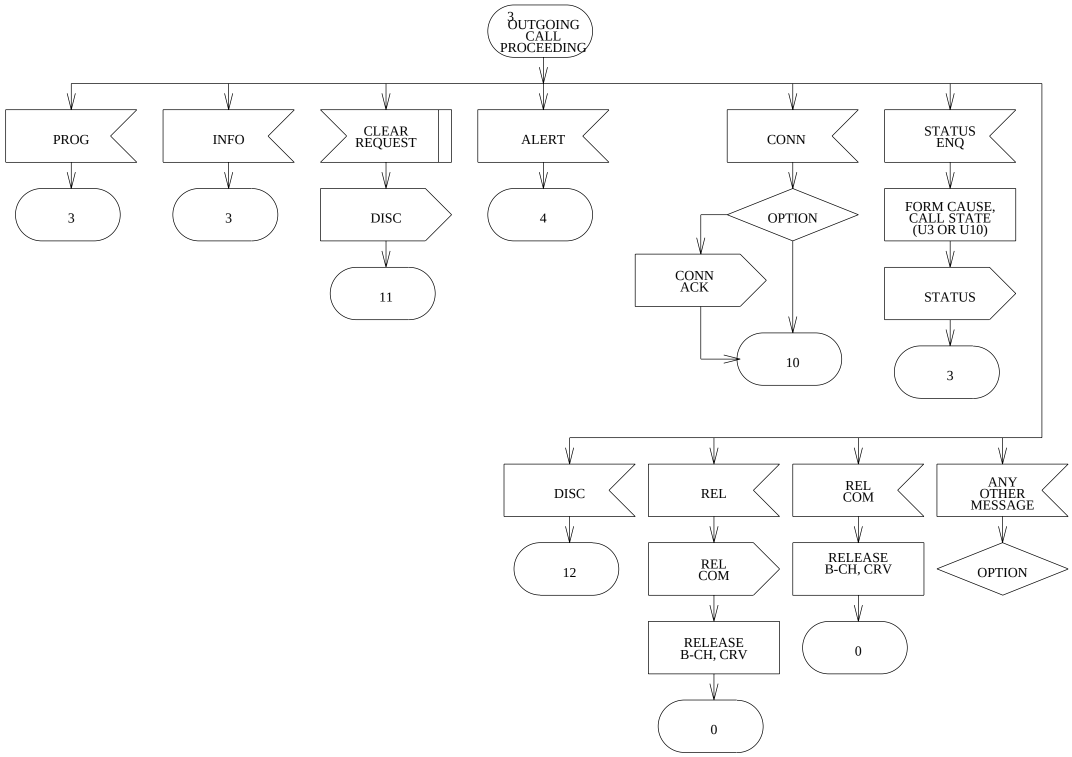


Figure 4.2.3-5 — Call Control—CPE Origination (OUTGOING CALL PROCEEDING) (User Side)

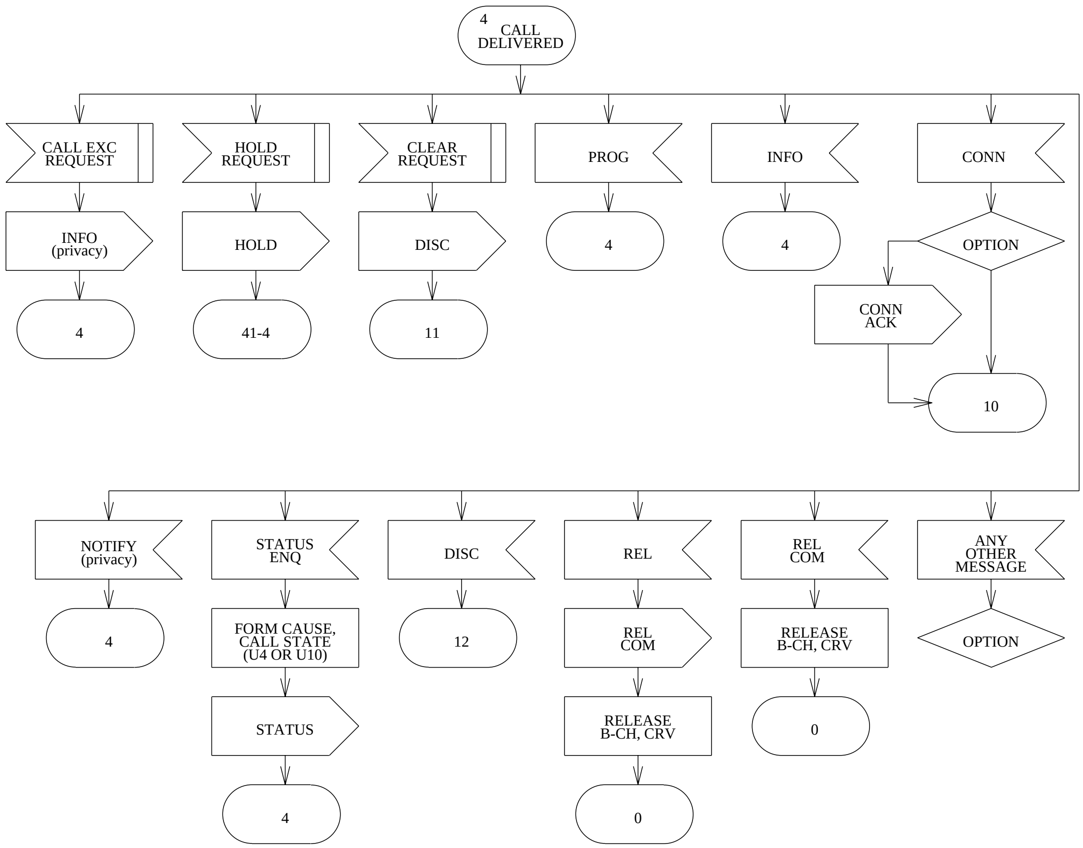


Figure 4.2.3-6 — Call Control—CPE Origination (CALL DELIVERED) (User Side)

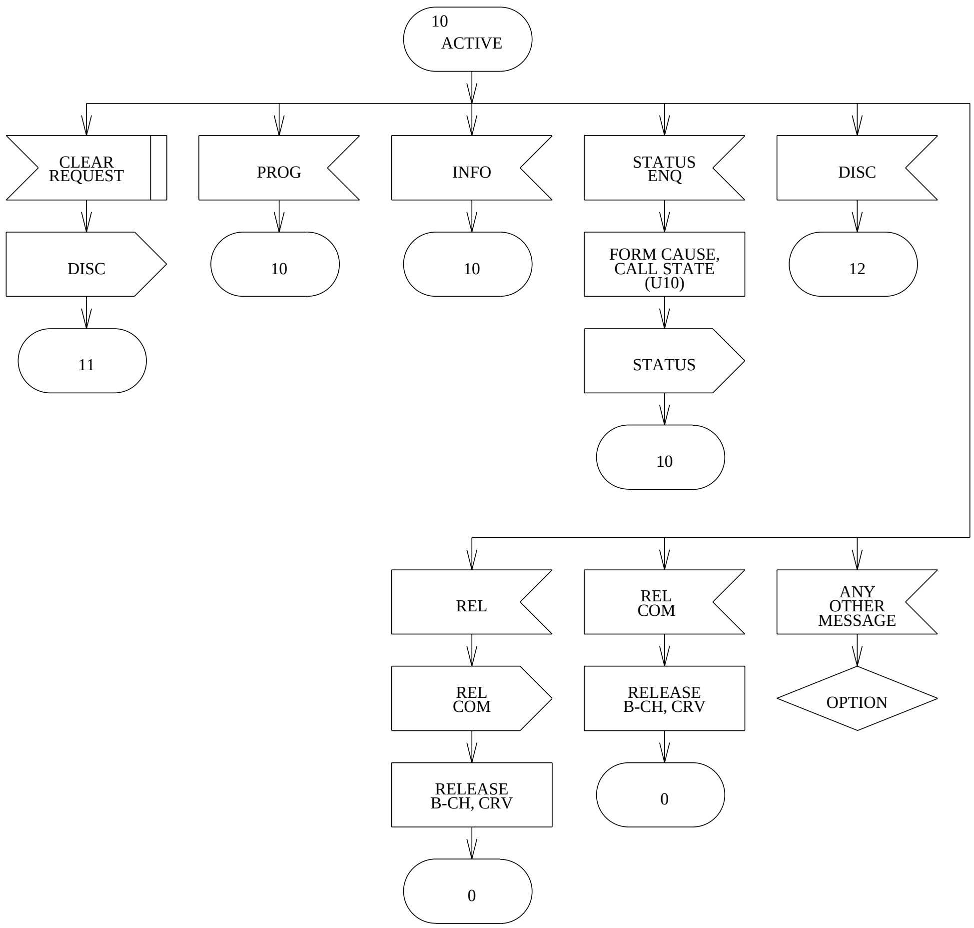


Figure 4.2.3-7 — Call Control—CPE Origination (ACTIVE) (User Side)

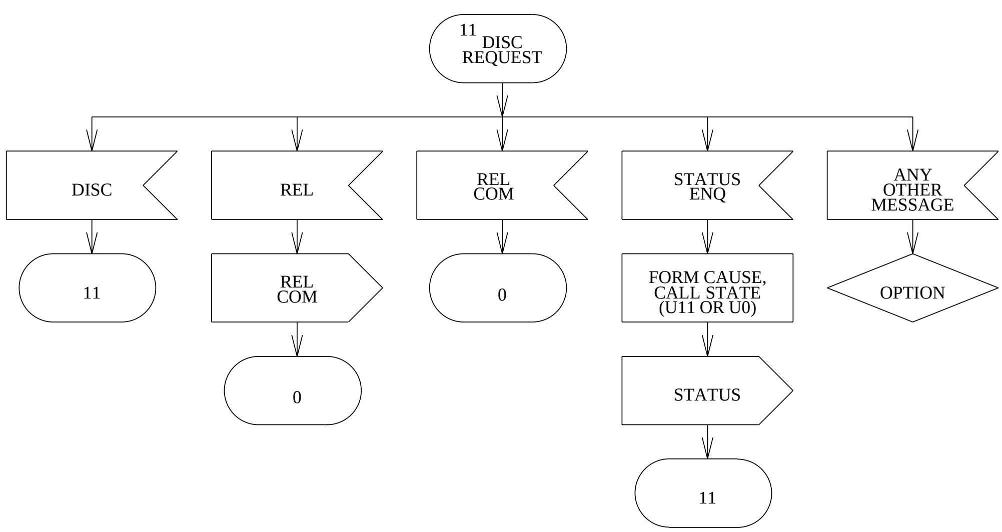


Figure 4.2.3-8 — Call Control—CPE Origination (DISC REQUEST) (User Side)

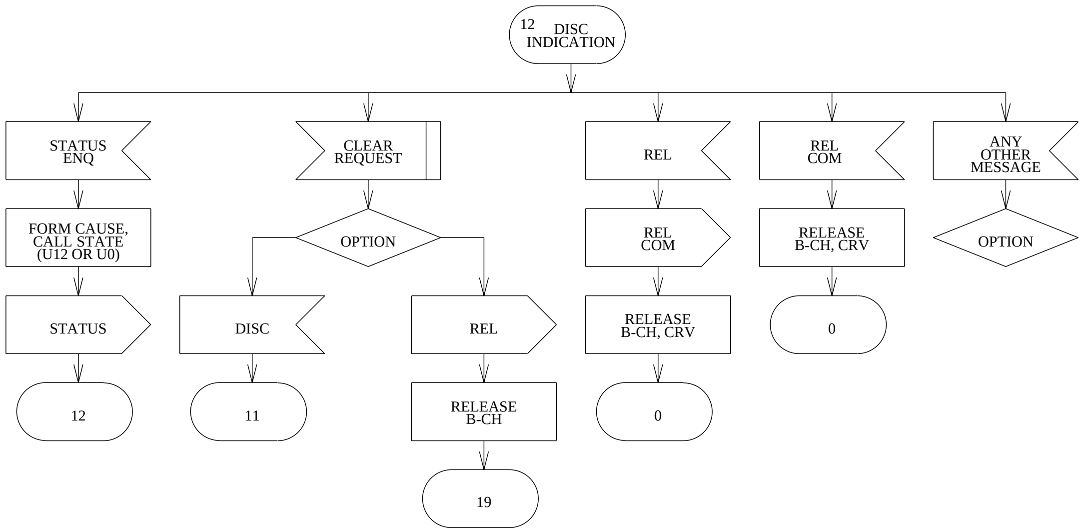


Figure 4.2.3-9 — Call Control—CPE Origination (DISC INDICATION) (User Side)

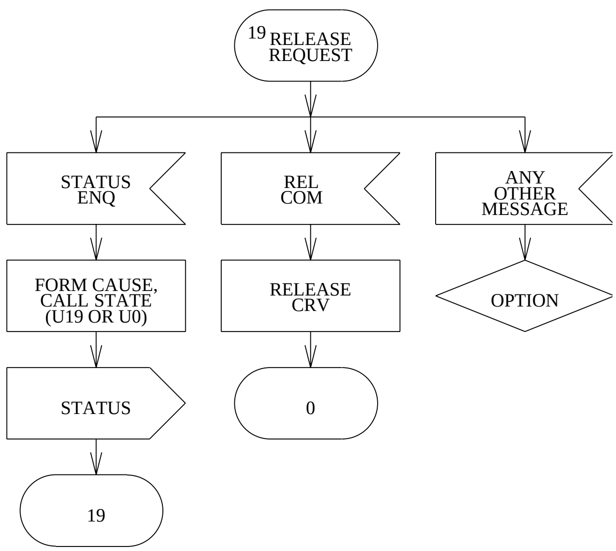


Figure 4.2.3-10 — Call Control—CPE Origination (RELEASE REQUEST) (User Side)

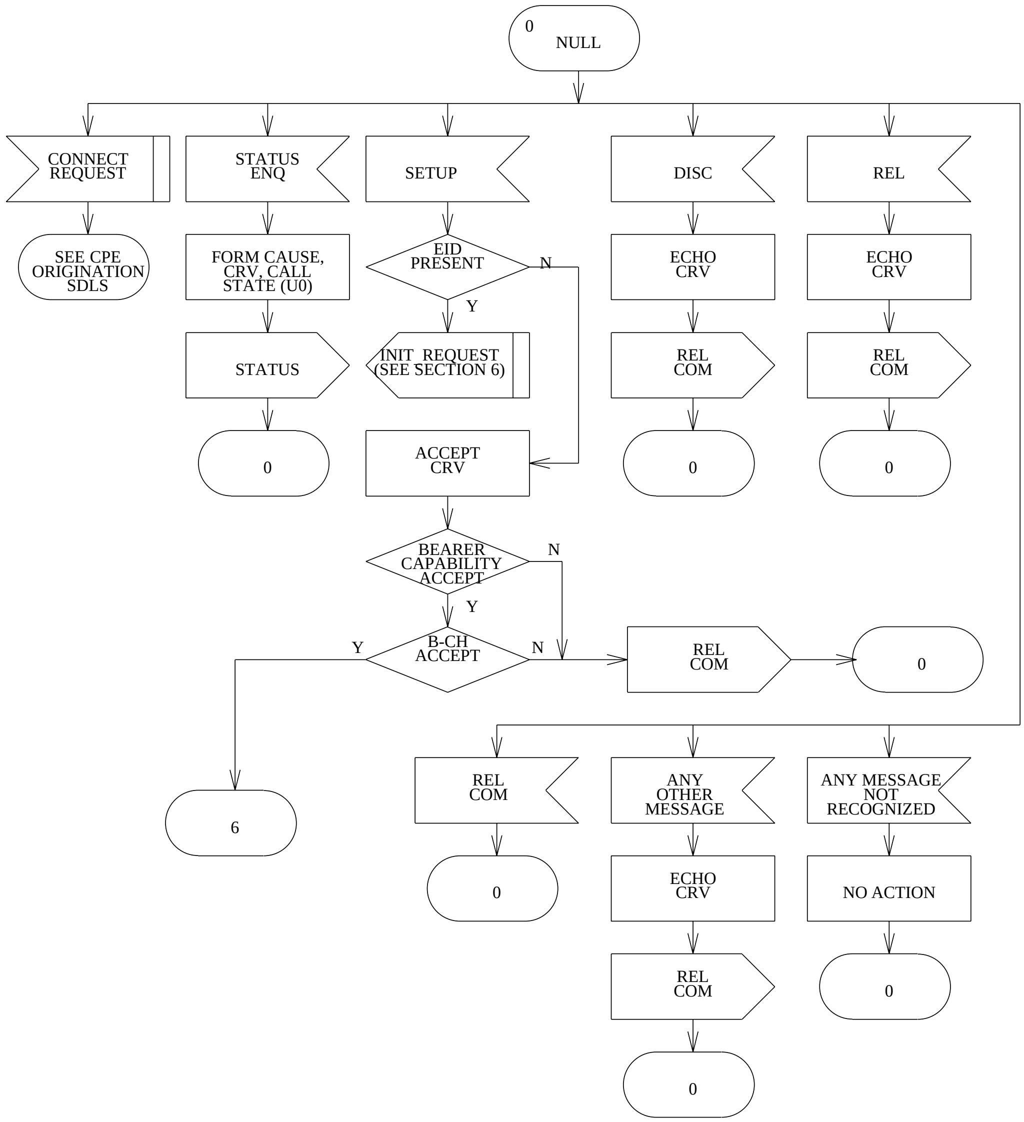


Figure 4.2.3-11 — Call Control—CPE Termination (NULL) (User Side)

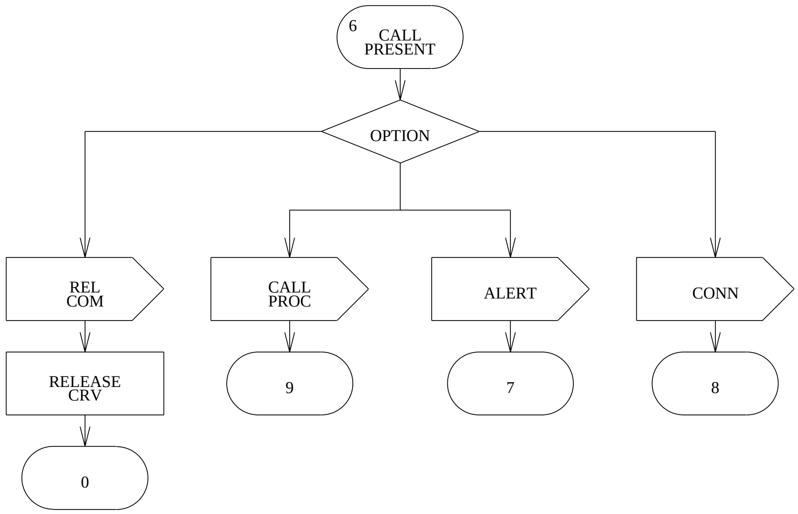


Figure 4.2.3-12 — Call Control—CPE Termination (CALL PRESENT) (User Side)

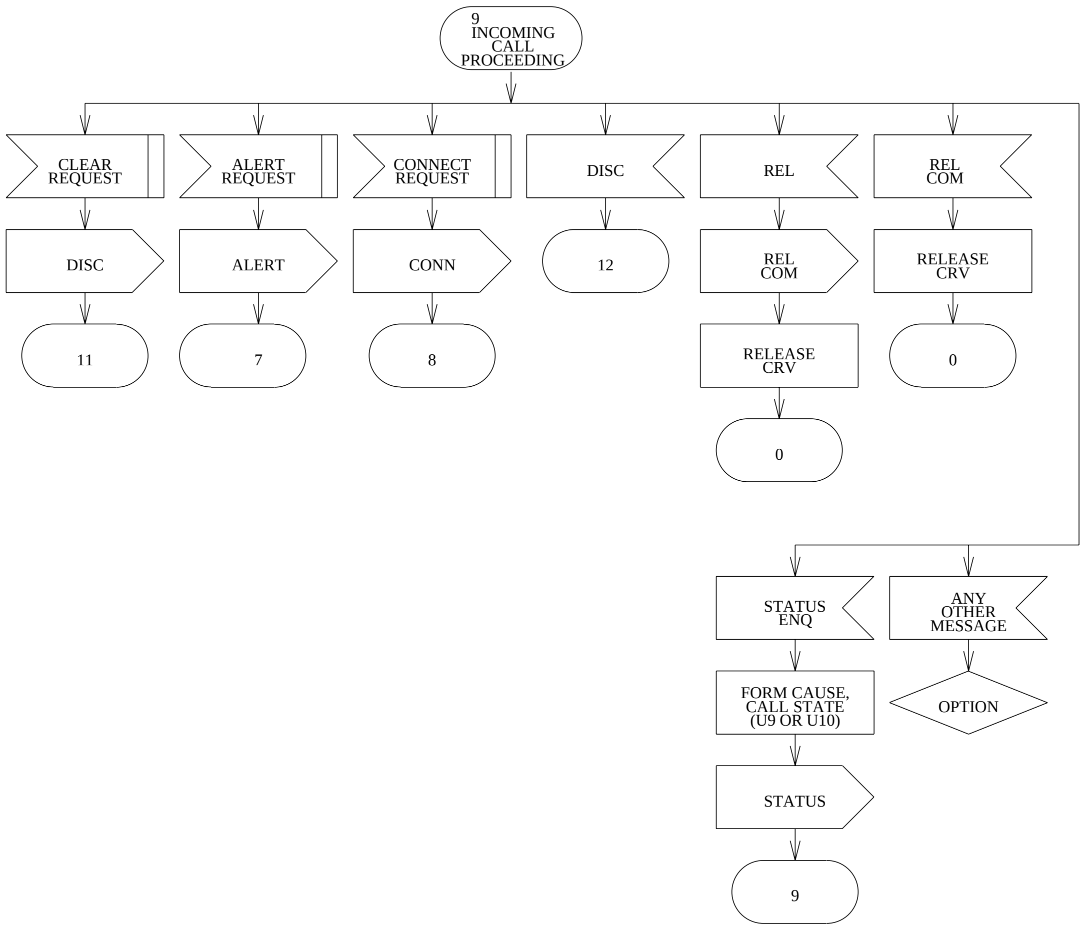


Figure 4.2.3-13 — Call Control—CPE Termination (INCOMING CALL PROCEEDING) (User Side)

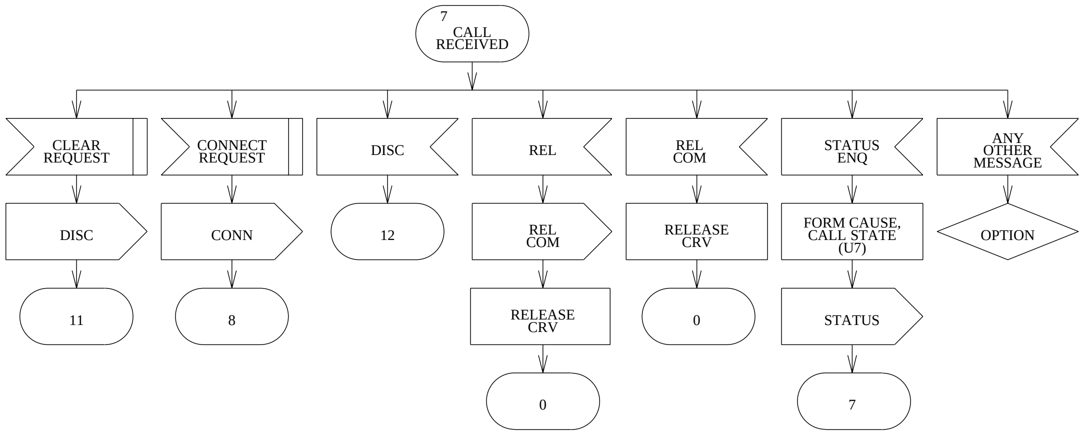


Figure 4.2.3-14 — Call Control—CPE Termination (CALL RECEIVED) (User Side)

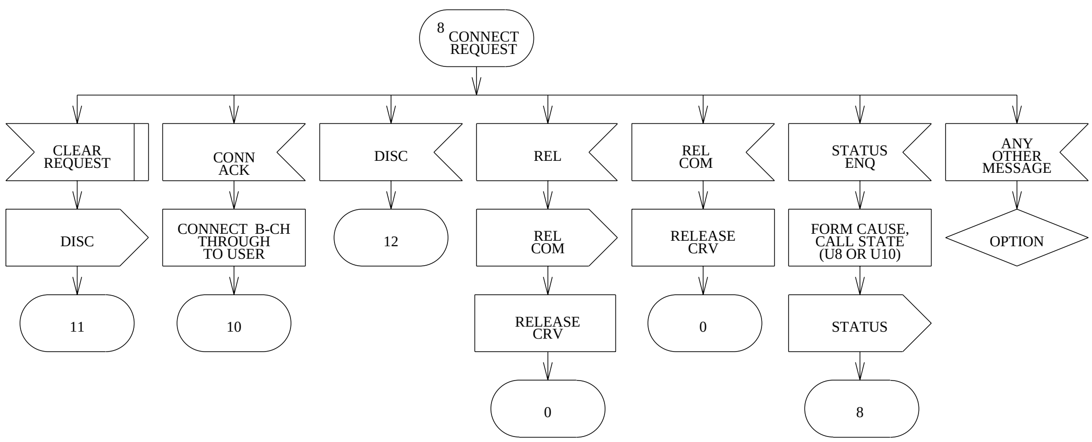


Figure 4.2.3-15 — Call Control—CPE Termination (CONNECT REQUEST) (User Side)

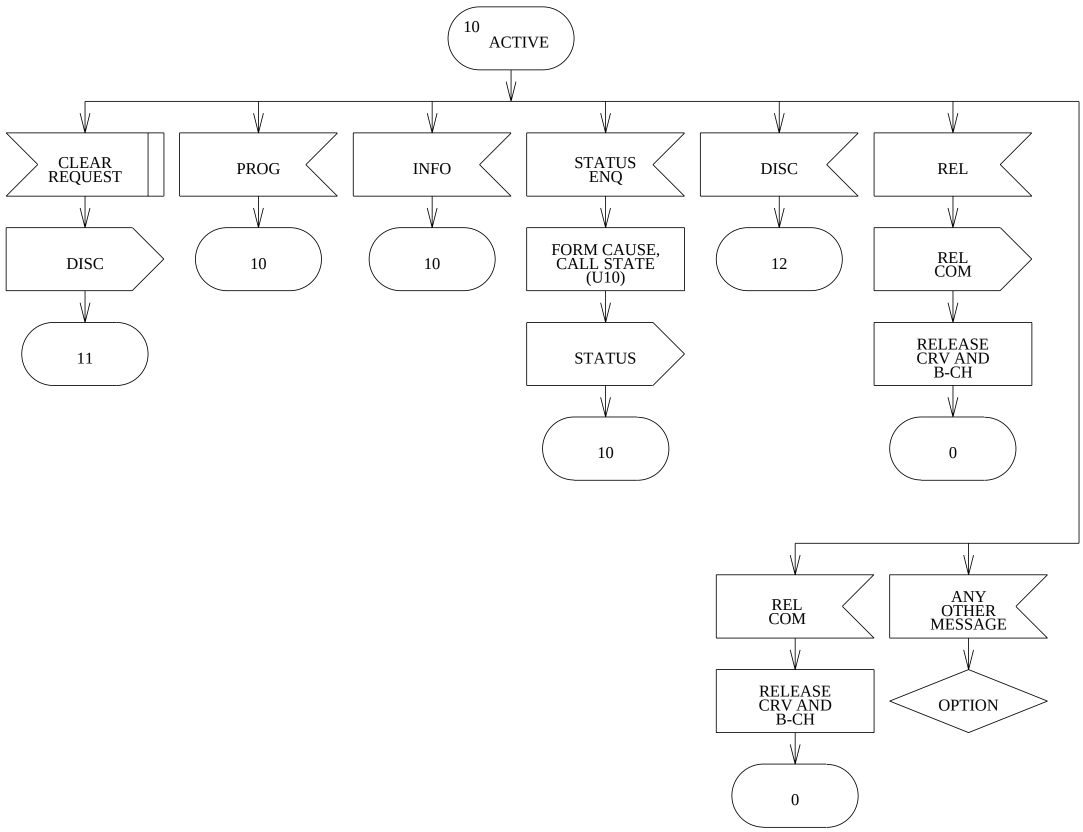


Figure 4.2.3-16 — Call Control—CPE Termination (ACTIVE) (User Side)

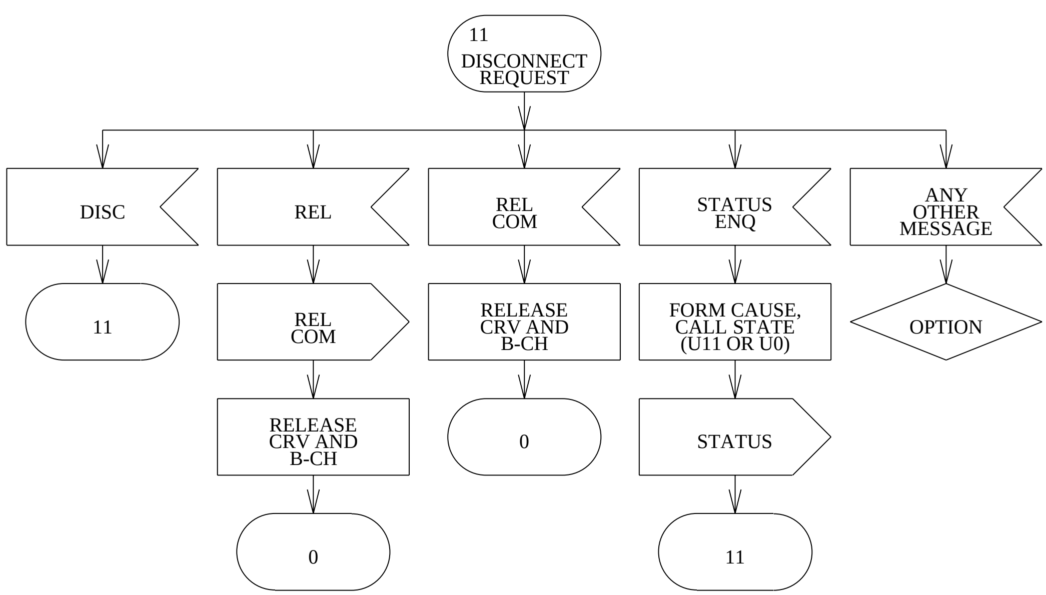


Figure 4.2.3-17 — Call Control—CPE Termination (DISCONNECT REQUEST) (User Side)

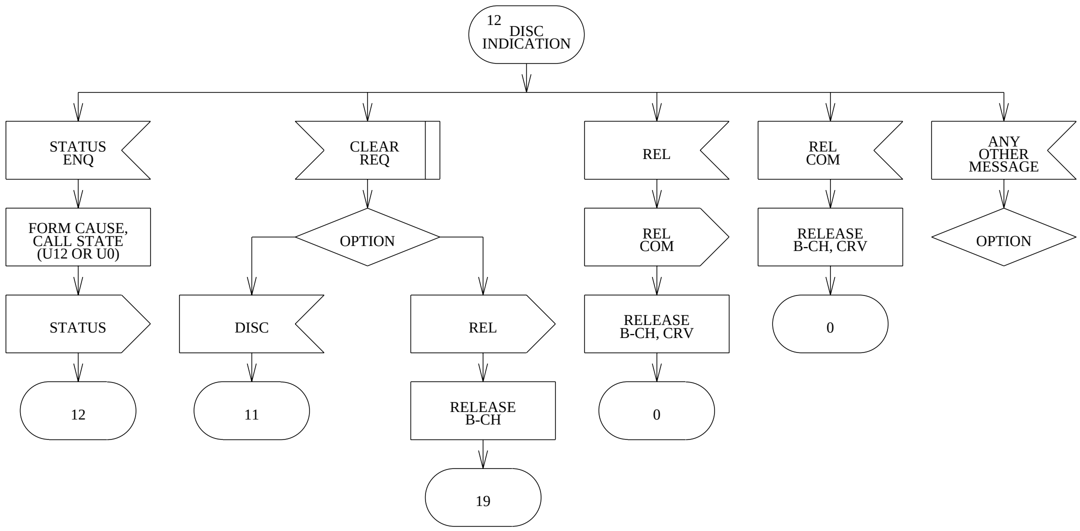


Figure 4.2.3-18 — Call Control—CPE Termination (DISC INDICATION) (User Side)

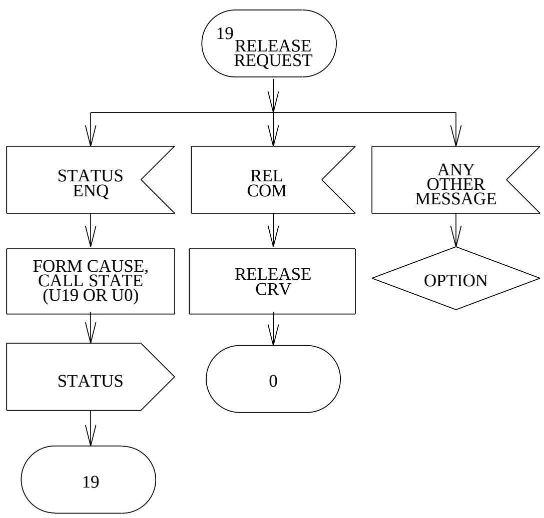


Figure 4.2.3-19 — Call Control—CPE Termination (RELEASE REQUEST) (User Side)

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

4.3 PACKET SERVICES

About this Section

This section of the specification describes the procedures for the establishment, maintenance and clearing of packet transport mode access connections for packet calls at the integrated services digital network (ISDN) basic rate interface (BRI). Where applicable, these procedures are defined in terms of I.451/Q.931[1] messages exchanged over the D-channel of the basic access interface structure. The functions and procedures of this protocol, and the relationship with other layers, are described in general terms in "Message Definitions," Section 4.1, and "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

This section also describes the X.25 procedures for the establishment, maintenance, and clearing of the virtual calls and permanent virtual circuits (PVCs) carried over a packet transport mode access connection. These procedures are defined in terms of X.25 packets exchanged over the packet mode access connection on the basic access interface structure. The functions and procedures of the protocol, and the relationship with other layers, are described in the 1984 CCITT X-series Recommendations. The Type of Address/Numbering Plan Indicator (TOA/NPI) format address block is described in the 1993 ITU-T Recommendation X.25.

A terminal accessing packet services may be either a fully initializing terminal (FIT) or a non-initializing terminal (NIT), and the need to initialize is dependent on only the services subscribed to by the user. If two different TEIs are used, one for circuit and one for packet services, the switch will treat the terminal as if it were two different physical terminals and will require separate service orders.

The procedures in this specification define a set of network capabilities that enable the network to effectively meet the currently identified essential demand, following the principles of evolution expressed in the ITU-TS I-series of Recommendations. As stated in "Introduction," Section 1, it is the intent of Lucent Technologies to follow and adopt domestic and international standards.

About Packet Services

In this section, the term "access connection" is used to refer to a B-channel or D-channel connection to a packet handling function. Packet transport mode is used when the network performs packet switching of the user’s data. The following types of packet transport mode connections are supported:

a. X.31 packet transport mode (B-channel):

- On-demand access connections: Q.931 signaling is used to establish and clear on-demand B-channel (ODB) connections to the packet handling function. Inband X.25 procedures are used to establish, maintain, and clear the individual virtual calls.

- Permanent access connections: Permanent access connections are supported (that is, Q.931 is not used to control D-channel access connections). Inband X.25 procedures are used to establish, maintain, and clear the individual virtual calls.

1. In the ITU-TS Recommendations, I.451 and Q.931 are dual numberings of the same recommendations. In this document, the reference used is Q.931.

b. X.31 packet transport mode (D-channel):

- On-demand access connections: For incoming calls, Q.931 signaling may be used to control user access to the D-channel. For outgoing calls, Q.931 is not used to control D-channel access. Inband X.25 procedures are used to establish, maintain, and clear the individual virtual calls.
- Permanent access connections: Permanent access connections are supported (that is, Q.931 is not used to control D-channel access connections). Inband X.25 procedures are used to establish, maintain, and clear the individual virtual calls. A NIT can access a D-channel permanent virtual circuit (PVC) if it uses a fixed TEI that is provisioned in the switch along with parameters defining the PVC.

Scope of this Section

Specifically, this section includes protocol and procedures for the establishment, maintenance and clearing of the following:

- Packet transport mode permanent access connections on either the B- or D-channel
- Packet transport mode on-demand access connections on the B- or D-channel
- Virtual calls and PVCs on permanent packet transport mode connections (that is, packet-switched by the network).
- Virtual calls on on-demand packet transport mode connections (that is, packet-switched by the network).

The following additional information is included for each transport mode:

- The applications supported
- The X.25 facilities supported for X.31 packet transport mode
- The protocols necessary for implementation.

Application to Interface Structures

The Layer 3 procedures apply to the basic access interface structure defined in "Physical Layer," Section 2. They use functions and services provided by Layer 2.

4.3.1 Q.931 CALL CONTROL

In this section, the terms "incoming" and "outgoing" are used to describe the establishment of a packet transport mode access connection as viewed by the user side of the interface.

4.3.1.1 Q.931 Call Control States

Detailed description of the procedures for call/access connection control is given in "X.31 Packet Transport Mode Specification," Section 4.3.2, in terms of the sequence of messages defined in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, which are transferred across the interface also apply to packet calls. Transitions between states are shown in the specification description language (SDL) diagrams. The SDL diagrams for packet transport mode access connections are included in "Specification Description Language (SDL) Diagrams," Section 4.3.3.

Table 4.3.1-1 depicts the relationships between the call states listed in "Message Definitions," Section 4.1, and on-demand B- and D-channels access connections for packet transport mode. These are the same states, with the same definition scope as described in "Message Definitions," Section 4.1. Note that the terminal may choose to support a reduced set of states.

Table 4.3.1-1 — Call Control States

CALL CONTROL STATES	B-CHANNEL[a] PACKET-MODE X.31	D-CHANNEL[a] PACKET-MODE X.31
USER SIDE		
Null (U0)	b	b
Call initiated (U1)	b	
Outgoing call proceeding (U3)	b	
Call delivered (U4)		
Call present (U6)	b	b
Call received (U7)	b	b
Connect request (U8)	b	b
Incoming call proceeding (U9)	b	b
Active (U10)	b	
Disconnect request (U11)	b	
Disconnect indication (U12)	b	
Release request (U19)	b	b
NETWORK SIDE		
Null (N0)	b	b
Call initiated (N1)		
Overlap sending (N2)		
Outgoing call proceeding (N3)	b	
Call delivered (N4)		
Call present (N6)	b	b
Call received (N7)	b	b
Connect request (N8)	b	b
Incoming call proceeding (N9)	b	b
Active (N10)	b	
Disconnect request (N11)	b	
Disconnect indication (N12)	b	
Release request (N19)	b	b

Note(s):

a. These are the call states associated with the control of on-demand B- or D-channel access connections to the packet handling function (that is, not call states for individual virtual calls).

b. These are the call states supported by customer premises equipment (CPE) and the switch.

4.3.1.2 Q.931 Message Functional Definitions

A subset of the Q.931 messages and information elements described in "Message Definitions," Section 4.1, are used for the establishment, maintenance, and clearing of on-demand packet transport mode access connections. Regardless of which section of this specification a message is included in, there is no end-to-end [that is, terminal endpoint (TE) to TE] significance to any message when used to control an ODB access connection for X.31 virtual calls.

This section describes the information elements and messages that may be used for packet transport mode access connections. It describes how information elements are coded differently, depending on whether they can be used for *only* packet applications or for voice also.

4.3.1.2.1 Q.931 Messages for Packet Calls/Access Connections

Table 4.3.1-2 lists packet call connection types and the messages that may be used to provide the desired service.

Table 4.3.1-2 — Messages for Packet Calls

CONNECTION TYPE	ALLOWED MESSAGES	SECTION OF THIS DOCUMENT
Call Establishment	ALERTing	Section 4.1.2.2
	CALL PROCeeding	Section 4.1.2.3
	CONNect	Section 4.1.2.4
	CONNect ACKnowledge	Section 4.1.2.5
	SETUP	Section 4.1.2.25
Call Disestablishment	DISConnect	Section 4.1.2.6
	RELease	Section 4.1.2.19
	RELease COMplete	Section 4.1.2.20
Miscellaneous	STATUS	Section 4.1.2.27
	STATUS ENQuiry	Section 4.1.2.28

The Q.931 messages used for packet calls are described in "Message Definitions," Section 4.1.

4.3.1.2.2 Coding for Q.931 Information Elements

This section provides the information element coding specific for on-demand packet transport mode access connections. It includes coding for information elements used specifically for packet applications. It also includes information elements whose coding differs, depending on whether the application is voice or packet.

4.3.1.2.2.1 Coding Rules

The coding of information elements in this section follows the coding rules described in "Message Definitions," Section 4.1.

4.3.1.2.2.2 Bearer Capability

The format of the bearer capability information element is as described in "Bearer Capability," Section 4.1.3.2.3.

4.3.1.2.2.3 Called Party Number

The format of the called party number information element is as described in "Called Party Number," Section 4.1.3.2.5, with the following specifications. When sending a Q.931 message to the user, the network will populate the field values as follows:

Type of number and numbering plan (Octet 3, Bits 7-1)

Bits

Bits	
1 0 0 0 0 0 1	Local (directory) number in ISDN numbering plan (Rec. E.164)

The called party number information is mapped from the called address field in an incoming X.25 packet.

4.3.1.2.2.4 Called Party Subaddress

The format of the called party subaddress information element is as described in "Called Party Subaddress," Section 4.1.3.2.6, with the following specifications.

The subaddress information corresponds to the called address extension facility, if present in an incoming X.25 packet call as a ITU-TS specified DTE facility. The network will translate Bits 8 and 7 of the first octet of the X.25 called address extension facility. If the translation reveals the subaddress field is of type X.213 or ISO 8348 AD2, the type of subaddress field (Octet 3) will be encoded as network address service access point (NSAP). If it is a subaddress of type "other," the type of subaddress field will be specified as user specified. If the type of subaddress is coded as reserved (0 1 or 1 1), then the type of subaddress in the Q.931 will be coded as 0 0 1 or 0 1 1. The digits are coded as received in the X.25 packet call, that is, each digit is coded in a semi-octet in binary coded decimal, where Bit 5 or 1 is the low-order bit of the digit. The length of the subaddress will be truncated if it exceeds 20 octets.

4.3.1.2.2.5 Calling Party Number

The format of the calling party number information element is as described in "Calling Party Number," Section 4.1.3.2.7, with the following specifications.

The network does not require the calling party number information element to be present in a SETUP message from the terminal. If it is present in a SETUP from a NIT, the switch will attempt to "bind" the terminal to the USOP identified by the calling party number. If it is not present in a SETUP from a NIT, the switch will attempt to use the terminal's current bound USOP (if any), or bind/rebind it to the Packet Default DN USOP, if it exists. See "Terminal Initialization," Section 6, for more detail.

4.3.1.2.2.6 Channel Identification

The format of the channel identification information element is as described in "Channel Identification," Section 4.1.3.2.10.

4.3.2 X.31 PACKET TRANSPORT MODE SPECIFICATION

This section describes the procedures that define the flow of messages across a BRI between an ISDN user and a supporting switch to establish, maintain, and clear data calls. This section also includes procedures for the information transfer portion of packet calls.

Before these procedures are invoked, a reliable data link connection must be established between the two sides of an ISDN interface.

The user-network packet transport mode services can be categorized into two groups: (1) permanent transport services and (2) on-demand transport services.

4.3.2.1 Packet Transport Mode Supported Types

The following types of packet transport mode services are supported.

- Type 1 - D-channel permanent packet transport mode on one logical link
- Type 2 - B-channel #1 permanent packet transport mode
- Type 3 - B-channel #2 permanent packet transport mode
- Type 4 - B-channel on-demand packet transport mode (the specific channel is chosen on a dynamic basis)
- Type 5 - D-channel on-demand packet transport mode (may require Q.931 procedures for setting up Layer 2 logical link).

The following configurations of packet transport mode service types are associated with no TEI:

a. Type 2

b. Type 3

c. a combination of a and b.

The following configurations of packet transport mode service types are associated with a single TEI:

a. Type 1

b. Type 4

c. Type 5

d. A combination of a, b, and c, except Type 1 and Type 5 cannot be in the same combination.

The following combinations of the previously mentioned list items are supported on a BRI:

a. Maximum of 8 terminals[1] each supporting Type 1 or Type 5, and/or Type 4 service.

b. One Type 2 service

c. One Type 3 service

1. Defining a terminal as a logical entity with a single TEI. If a single physical device makes use of multiple TEIs, then it is considered as multiple terminals.

d. Any combination of a, b, and c, except Type 2, Type 3, and Type 4. Also, Type 1 and Type 5 cannot be in the same combination.

A terminal, as identified by a TEI, may have a unique X.25 packet address for each type of packet transport mode service, or may have a common address for two or more types of packet transport mode services. Note that Type 2 and/or 3 service do not require a TEI, but may have a unique address or may share a common address with other types of packet transport mode services. A specific channel or logical link with PVC service must have a unique packet address, that is, the packet address cannot be shared with other packet transport mode services. Examples of address assignments are as follows:

a. One packet address common to Type 1, Type 2, and Type 3 services

b. One packet address common to Type 4 and Type 5 services, another packet address unique to Type 3 service.

The following subsections describe the characteristics of permanent and on-demand packet transport mode services.

4.3.2.2 Permanent Packet Transport Services

4.3.2.2.1 Overview of Permanent Packet Transport Services

The user and network establish permanent transport access connections at the time of subscription.[2] The user and network use this type of data transport facility to convey virtual call and PVC data services. The signaling for virtual call establishment is accomplished through standard X.25 call setup procedures. The packet handling function processes the virtual call control messages and provides logical channel switching.

Incoming virtual calls are routed to a specific channel or logical link based on the called number (for example, each channel/logical link can be assigned a unique directory number). B-channels provisioned for permanent packet transport mode may be administered as a multiline hunt group (see "Multiline Hunt Group," Section 4.3.2.4).

4.3.2.2.2 X.31 D-Channel Packet Transport Mode

The X.31 D-channel virtual call establishment is initiated by transmitting an X.25 call request packet in a link access procedures-D (LAPD) frame. This frame will be sent with a service access point identifier (SAPI) of 16 and a TEI chosen in accordance with procedures in "Data Link Layer," Section 3. A terminal that can establish a fixed TEI can access permanent packet transport service (PVC) if the fixed TEI is provisioned along with the PVC parameters in the switch.

4.3.2.2.3 X.31 B-Channel Packet Transport Mode

The X.31 B-channel virtual call establishment is initiated by transmitting an X.25 call request packet in a link access procedure-balanced (LAPB) frame. Recommendation X.25 procedures as described in "X.25 Procedures," Section 4.3.2.7, govern any further virtual call handling.

---

2. A B-channel that is provisioned for permanent packet transport mode service will always be considered busy by the network (that is, the B-channel is considered in use for the purposes of choosing an available channel for voice or data circuit transport mode or on-demand packet transport mode connections).

4.3.2.3 On-Demand Packet Transport Services

4.3.2.3.1 Supported On-Demand Packet Transport Services

On-demand transport access connections are established on a need basis. On-demand packet transport mode is supported for both B- and D-channel applications. The user and network use this type of data transport facility to convey only virtual call data services (that is, PVC service is not supported on on-demand access connections).

4.3.2.3.2 General Rules

The general rules for message processing as described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, are applicable to X.31 packet transport mode connections and will not be repeated.

4.3.2.3.3 X.31 D-Channel Packet Transport Mode

The X.31 D-channel virtual call establishment is initiated by transmitting an X.25 call request packet in a LAPD frame. This frame will be sent with an SAPI of 16 and a TEI chosen in accordance with procedures, in "Data Link Layer," Section 3. For terminals that do not perform initialization procedures, the following applies:

a. The X.25 call request packet may optionally contain the calling party number information, although a non-initializing terminal may become associated with different service if it changes the DN it sends, or if it does not send a DN. Details on associating a terminal with a USOP can be found in "Terminal Initialization," Section 6.

b. If the user subscribes to the "no notification" class of service, the terminal should initiate an X.25 call request every time the Layer 2 (SAPI=16, TEI) logical link is established. Otherwise, the network may not be able to deliver incoming packet calls. The terminal may initiate a call to itself.

Recommendation X.25 procedures as described in "X.25 Procedures," Section 4.3.2.7, govern any further virtual call handling.

4.3.2.3.4 Access Connection Establishment at the Originating Exchange

4.3.2.3.4.1 Overview of Access Connection Establishment at the Originating Exchange

The procedures in this section apply to only the establishment of a B-channel access connection to the packet handling function. Virtual calls to be placed over an already established access connection are established by using only inband X.25 procedures.

The assignment of a call reference value for the SETUP message is performed according to the procedure described in "SETUP," Section 4.1.2.25. The call reference value specified in the SETUP message will be used for all subsequent messages relating to that access connection. A user initiates access connection establishment by transferring a SETUP message across the interface. Following the transmission of the SETUP message, the access connection shall be considered by the user equipment to be in the *Call Initiated* state.

4.3.2.3.4.2 Access Connection Request

The SETUP message must contain the mandatory information elements as shown in "Message Definitions," Section 4.1, and may also contain the Channel Identification information element. See "Channel Identification," Section 4.1.3.2.10. The SETUP message may optionally contain the calling party number, although a non-initializing terminal may become associated with different service if it changes the DN it sends, or if it does not send a DN. Details on associating a terminal with a USOP can be found in "Terminal Initialization," Section 6.

The network determines that a B-channel will be connected to the packet handling function based on the bearer capability. Therefore, address information (that is, keypad information element) will not be included in the SETUP message.

If the network determines that the call information received from the user is invalid (for example, invalid bearer capability), then the network shall initiate clearing as described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

4.3.2.3.4.3 Channel Negotiation - Originating

Channel selection for X.31 packet transport mode connections on the B-channel follows the procedures described in this section.

The user may indicate in the SETUP message the channel desired for the packet transport mode access connection as follows:

a. An exclusive B-channel (that is, no acceptable alternative)

b. A preferred B-channel (that is, desired, but the other B-channel is acceptable)

c. Any channel (that is, either B-channel is acceptable).

Note: Omission of the channel identification information element from the SETUP message is equivalent to requesting any channel.

In all cases, the network will first distinguish whether the request is allowed based on the subscriber profile. If the selection is not allowed, the network will clear the access connection by sending a RELease COMplete message with Cause 57, "bearer capability not authorized." If the selection is allowed, the following rules apply.

In cases a and b, if the requested channel is not in use, the network connects it to the packet handling function.

In Case c, or if no indication is included, the network will determine the B-channel to be connected to the packet handling function.

In Case a, if the requested channel is busy, the network will clear the access connection request by sending a RELease COMplete with Cause 34, "no channel available."

In Case b, if the preferred channel is busy, the network will connect the other B-channel, if it is available. If no B-channel is available, the network will clear the access connection request by sending a RELease COMplete with Cause 34, "no channel available."

In Case c, if no channel is available, the network will clear the access connection request by sending a RELease COMplete with Cause 34, "no channel available."

In all cases, the connected channel (coded as exclusive) is indicated in the CALL PROCeeding message returned by the network. The user equipment will connect to the B-channel indicated in the CALL PROCeeding message (that is, the user equipment will not connect to the B-channel prior to the receipt of the CALL PROCeeding message). At this time, the access connection enters the *Outgoing Call Proceeding* state.

If the user does not wish to accept the channel indicated by the network, then the user clears the access connection as described in "Call Clearing," Section 4.2.1.4.

4.3.2.3.4.4 Access Connection Connected

After connecting the B-channel to the packet handling function, a CONNect message is sent across the user-network interface to the calling user. This message indicates to the calling user that a connection has been established to the co-located packet handling function. At this time, the access connection enters the *Active* state.

On receipt of the CONNect message, the calling user equipment will connect the B-channel (if it did not connect the B-channel upon receipt of the CALL PROCeeding message). The equipment may also optionally generate a CONNect ACKnowledge message. The network will not take any action on receipt of this message when it perceives the access connection to be in the *Active* state. Once the user detects that the network is transmitting contiguous flags over the indicated B-channel, the user will then initiate LAPB by sending an SABM. If the user has subscribed to the "no notification" class of service, the network starts a timer, referred to as initial connection timer, upon transmission of the CONNect message. If the user does not establish LAPB before the expiry of this timer, the network will clear the access connection (see "Network Initiated Clearing," Section 4.3.2.3.6.2, for details). The network also starts the B-channel timer[3] if the user has subscribed to the "no notification" class of service or Timer T320 if the user has subscribed to the "conditional notification" class of service (see "Network Initiated Clearing," Section 4.3.2.3.6.2, for details).

4.3.2.3.4.5 Access Connection Rejection

If the network is unable to connect the access connection to the packet handling function, the network will initiate clearing as described in "Call Clearing," Section 4.2.1.4.

4.3.2.3.5 Access Connection Establishment at the Destination Exchange

4.3.2.3.5.1 Overview of Access Connection Establishment at the Destination Exchange

The network uses the called number to identify the access connection over which to offer the incoming packet call. If the called number identifies a unique access connection, the network selects that particular access connection. If the called number is associated with more than one access connection, the network uses an algorithm to select the access connection over which to offer the call. An access connection may consist of a B-channel if the B-channel type is selected or may consist of a logical link (SAPI=16, TEI) if the D-channel is selected. If the access connection selected by the network is busy (see "Access Connection Busy," Section 4.3.2.7.1.2, for the definition of "busy"), the network will either attempt to select another access connection or clear the virtual call, depending on the user’s subscription parameters.

The user may subscribe to the "no notification" class of service, or to the "conditional notification" class of service. If the user subscribes to the "no notification" class of service, the network will deliver only incoming virtual calls over nonbusy established

3. This timer is a network timer that applies only when the user has subscribed to the "no notification" class of service.

access connections (for example, an already established ODB). If the network is unable to find a nonbusy established access connection, the network will clear the incoming virtual call.

If the user subscribes to the "conditional notification" class of service, the network then proceeds as follows:

a. If the access connection selected is established (that is, active) and not busy, the network uses inband X.25 procedure to deliver the incoming packet call.

b. If the channel selected is an idle ODB (Type 4 service) the network will notify the user of the incoming virtual call through Q.931 procedure.

c. If the channel selected is a D-channel (Type 5 service) but no logical link (SAPI=16, TEI) is established, the network will notify the user of the incoming virtual call through Q.931 procedure. The purpose of the Q.931 notification procedure is to trigger the establishment of the Layer 2 logical link. After the logical link is established, the Q.931 call is cleared.

d. If the network is unable to select an access connection for the incoming virtual call, the network will not transmit a SETUP message to the called party, and will clear the X.25 incoming call.

If the network determines that the called party should be notified through the Q.931 procedure, the network will transmit a SETUP message across the interface through the broadcast capability at the data link layer. The SETUP message contains the following information elements: call reference, bearer capability, channel identification marked with the exclusive option,[4] called party number, and called party subaddress (if available).

4.3.2.3.5.2 Call Confirmation

The general rules for message processing as described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, are applicable to X.31 packet transport mode connections and will not be repeated here. Exceptions to these rules are noted in the following paragraphs.

The network will not provide inband tones and will not send Q.931 messages to the calling party. All Q.931 messages have only local significance at the interface.

4.3.2.3.5.3 Call Acceptance

To accept the incoming call, the user must send a CONNect message. When the network receives a CONNect message, the call enters the *Connect Request* state.

If the B-channel was selected, the network completes the path to the selected B-channel and subsequently sends a CONNect ACKnowledge message to the user that has accepted the call. The CONNect ACKnowledge message indicates completion of the path at the terminating exchange. The network will start transmitting continuous flags, start Timer T320, and initiate LAPB link setup. If Layer 2 has been successfully established, the network stops Timer T320 and sends the X.25 incoming virtual calls in-band in the order they have been received. If the network is not successful in setting up Layer 2, the network will move the LAPB link to the *Disconnected* state. If Timer T320 expires before Layer 2 has been established successfully, the network will

4. When channel negotiation is supported in future software releases, the channel identification could be marked with the preferred option.

send the user a DISConnect message, move the call to the *Disconnect Indication* state, and clear all X.25 virtual calls.

If the D-channel was selected, the network starts Timer T320 and attempts to establish the (SAPI=16, TEI) link layer.[5] The user must have the same TEI for SAPI=0 and SAPI=16 procedures for the link establishment procedure to work correctly. Once the link layer has been established, the network stops Timer T320, sends the user a RELease message, moves the call to the *Release Request* state, and the network then sends the X.25 virtual calls inband to the user in the order they have been received. If the network is not successful in setting up Layer 2, the network will move the SAPI=16 link to the *TEI-Assigned* state. If Timer T320 expires before Layer 2 has been established successfully, the network will send the user a RELease message, move the call to the *Release Request* state, and clear all X.25 virtual calls.

4.3.2.3.5.4 Premature Clearing of the Virtual Circuit

If during the notification procedure and before the X.25 incoming call packet is delivered, the network receives an X.25 clearing request from the calling party, the network will clear the X.25 virtual call and the Q.931 call. If there are other X.25 virtual calls in the queue, the network continues the current notification procedure. In this case, the called subaddress information sent in the X.25 incoming call packet may be different from what was previously sent in the SETUP message.

4.3.2.3.6 Access Connection Clearing

4.3.2.3.6.1 Clearing Initiated by the User

Any time after clearing the last virtual call on the B-channel, the user may initiate a request to disconnect the B-channel by transmitting a DISConnect message with the appropriate cause information element. The normal clearing procedures described in "Call Clearing," Section 4.2.1.4, are then followed.

The user may choose to leave the B-channel connected to the packet handling function (that is, leave the access connection in the active state) without any active virtual calls in order to receive incoming virtual calls. However, in this case, Layer 2 must remain established in order to originate or receive virtual calls.

4.3.2.3.6.2 Network Initiated Clearing

Under normal conditions, the network will not initiate clearing of an ODB. The network initiates clearing of the ODB when any of the following timers expire:

a. ***B-Channel Timer:*** This timer is applicable only when the user has subscribed to the "no notification" class of service. It is started when the network transmits a CONNect message or whenever no virtual calls are active on an ODB (for example, upon clearing of the last virtual call). The timer is canceled whenever the network receives a call request packet, processes an incoming call packet, or receives a Q.931 clearing message with the call reference value associated with the access connection. Upon expiry of this timer, the network initiates access connection clearing. The B-channel timer is set at time of subscription on a per-subscriber basis, with a range of 10 to 60 minutes in 1-minute increments. The timer may also be disabled at subscription time.

---

5. The terminal may initiate the establishment of the (SAPI=16, TEI) link after sending a CONNect message to the network. The terminal should not attempt to establish the (SAPI=16, TEI) link before sending a CONNect message.

b. ***Initial Connection Timer:*** This timer is applicable only when the user has subscribed to the "no notification" class of service. It is started when the network transmits a CONNect message. The timer is canceled when the network receives an SABM or a Q.931 clearing message with the call reference value associated with the access connection. Upon the expiry of this timer, the network initiates access connection clearing. The timer has a fixed value of 120 seconds.

c. ***Timer T320:*** This timer is applicable when the user has subscribed to the "conditional notification" class of service. It is started when the network sends or receives a CONNect message or after clearing of the last virtual call on the B-channel. The timer is canceled whenever a new virtual call process is established or when the user initiates B-channel clearing procedure. Upon expiry of Timer T320, the network initiates clearing procedures.

4.3.2.3.7 Handling of Error Conditions

Error handling procedures used during access connection establishment are the same as those specified in "Handling of Error Conditions," Section 4.2.1.5.

4.3.2.4 Multiline Hunt Group

This facility is established by service provisioning. It distributes incoming virtual calls over a group of users. Two types of hunting algorithms are supported: uniformly-distributed hunting and uniformly-distributed/linear hunting. The hunt group must be assigned at least one address for the uniformly-distributed hunt group. A hunting address must be assigned to the first member in the linear hunt group. Other characteristics of the multiline hunt group service are as follows:

a. Any feasible combination of type of services, as described in "X.31 Packet Transport Mode Specification," Section 4.3.2, can be assigned as a hunt group member.

b. If a hunt group member is of the noninitializing type and the member has subscribed to packet on on-demand B-channel and/or D-channel, the terminal must have an individual (nonhunt) address assigned to it. When initiating an X.25 call request over the D-channel or a SETUP request for B-channel access connection, the hunt group member must include its individual address in the calling number information.

c. If the hunt group member subscribes to packet on permanent B-channel, the member must maintain Layer 2 LAPB active. If Layer 2 LAPB is not active, the network will treat the access connection as busy for purposes of hunting.

d. A hunt group member cannot subscribe to the "conditional notification" class of service. The member can subscribe to only the "no notification" class of service.

e. The called line address modified notification (CLAMN) is supported as specified in Bellcore TR-TSY-000859, Issue 1, December 1988.

f. When delivering an incoming packet call, the network will include the hunt group address in the X.25 incoming call packet. The network may include the hunt address or the nonhunt address in the SETUP message if notification is supported.

4.3.2.5 ISDN Packet-Switched Data Business Group (PBG)

4.3.2.5.1 Abbreviated Dialing for Packet Mode Calls

The "abbreviated dialing" service allows members of a PBG to originate calls using a subset of the called user’s address. The network supports a called user’s address of fewer than seven digits.

Note that for a terminal of the noninitializing type, it must always provide the full calling address information when requesting a packet call on the D-channel or when requesting the setup of a B-channel access connection.

4.3.2.5.2 Abbreviated Number Delivery

On a per PBG basis, the network will allow "abbreviated number delivery" subscription option. When a PBG is configured with the "abbreviated dialing" and "abbreviated number delivery" option is set to yes, for packet mode calls that originate and terminate within the same PBG, the network will allow the delivery of the calling address in the abbreviated form to the called user. The network will abbreviate the calling directory number (DN) by deleting a subset of the digits from the calling DN. The leading digits that will get deleted from the calling DN during the abbreviation must exactly match with the corresponding leading digits from the called DN. The network supports an X.25 calling address of fewer than seven digits.

4.3.2.6 User Testing

The user may initiate an X.25 call to itself to test its B- or D-channel. As a minimum requirement, the user must be able to support two logical channels. When receiving a request for user testing, the network will treat the request as a regular call, except that the network will override the incoming calls barred facility if active. If the user belongs to a multiline hunt group (MLHG) and initiates a call using the hunt DN as the called address, the call may be delivered to that user or to a different user depending on the results of the hunting algorithm. Also, the network may use a channel selection algorithm to select an access connection for the call. The access connection selected may be the connection over which the call request was initiated or may be a different access connection.

4.3.2.7 X.25 Procedures

4.3.2.7.1 X.25 Packet Mode Virtual Call Control Procedures

4.3.2.7.1.1 Supported X.25 Packet Mode Virtual Call Control

This section assumes that a specific B-channel (that is, B1 or B2) or logical link on a D-channel (that is, SAPI 16 and TEI value) has been selected, and that the link has been established. These procedures were covered in previous sections describing the establishment of access connections. For a NIT, the terminal must have this link (B-channel or D-channel) established before any incoming calls can be delivered. If the terminal subscribes to the "no notification" option described in "Channel Negotiation - Originating," Section 4.3.2.3.4.3, then the terminal must initiate a call request before any incoming calls can be delivered.

The protocol supported herein conforms to the CCITT Recommendation X.25 (1984) Layer 3 specification for connecting packet mode data terminal equipment (DTE) to a packet handling function: setup, maintain the data transfer, clear virtual calls, and maintain the PVCs.

In addition, the network supports the following capabilities:

- Support of a local interface between the network and a DTE conforming to the CCITT Recommendation X.25 (1980).
- Support of interworking between 1980 and 1984 X.25 based DTEs for CCITT-defined end-to-end signaling.
- The TOA/NPI format address block defined in ITU-T Recommendation X.25 (1993) Layer 3 specification is supported for the Call Request, Call Accept, and Clear Request messages when the 15 Digit International Direct Distance Dialing (IDDD15) feature is purchased and active.

The network assumes that the DTEs conforming to the 1980 CCITT Recommendation X.25 can operate with only networks that support 1980 CCITT Recommendation X.25.

4.3.2.7.1.2 Access Connection Busy

An access connection may consist of a B-channel or a D-channel logical link (SAPI=16, TEI). An access connection is considered busy if:

a. All X.25 logical channels are in use.

b. The sum (SUM) of negotiated throughput class values for all packet calls active or in progress on the access connection equal or exceed the maximum combined throughput (MCT) parameter. If SUM is less than the MCT parameter and the new virtual call causes SUM to exceed the MCT parameter, the network will negotiate the throughput class value to the lowest standard value that would cause SUM to equal or exceed the MCT parameter. This procedure applies for incoming and outgoing virtual calls. The MCT parameter has a value for each direction of transmission and can be set by the user at subscription time.

Upon receiving an X.25 call request packet from the user, the network checks for access connection busy condition. If the access connection is busy because the MCT parameter has been reached or exceeded prior to receipt of the current virtual call, the network will clear the call by sending to the calling user a clear indication packet with clearing cause "local procedure error" and Diagnostic Code 71 "no logical channel available."

4.3.2.7.1.3 Virtual Call Setup and Clearing

ITU-TS Recommendation X.25 specifies three basic interface attributes that networks provide to allow for packet switching access. The three X.25 basic attributes associated with virtual call setup and clearing are as follows:

- Maximum user data field length of 128 octets (for fast select)
- Packet sequence numbering modulo 8
- Packet level window size of 2 and 3.

The virtual call setup and clearing procedures follow X.25, Section 4.1, "Procedures for Virtual Call Service." Figures B-1, B-2, and B-3 in the X.25 document show the state diagrams that define the events at the user-network interface. Annex B of X.25

provides details of the action the network side of the interface takes on the receipt of packets in each of Figures B-1, B-2, and B-3.

Note: It is possible for a clearing packet to "pass" data packets within the network. Therefore, when operating with the D-bit set to 0 it is possible for acknowledged packets to be dropped if the user transmits a clearing packet prior to delivery of the data packets to the far end.

Note that when using the non-TOA/NPI format address block, an access escape code "0" must be used when the calling party wishes to place a virtual call requiring an X.121 number in the called address field.

When the terminal includes diagnostic codes in clear, reset or restart packets, the diagnostic code is passed transparently through the switch. If the cause code in a clear, reset or restart packet is "DTE Originated," then the diagnostic code will be coded in accordance with ISO 8208.

4.3.2.7.1.4 PVC Initialization

The CPE will receive a Reset Indication packet with cause code "network operational" when the setup is complete (this does not necessarily mean that the PVC has been established). PVC services are accessible to either a fully-initializing terminal or a non-initializing terminal with a fixed TEI that has been provisioned in the switch in the same USOP as the PVC services. A fixed TEI can be provisioned only if PVC parameters are also provisioned for the same user. PVC services continue to be still accessible to FITs. After the initialization of Layer 3 by a FIT, or the establishment of Layer 2 by a NIT, the following procedures apply:

- If the CPE attempts to send data or a reset request before the PVC has been established through the network, the network either will not respond or will send a Reset Indication packet with cause code "out-of-order" on that PVC.
- If the CPE does not attempt to send data or a reset request until after the PVC has been established through the network, the CPE will not be informed through a Reset Indication packet with cause code "network operational," and the data or reset packet will undergo the normal data transfer procedures.

4.3.2.7.1.5 Logical Channel

The X.25 logical channels are identified by a 4-bit logical channel group number and an 8-bit logical channel number. These channel numbers must appear in every X.25 packet except RESTART and DIAGNOSTIC.

Logical Channel 0 is reserved for control packets (RESTART and DIAGNOSTIC). As a subscriber option, 1 to 127 logical channels are supported for virtual circuits on a communication link carried by a B-channel; 1 to 15 logical channels are supported on each D-channel SAPI 16 logical link.

Logical channel assignment is in accordance with X.25, Annex A. Logical channel numbers assigned for virtual calls and PVCs must be in the range of 1 to 127 on the communication link carried by a B-channel, or in the range of 1 to 15 for each communication link carried by the D-channel. The range of logical channels for PVCs is specified by service provisioning. This range of logical channels includes the assigned PVC, as well as logical channels for future PVCs. The user must specify the logical channel number of each active PVC at subscription time.

4.3.2.7.1.6 Data/Interrupt Transfer

The procedures for data and interrupt transfer follow the procedures described in X.25, Section 4.3. The following paragraphs detail the significance of these procedures to the network side of the user-network interface and the particular features the network side supports.

a. ***Delivery Confirmation Bit:*** When the delivery confirmation bit (D-bit) is set, it indicates whether or not the user wishes to receive an end-to-end acknowledgment of delivery by means of the packet receive sequence number, P(R). The network side interprets the D-bit and passes it unaltered in the call request and call accepted packets during virtual call setup so each user is aware of the D-bit option selected by the other user.

   When a user sends a data packet with the D-bit set to 1, the network side withholds the P(R) acknowledgment until the destination user has given a P(R) acknowledgment for the data packet. On the other hand, if the D-bit is set to 0, acknowledgments do not necessarily have end-to-end significance. An acknowledgment can be a receive-ready or receive-not-ready packet with P(R).

b. ***Qualifier Bit:*** The network does not act on the value of the qualifier bit (Q-bit). The Q-bit will be set to the same value in all data packets of a complete packet sequence. If this is not the case, the network still accepts the packets and transfers the Q-bit values transparently.

c. ***More Data Mark Bit:*** The network does not perform packet fragmentation or recombination. The more data mark (M-bit) procedures are supported as specified in X.25, Section 4.3.4.

d. ***Data Transfer:*** The network delivers data packets to the terminating user side in the same sequence as the packets were transmitted by the originating user side; the network attempts to deliver the packets without packet duplication.

4.3.2.7.1.7 Flow Control

The network side follows the standard flow control principles specified in Section 4.4.1.3 of X.25. If the network side receives a data packet containing a packet send sequence number, P(S), that is out of sequence within the window, the network side resets the virtual circuit. The network side does not pass these packets across the network to the terminating user side equipment.

The network side uses service provisioning to allow negotiation on a per-call basis of the following flow control parameters:

a. ***Virtual Circuit Throughput Class:*** The network recognizes the following throughput classes for virtual calls on D- and B-channels: 75, 150, 300, 600, 1,200, 2,400, 4,800 and 9,600 bps. In addition, the network also recognizes a throughput class of 19,200 bps for virtual calls on the B-channel.

b. ***Packet Size:*** The network supports a maximum size of 256 octets of user data. The default size is 128 octets of user data.

c. ***Window Size:*** The network supports window sizes of 2 or 3. The network defines a window for each direction of data transmission and for each end of a logical channel for a virtual call or PVC. A default window size of 2 is associated with the virtual call if neither side requests a window size value.

4.3.2.7.1.8 DIAGNOSTIC Packet

The network side supports the use of DIAGNOSTIC packets to indicate error conditions under circumstances when the usual methods of indication (for example, reset, clear, and restart with cause and diagnostic codes) are inappropriate. The conditions under which the network side sends the DIAGNOSTIC packet are as specified in X.25, Section 3.4.1.

4.3.2.7.1.9 Effects of the Physical Level and the Link Level Failure

When the network side detects a failure on the physical level, the network side terminates virtual calls and transmits toward the far-end user:

- A reset for each PVC
- A clear for each virtual call.

For a link failure (Layer 2, see "Data Link Layer," Section 3) the network handles all the virtual calls as a physical level failure.

The network treats a disconnection of an ODB access connection as a physical level failure.

4.3.2.7.2 Data Link Layer Specifications

This section covers the data link layer specification for both the B-channel and the D-channel.

4.3.2.7.2.1 Data Link Layer Specification for the D-Channel

The data link requirements are specified in "Data Link Layer," Section 3. The D-channel Layer 2 services for packet transport mode CPE are stated in the following paragraphs. (For additional details, see "Data Link Layer," Section 3.)

a. LAPD support on the D-channel for D-channel packet transport mode services:
   - Terminals support multiple frame mode information transfer procedures on packet data point-to-point "p" links.
   - Each individual terminal (see "Terminal Initialization," Section 6) supports one SAPI 16/TEI logical link.
   - Terminals respond to XID command frames as specified in "Data Link Layer," Section 3.
   - Terminals use LAPD procedures as specified in "Data Link Layer," Section 3.
   - If subscribed to the "no notification" class of service, terminals are responsible for initiating link setup procedures by sending a set asynchronous balanced mode (SABME) when they want to receive incoming calls (that is, the network will clear incoming calls if the SAPI 16/TEI logical link is not in the multiple frame establish state). If subscribed to the "conditional notification" class of service, the network will initiate link setup procedures.
   - Link test procedure implementation is optional.
   - On a BRI the following apply:
     — Each BRI supports up to eight SAPI 16/TEI logical links (that is, up to eight terminals).
     — Terminals support unacknowledged information transfer procedures on SAPI 0 broadcast links and SAPI 63 links.

— Terminals support SAPI 0/TEI and SAPI 63/TEI associated links (that is, associated with their SAPI 16/TEI logical link).

b. LAPD support on the D-channel for permanent B-channel packet transport mode services:

- Terminals are not required to implement the D-channel in order to support a permanent B-channel connection for packet transport mode [that is, the level of D-channel support is based on the other applications supported (for example, D-channel packet, voice on a B-channel)].

c. LAPD support on the D-channel for ODB packet transport mode services:

- Terminals support unacknowledged information transfer procedures on SAPI 0 broadcast links and SAPI 63 links.
- Terminals support multiple frame mode information transfer procedures on SAPI 0 point-to-point links.
- Terminals respond to XID command frames as specified in "Data Link Layer," Section 3.
- Terminals use LAPD procedures as specified in "Data Link Layer," Section 3.
- Link test procedure implementation is optional.
- Terminals support SAPI 0/TEI and SAPI 63 associated links.

4.3.2.7.2.2 Data Link Layer Specification for the B-Channel

The LAPB protocol is used on B-channel packet transport mode connections.

4.3.2.7.2.2.1 LAPB Data Link Layer Specification

The LAPB as specified in CCITT Recommendation X.25 (1984 X.25, Section 2) may be used in the case of B-channel packet transport mode service. This section addresses only unspecified areas of LAPB, or those for which implementation option specifications are required.

4.3.2.7.2.2.2 Restrictions

The network side supports the LAPB single link procedures, but not the LAPB multilink procedures as specified in Section 2.5 of X.25.

The LAPB frames supported by the network side must always consist of an integral number of octets.

The B-channel links "come into existence" at the network side in a *Disconnected* state. In this state, the network side initiates link setup upon craft request or on an incoming call when the user is notified through Q.931 procedure. Otherwise, the network does not initiate link setup procedures for virtual call establishment, but waits for the user side to initiate this action. The network side responds to the receipt of a SABM command from the user side as specified in Section 2.4.4.1 of X.25.

The network side supports only the "basic mode" (modulo 8) of LAPB, as specified in Section 2.4.1 of X.25.

4.3.2.7.2.2.3 LAPB System Parameters

Section 2.4.8 of X.25 defines several system parameters, without specifying their values. The following values are required for the implementation of packet transport mode service.

a. Timer T1 is set per-link, by service order, within a range of 2 through 20 seconds, in approximately 0.2-second increments

b. Timer T3 is set per-link (that is, B-channel), by service order, within a range of 3 through 30 seconds, in 1-second increments. It is also possible, by service order, to set Timer T3 to an infinite value. In this case, the network side makes no attempt to recognize or react to "excessively long idle channel" conditions.

c. Parameter N1 is 2,136 bits, supporting a maximum I-field size of 260 octets; the information field is restricted to an integral number of octets.

d. Parameter N2 is set per link, by service order, within a range of 2 through 15, in unitary increments.

e. Parameter k is set per-link, by service order, within a range of 1 through 7, in unitary increments.

The X.25 specification states that the network side parameters T1, T2, T3, N1, and N2 "shall be made known" to the user side, and that the user side parameters T1, T2, N1, and N2 "shall be made known" to the network side. The X.25 specification suggests no actual mechanism for making the information known. The network side values are negotiated with and/or communicated to the user side administrator through the service provider's service ordering process; similarly, any needed information concerning the user side parameters are communicated to the network side by the service provider through standard service order processes.

4.3.2.7.2.2.4 Link Setup Procedure Failure Handling

Section 2.4.4.1 of X.25 states that, after N2 occurrences of the network sending an SABM frame to request link setup, followed by a failure of the user side to respond with a UA or DM frame within T1 seconds, the network side initiates "appropriate higher level recovery action." The appropriate action is unspecified. The network side responds to this failure by entering the *Disconnected* state after following the procedures specified in Section 2.4.2.1.6 of X.25.

4.3.2.7.2.2.5 Link Disconnection Procedure Failure Handling

Section 2.4.4.3 of X.25 states that, after N2 occurrences of the network side sending a DISC frame to request link disconnection, followed by a failures of the user side to respond with a UA or DM frame within T1 seconds, the network side initiates "appropriate higher level recovery action." Again, the appropriate action is unspecified within X.25. The network side responds to this failure by entering the *Disconnected* state after following the procedures specified in Section 2.4.2.1.6 of X.25.

4.3.2.7.2.2.6 RNR and Timer Recovery Procedure Failures

Sections 2.4.5.7 and 2.4.5.9 of X.25 give the network side two options for responding to the occurrence of N2 timeouts in attempting to perform RNR and timer recovery procedures. The network side responds to these failures by entering the *Disconnected* state.

4.3.2.7.2.2.7 Link Reset Procedure Failure Handling

Section 2.4.7.2 of X.25 states that, after N2 occurrences of the network side sending an SABM frame to request link reset, followed by a failure of the user side to respond with a UA or DM frame within T1 seconds, the network side initiates the "appropriate higher level recovery action." The network side responds to this failure by entering the *Disconnected* state.

4.3.2.7.2.3 Interface Subscription Parameters

The interface subscription parameters are as follows:

a. ***Notification Alternatives:*** A user may subscribe per DN to the "No Notification" class of service or to the "Conditional Notification" class of service. The user/DN cannot subscribe to both classes of service at the same time. The "No Notification" class of service is a subset of the "Conditional Class" of service. A user/DN subscribing to the latter gets all the features of the "No Notification" class of service.

b. ***MCT Parameter:*** This MCT parameter indicates how much load, as measured by the throughput class facility, is the user willing to accept on each access connection (B-channel or D-channel logical link) for each direction of the data flow. A user may subscribe to different parameter values for each service type, and for each direction of transmission. Each semipermanent B-channel (service Type 2 and 3) may have its own MCT values, but if both B-channels are on-demand (service Type 4), the same parameter values apply to both channels. If there are several users accessing packet on the D-channel, each user may subscribe to a pair of MCT values (one value for each direction of transmission). However, the switch will not check to ensure that the sum of all MCT values over the D-channel is within the allowable range. MCT values do not include PVC. For access connections supporting PVC service, the throughput of the PVCs should be considered when selecting MCT values for a connection. If the user does not select values for this parameter, the switch will not use the parameter to check whether a channel is busy. This may result in some degradation of the total throughput on a given channel.

   The subscription is as follows:

Channel	Parameter Range	Default
B-channel	Null, or 64 to 128 kbps (stepsize: 8 kbps)	Null
D-channel	Null, or 16 to 32 kbps (stepsize: 2 kbps)	Null

c. ***Throughput Indication of D-Channel:*** The network uses this parameter to select an access connection for incoming virtual calls. Incoming virtual calls with throughput class value less than or equal to this parameter will be offered over the D-channel (if packet mode on the D-channel is subscribed to). Incoming virtual calls with requested throughput class value higher than this parameter will be offered over a B-channel. If the user does not specify a value for this parameter, the switch will use the default value of 9.6 kbps when a common DN is used.

   The range of values for the parameter are as follows:

   Null or X.25-defined values between 75 bps and 9,600 bps,
   default = 9,600 bps

This parameter does not apply if the called number identifies a unique access connection or a hunt group.

d. ***Number of ODBs:*** The user can subscribe to packet on zero, one or two ODBs at the same time, if consistent with other subscription parameters. For example, if the user has subscribed to a semipermanent B-channel, the user can subscribe to only one ODB. The default value for this parameter is one ODB.

4.3.2.8 Always On/Dynamic ISDN (AO/DI)

Always On/Dynamic ISDN is an X.25 application that uses ISDN as it is defined in this specification. No *5ESS*® switch BRI specification changes were needed to support this application.

When AO/DI is active, an "always on" D-channel connection between two points is established; for example, between an end user and an internet service provider (ISP). Since this D-channel connection is always up, messaging that requires small bandwidth (such as an electronic mail notification or a chat room application) is sent in X.25 packets on the D-channel.

AO/DI software on the end user’s CPE monitors the data transmission rate. When this rate requires larger bandwidth, dynamic channel allocation occurs as follows. The CPE sends a Bandwidth Allocation Control Protocol (BACP) message to signal that one or both B-channels must be invoked; then the AO/DI software makes the call(s) needed to bring up the B-channel(s).

While the B-channel(s) are active, no data is to be transmitted over the D-channel. When the AO/DI software determines that the larger bandwidth is no longer required, the CPE sends a BACP message to release the B-channel(s).

4.3.2.9 X.25 Facilities

4.3.2.9.1 Supported X.25 Facilities

The network layer supports the X.25 form of packet mode transport facilities. The user accesses these facilities as though accessing an X.25 data network. All essential X.25 facilities (per X.2) plus additional facilities [intercom addressing, interexchange carrier preselect, recognized private operating agency (RPOA) selection, reverse charging, and reverse charging acceptance] are available to the user. The network also supports the use of the facility marker to identify ITU-TS-specified DTE facilities.

The X.25 facilities consist of two types, per-call and provisioned. Provisioned facilities are added, removed, or changed through a service order. These services include intercom addressing, incoming and outgoing calls barred, closed user groups (CUGs), fast select acceptance, flow control parameter negotiation, interexchange carrier preselect, multiline hunt group, 1-way logical channel outgoing, PVC, reverse charging acceptance, and throughput class negotiation.

The following subsections provide a definition of the X.25 facilities and definitions of the user-network transport services associated with X.25 packet mode.

Note: We recommend that CPE be designed to place as much information as possible per data packet. This will provide the most efficient and cost effective use of resources. One recommended way of accomplishing this would be to provide a line mode option, whereby all the characters in one line of data are shipped in one data packet.

4.3.2.9.2 X.25 Facilities Definition

This section lists and defines the X.25 facilities.

a. ***Calls Barred (Incoming) - for Virtual Calls:*** This facility is established by service provisioning. It prevents the network from presenting incoming virtual calls to the terminating user side. This facility is equivalent to specifying *all* logical channels for virtual calls as 1-way outgoing (that is, originate only).

   Note that MLHG members cannot subscribe to this facility.

b. ***Calls Barred (Outgoing) - for Virtual Calls:*** This facility is established by service provisioning. It prevents the network from accepting outgoing virtual calls from the calling user side. This facility is equivalent to specifying *all* logical channels for virtual calls as 1-way incoming (that is, answer only). This facility is not available for terminals that do not support initialization procedures.

c. ***CUGs - for Virtual Calls:*** This facility is established by service provisioning. It enables the user side to belong to one or more CUGs. A CUG permits the user side equipment belonging to the group to communicate with other user side equipment belonging to the group, but precludes communication with all user side equipment not in the group. It is the X.25 facility for creating and protecting customer subnetworks.

   The CUG facility is supported in accordance with ITU-TS Recommendations X.300 and X.25.

   The network side supports 100 CUGs for each B-channel transport service and 10 CUGs for each D-channel transport service. As specified in X.300, if multiple CUGs are supported for a given transport service termination, one CUG must be designated by service provisioning as the preferential CUG.

   The CUGs use international interlock codes as specified in X.300.

   Membership in a particular CUG is authorized by the user membership authority responsible for the CUG.

   1. ***CUG Selection - for Virtual Calls:*** The calling user equipment may use this per-call user facility in the call request packet to specify the CUG selected for a virtual call. This facility need not be present in the call request or incoming call packet when the user side equipment subscribes to the CUG facility and when the virtual call is associated with the user side preferential (or only) CUG. If the network side receives a call request packet that does not contain the CUG selection facility on lines that subscribe to the CUG facility, the network automatically selects the preferential (or only) CUG.

      The basic format of the CUG selection facility is used. This facility is supported in accordance with ITU-TS Recommendations X.300 and X.25. The network side also conforms with ITU-TS Recommendation X.25 on the use and interpretation of the facility for various types of CUG subscriptions (see Tables 24 and 25 of X.25).

   2. ***CUG with Outgoing Access - for Virtual Calls:*** This facility is established by service provisioning. It is an extension to the basic CUG facility, which permits the user to make virtual calls to the open part of the network and to user side equipment subscribing to the CUG with

incoming access facility. The user side may choose whether or not to have a preferential CUG.

The CUG with outgoing access facility is supported in accordance with ITU-TS Recommendations X.300 and X.25. All nonconflicting requirements listed for the basic CUG facility also apply to the CUG with outgoing access facility. An example of a conflicting requirement is that a preferential CUG be specified if the CUG facility is subscribed to and if more than one CUG is supported; the CUG with outgoing access facility does not require a preferential CUG.

3. ***CUG with Outgoing Access Selection Facility - for Virtual Calls:*** The calling user side may use this per-call facility in the call request packet to specify the CUG selected for a virtual call and also to indicate that the calling user side may desire outgoing access. This facility may be used only if the user side does not have a preferential CUG.

   The network side supports the basic format of the CUG with outgoing access selection facility in accordance with ITU-TS Recommendation X.25. The network side also conforms with ITU-TS Recommendation X.25 on the use and interpretation of the facility for various types of CUG subscriptions (see Tables 24 and 25 of X.25).

4. ***CUG with Incoming Access - for Virtual Calls:*** This facility is established by service provisioning. It is an extension to the basic CUG facility that also permits the user to receive virtual calls from the open part of the network and from user side equipment subscribing to the CUG with outgoing access facility. The user side may choose whether or not to have a preferential CUG.

   The CUG with incoming access facility is supported in accordance with ITU-TS Recommendations X.300 and X.25. All nonconflicting requirements listed for the basic CUG facility also apply to the CUG with incoming access facility.

d. ***Fast Select - for Virtual Calls:*** This per-call facility allows the calling user side equipment to send up to 128 octets of data in the call request packet and indicate to the network side and called user side if any restrictions apply on the called user side's response.

   If there are no restrictions on the response, the network side may send to the calling user side, during the user side *Waiting* state, a call connected or clear indication packet containing up to 128 octets of data; also, the network side authorizes the calling user side and the network side to transmit, at any time after the virtual call is connected, a clear request or a clear indication packet, respectively, with a clear user data field of up to 128 octets.

   If the response is restricted, the network side may send to the calling user side, during the user side *Waiting* state, a clear indication packet with a clear user data field of up to 128 octets; the network side would not be authorized to transmit a call connected packet.

e. ***Fast Select Acceptance - for Virtual Calls:*** This facility is established by service provisioning. It allows the network side to transmit to the called user side incoming call packets that request the fast select facility. When a user side does not subscribe to the fast select acceptance facility, the network side does not transmit to that user side incoming call packets that request the fast select facility. This prevents fast select incoming call packets from being delivered to a user side that does not support fast select.

f. ***Facility Marker - for Virtual Calls:*** The facility marker field is used to identify ITU-TS-specified DTE facilities as defined in Annex G of Recommendation X.25. The network supports "0000 1111" as the facility parameter field of a marker preceding requests for ITU-TS-specified DTE facilities. The DTE facilities are passed unchanged by the network between the two DTEs.

g. ***Flow Control Parameter Negotiation - for Virtual Calls:*** This facility is established by service provisioning. It permits negotiation on a per-call basis of the flow control parameters (window size and packet size) for each direction of data transmission at the user-network interface.

The network side supports negotiation of window sizes to the values of 2 and 3. If, at virtual call setup, the calling user side requests a window size that is not allowed for its port, the network will negotiate toward a value of 2. At the called user side, the network side will choose a window size for that end of the virtual call. The called user side may then negotiate toward a value of 2. Both user sides are responsible for requesting window sizes large enough to achieve the desired throughput class.

The network side supports negotiation of packet sizes (maximum user data field lengths) to the values of 128 to 256 octets. Maximum user data field length refers to the amount of user data, in octets, that can be present in data packets. The negotiation results in the same value, for a given direction of transmission, at both ends of a virtual call. A default maximum packet size of 128 octets is associated with the virtual call if no value is requested in the call request packet or if one or both of the user sides do not subscribe to this facility. After the calling user side initially chooses a maximum packet size, the negotiation always proceeds toward a value of 128 octets.

h. ***Intercom Addressing:*** This non-X.25 facility is established by service provisioning. It allows ISDN packet service subscribers to originate virtual calls to other ISDN packet service subscribers on the same switch, using a subset of the called user side address (that is, the last four or seven digits of the complete address).

i. ***Interexchange Carrier Preselect:*** This non-X.25 facility is established by service provisioning. It allows a user to indicate a default interexchange carrier for inter-local access and transport area (inter-LATA) virtual calls. This preselection allows the user to select only the first gateway in the virtual call path. A user can override the preselection at virtual call setup time through use of the X.25 RPOA selection facility.

j. ***Local Charging Prevention -*** When assigned, this feature allows users to prevent their ISDN DN from being charged for virtual calls, whether outgoing or incoming.

On outgoing calls:

- If the reverse-charging facility is present, the call request will be processed normally.

- If the reverse-charging facility is absent, the network will insert the reverse charging facility and then process the call.

On incoming calls:

- The network will clear any X.25 incoming calls that contain the reverse charging facility.

k. ***Multiline Hunt Group - for Virtual Calls:*** This facility is established by service provisioning, it distributes incoming virtual calls over a group of users. See "Multiline Hunt Group," Section 4.3.2.4, for details.

l. ***One-Way Logical Channel Outgoing - for Virtual Calls:*** This facility is established by service provisioning. It restricts the logical channel use to originating outgoing virtual calls only. This facility ensures that one or more logical channels are available for originating outgoing virtual calls, regardless of the number of incoming virtual calls at the user-network interface.

m. ***PVC Service:*** This facility is established by service provisioning. It offers packet-switched network users the same capabilities provided in virtual call service except that call setup and call clearing are not required. Certain facility negotiations performed at call setup for virtual calls are handled by service provisioning for PVCs.

The PVC service is supported on:

- D-channel logical links
- Permanent B-channel access connections.

The PVC service is not supported on ODB connections. This facility is not available for terminals that do not support initialization procedures.

n. ***RPOA Selection - for Virtual Calls:*** This per-call user facility, when requested, allows calling user side equipment to specify a sequence of one or more RPOA transit network (interexchange carrier) within the originating country, through which the virtual call is to be routed when one or more RPOA transit networks exist, at a sequence of one or more gateways. In the case of international calls, this capability includes allowing calling user side equipment to select an international RPOA in the originating country. Each RPOA transit network in the facility field of a call request packet corresponds to a gateway.

If the user side selects only one RPOA transit network, calling user side equipment may use either the basic or the extended format of a RPOA selection field. If the user side selects more than one RPOA transit network, the user side equipment uses the extended format of the RPOA selection field. The network treats the simultaneous appearance of both formats in a call request packet as a not-allowed facility code.

o. ***Reverse Charging - for Virtual Calls:*** This per-call facility allows the calling user side to request, in the call request packet, that the virtual call be charged to the called user.

p. ***Reverse Charging Acceptance - for Virtual Calls:*** This facility is established by service provisioning. It permits the network side to transmit to the user incoming virtual calls requesting reverse charging. In the absence of this facility, the network does not transmit to the user side incoming virtual calls that request the reverse charging facility.

q. ***Throughput Class Negotiation - for Virtual Calls:*** This facility is established by service provisioning. It permits negotiations on a per-call basis of the throughput class for each direction of data transmission.

   The network side recognizes a maximum throughput class of 9.6 kbps on the D-channel and 19.2 kbps on the B-channel. The default throughput class for a given channel is established by service order. After the calling user side initially chooses a throughput class, the negotiation always proceeds toward smaller (slower) values.

r. ***Transit Delay Selection and Indication - for Virtual Calls:*** This per-call facility permits a user side to select and indicate the desired transit delay in the call request packet. The delay is defined as t3c in ITU-TS Recommendation X.135 and is expressed in terms of a 95-percent probability value. The network, through this facility, indicates in the incoming call packet transmitted to the called user side, and in the call connected packet transmitted to the calling user side, the nominal transit delay applicable to the virtual call. The value indicated by the network may be different from the transit delay selected by the calling user side.

s. ***Virtual Call Facility:*** The X.25 virtual call facility provides users with the following capabilities.

   - Logical link and logical channel initialization
   - Switching of multiplexed streams of packets from the user side equipment
   - Virtual call setup and clearing
   - Flow control
   - A full duplex path
   - Data transparency
   - Sequenced data transfer (the network transmits packets in the same sequence that it received them).

The virtual call procedures and formats are as specified in the 1984 CCITT Recommendation X.25.

4.3.2.10 Compendium of Support for X.25

4.3.2.10.1 X.25 Attributes

4.3.2.10.1.1 Physical and Link Layer Attributes

The physical and link layer attributes are as follows:

- Information flow
  — 64 kbps on B-channel
  — 16 kbps on D-channel.
- LAPB single link protocol
  — Modulo 8
  — Parameter k `1 to 7`
  — T1 `2-20 seconds`

— T3 3-30 seconds

It is also possible to set Timer T3 for an infinite value.

— N1 2,136 bits

— N2 2-16

- LAPD protocol (parameters - "Data Link Layer," Section 3)

— Maximum of 8 SAPI 16/TEI links per D-channel for X.25.

4.3.2.10.1.2 Network Layer Attributes

The network layer attributes are as follows:

- Packet sequence numbering: modulo-8
- Logical channels used for virtual calls and PVCs.[6]

— B-channel 127

— D-channel 15/link

4.3.2.10.2 Network Layer X.25 Facilities

The network layer X.25 facilities are as follows:

- Virtual call service on permanent and ODB and permanent D-channel connections
- PVC service on permanent B- and D-channel connections.

4.3.2.10.2.1 X.25 Essential Facilities (per X.2)

The X.25 essential facilities are as follows:

- Calls barred (incoming)
- Calls barred (outgoing)
- CUGs

— Maximum of 100 for B-channel

— Maximum of 10 for D-channel.

- CUG selection
- Fast select
- Fast-select acceptance
- Flow control negotiation

— Support window sizes of 2 or 3

— Support maximum packet sizes of 128- and 256-octet data fields.

- One-way logical channel outgoing
- Throughput class negotiation

— X.25 standard values up to 9.6 kbps on the D-channel and 19.2 kbps on the B-channel (75, 150, 300, 600, 1,200, 2,400, 4,800, 9,600, 19,200 bit/s).

6. Not counting logical Channel 0, which is reserved for DIAGNOSTIC and RESTART packets.

- Transit delay selection and indication.

4.3.2.10.2.2 Additional Facilities

Additional facilities are as follows:

- Single address hunt group
- Single address hunt group with individual addressing
- Multiple address hunt group
- Multiple address hunt group with individual addressing
- RPOA selection
- Reverse charging
- Reverse charging acceptance
- CUG with outgoing access
- CUG with outgoing access selection
- CUG with incoming access
- Default throughput class assignment
- Interexchange carrier preselect (non-X.25 facility)
- Intercom addressing (non-X.25 facility)
- Local charging prevention.

Some characteristics attributed to other X.25 facilities are available, although the full facilities themselves are not available. These include:

- Nonstandard default window sizes (3 only)
- Nonstandard default packet sizes (256 only).

4.3.3 SPECIFICATION DESCRIPTION LANGUAGE (SDL) DIAGRAMS

This section contains SDL diagrams (Figures 4.3.3-1, 4.3.3-2, 4.3.3-3, 4.3.3-4, 4.3.3-5, 4.3.3-6, 4.3.3-7, 4.3.3-8, 4.3.3-9, 4.3.3-10, 4.3.3-11) illustrating the call processing logic for controlling ODB packet transport mode access connections and on-demand, D-channel packet transport mode access connections. The SDL diagrams combine the originating and terminating ends of the access connection. Potential message flows and interactions are portrayed as viewed from the user side of the interface.

These SDLs will be reviewed and considered with several points in mind:

a. Note that they represent this interface as viewed from the *user* (that is, terminal) side. This differs from the text, which is written largely from the network perspective. This will help terminal vendors understand how the *5ESS*® switch will expect them to perform and what actions the switch itself may take (that is, will clarify the text of "X.31 Packet Transport Mode Specification," Section 4.3.2).

b. Most important, note that these SDLs are not intended to impose design constraints upon CPE beyond those discussed in "X.31 Packet Transport Mode Specification," Section 4.3.2, (that is, are not to be considered design blueprints). In short, the SDLs will be viewed merely as a suggested interpretation of "X.31 Packet Transport Mode Specification," Section 4.3.2.

The SDLs are drawn from the perspective of a full-state terminal (one cognizant of all supported *User Call* states as defined in "Message Definitions," Section 4.1) to provide a clear, detailed picture of the protocol interactions supporting this interface. The actual interface itself, however, supports terminals with less complicated perspectives. Moreover, the internal design of a terminal (for example, state machine design) is transparent to the interface. All that really affects the compatibility of a given terminal is whether the proper interface — the proper messages and information elements at the proper times — is presented to the switch.

As stated in the text, only recognition of States U0 *(Null)* and U10 *(Active)* are required of a CPE as a minimum for the support of on-demand packet transport mode access connections. The SDLs specifically drawn for such a terminal would likely be significantly different from those shown here. The only manifestation of this difference at the interface will be the call state information element returned to the network in a STATUS message in response to a network STATUS ENQuiry. Hence, the SDLs given depict the minimally-acceptable mapping of call state information that such a terminal must be able to perform. When in State U0 or U10, the terminal will so code the call state information element when responding to a STATUS ENQuiry. Otherwise, the terminal will return the state it is in (if it recognizes any other states), or will return State U10 *(Active)* as a default response for all *Nonclearing* states. State U0 *(Null)* will be returned as the default for the *Clearing* states.

In summary, these SDLs do not portray the content of message information elements. One exception (in addition to the preceding) exists: a terminal sending a SETUP message to the network with channel identification information element coded to the no channel value is unacceptable.

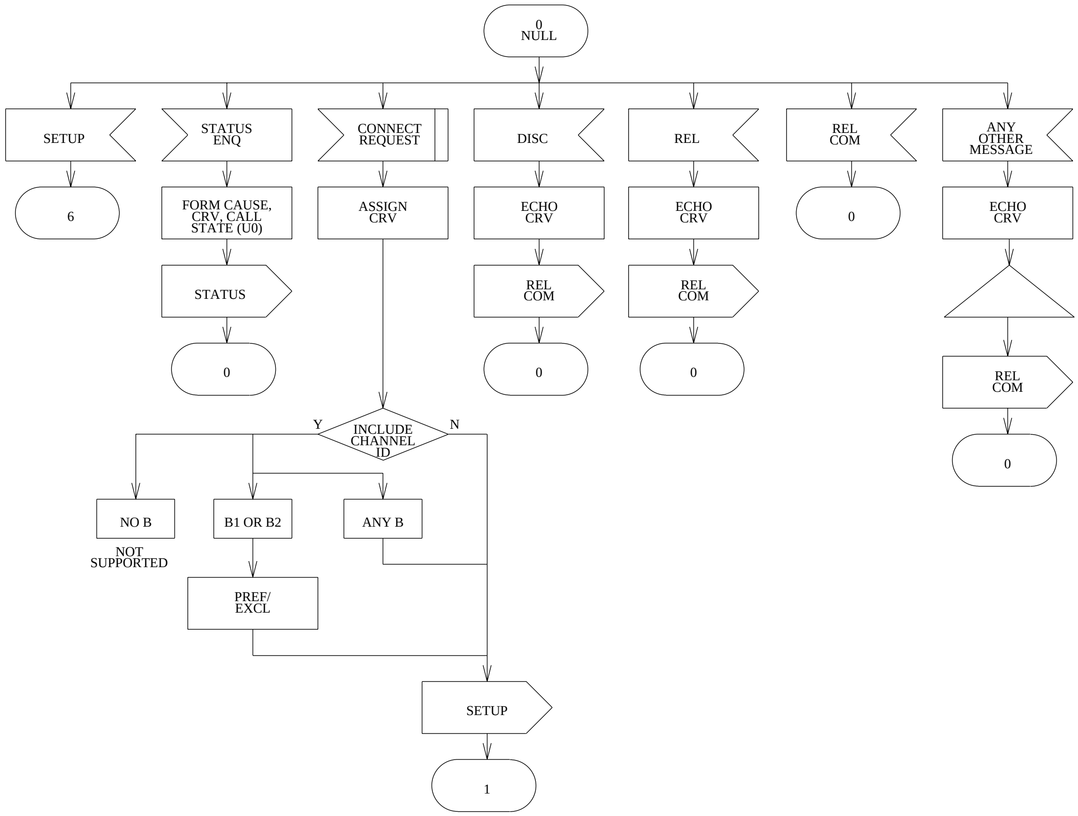


Figure 4.3.3-1 — Call Control—NULL State (User Side)

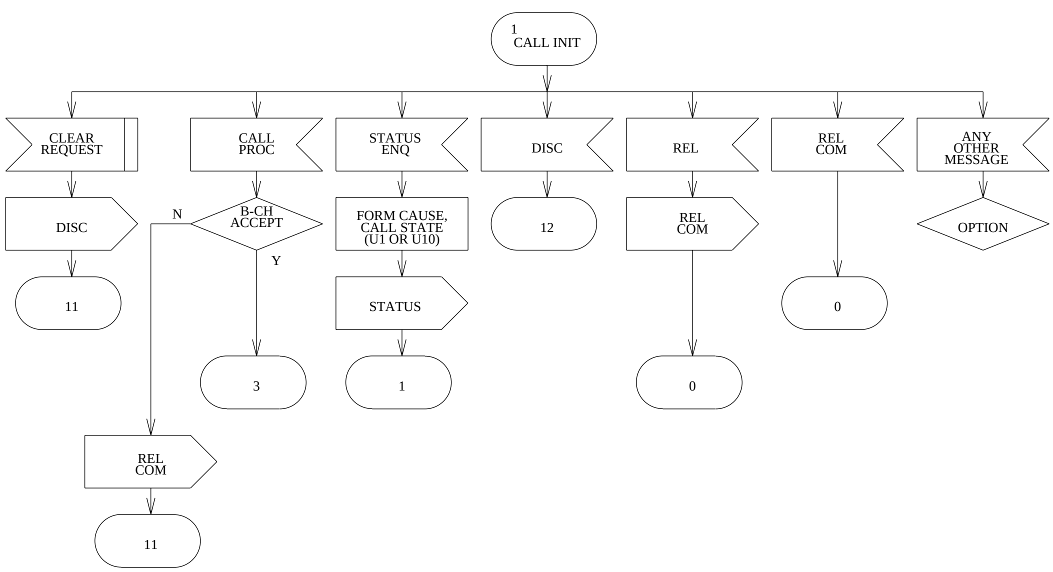


Figure 4.3.3-2 — Call Control—CALL INIT State (User Side)

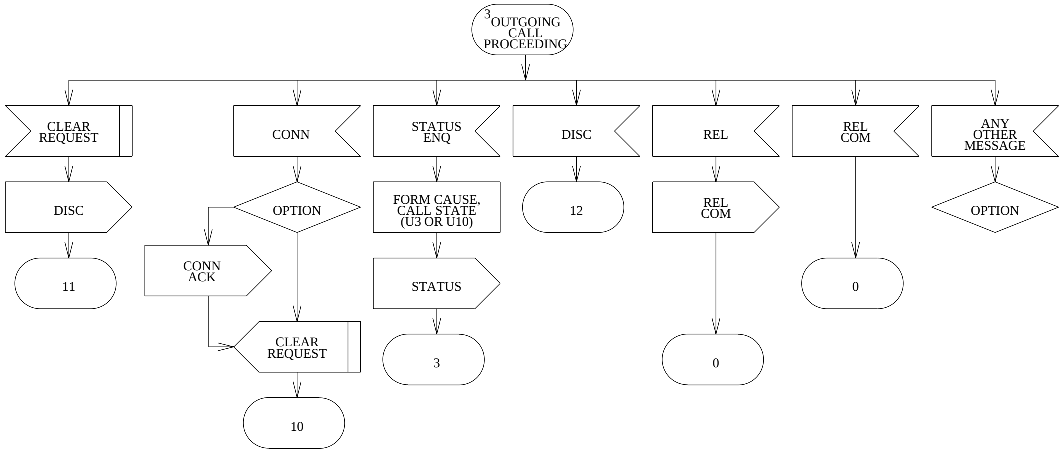


Figure 4.3.3-3 — Call Control—OUTGOING CALL PROCEEDING State (User Side)

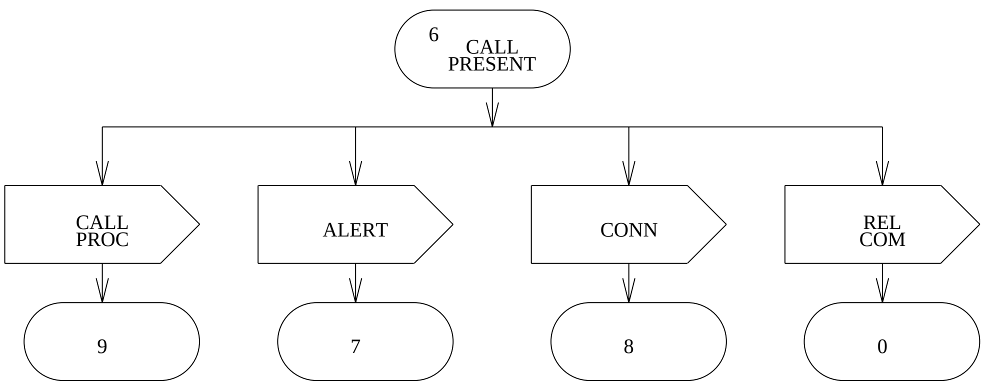


Figure 4.3.3-4 — Call Control—CALL PRESENT State (User Side)

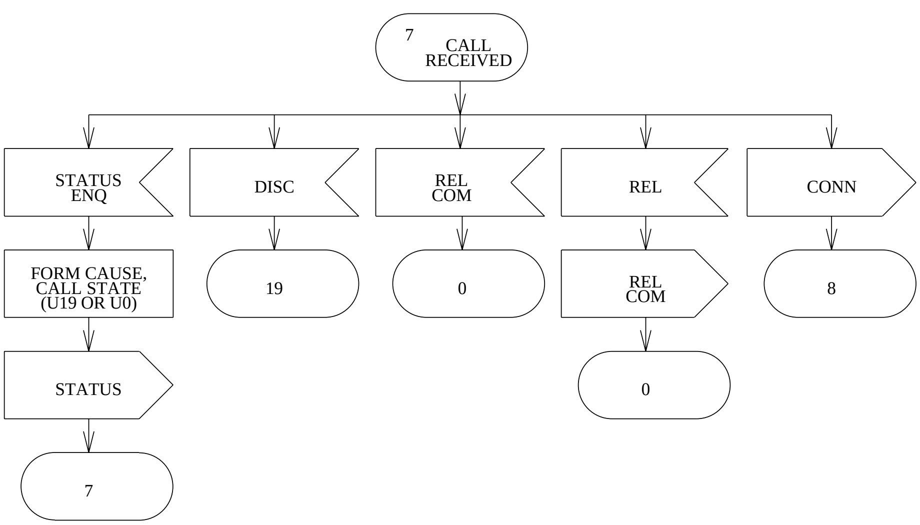


Figure 4.3.3-5 — Call Control—CALL RECEIVED State (User Side)

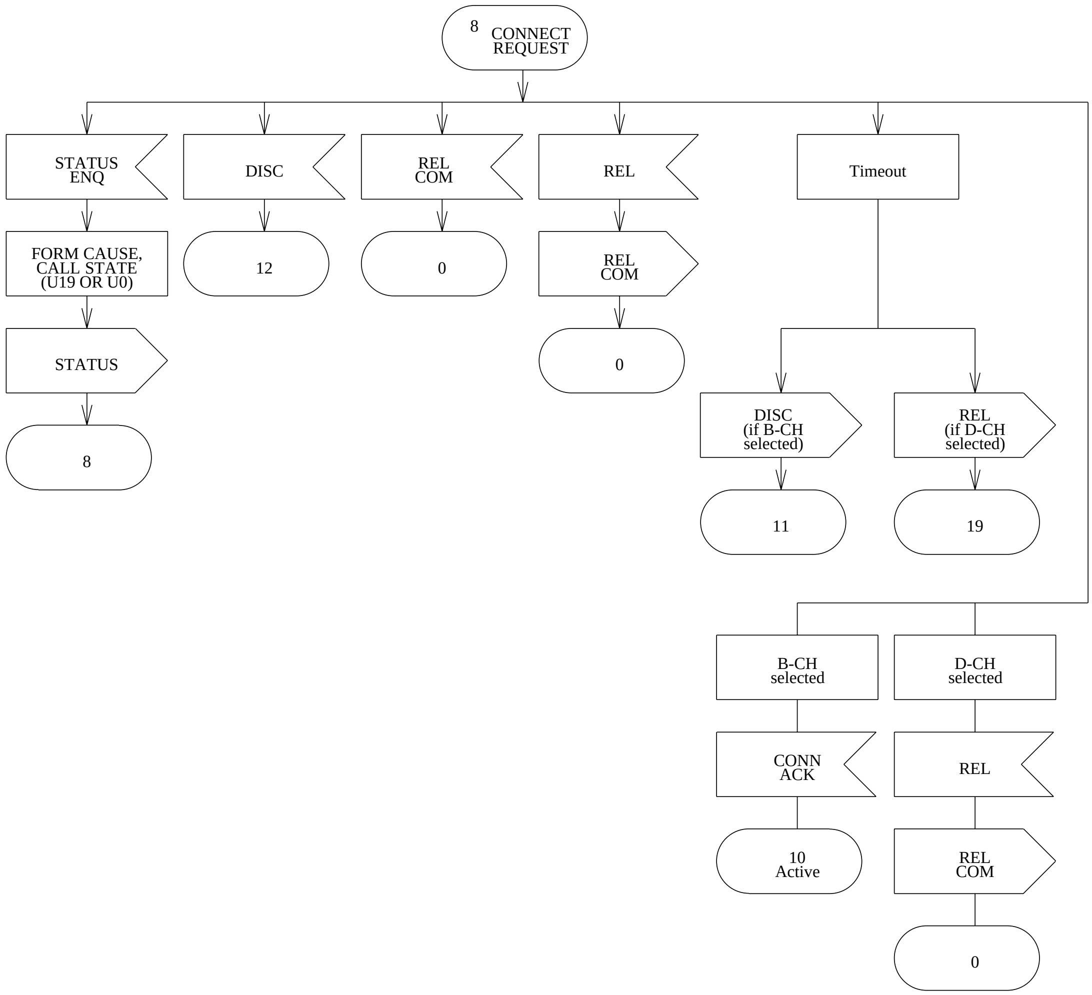


Figure 4.3.3-6 — Call Control—CONNECT REQUEST State (User Side)

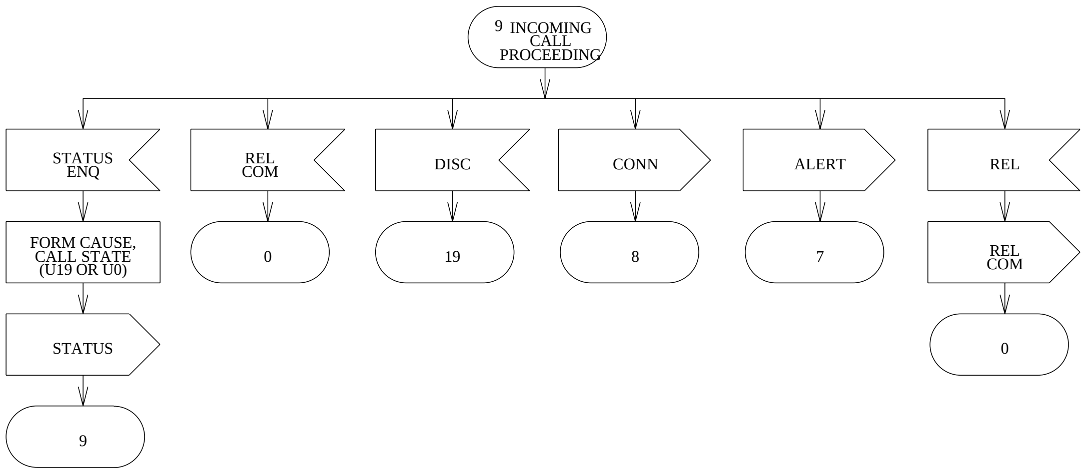


Figure 4.3.3-7 — Call Control—INCOMING CALL PROCEEDING State (User Side)

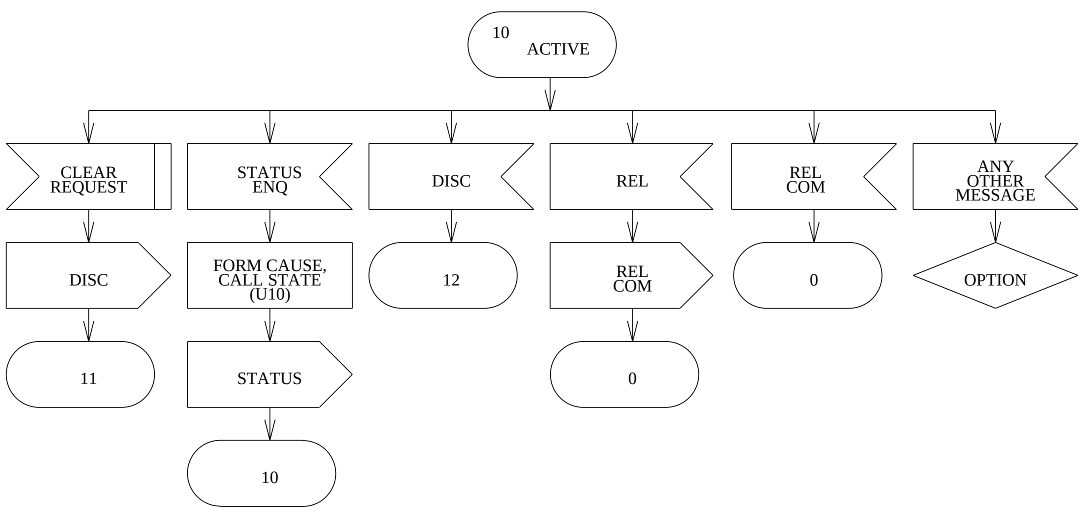


Figure 4.3.3-8 — Call Control—ACTIVE State (User Side)

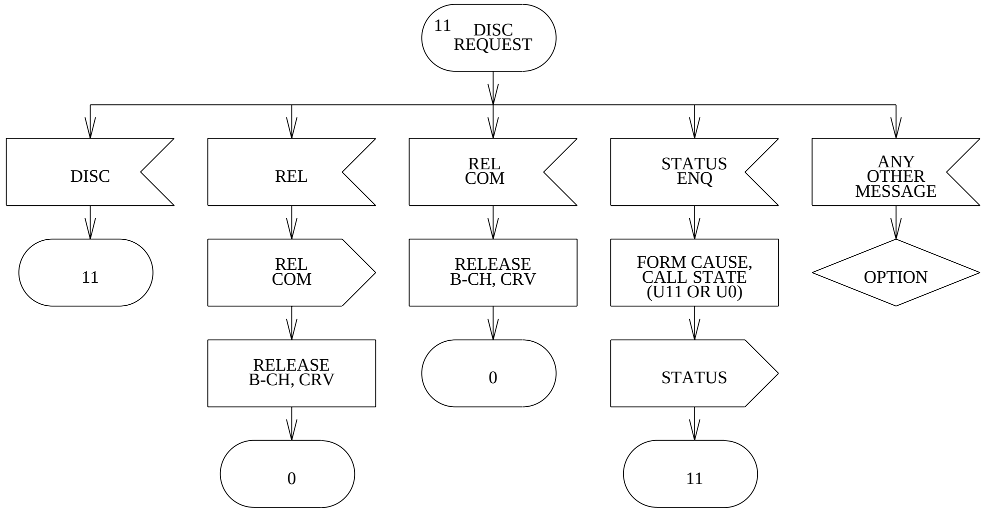


Figure 4.3.3-9 — Call Control—DISC REQUEST State (User Side)

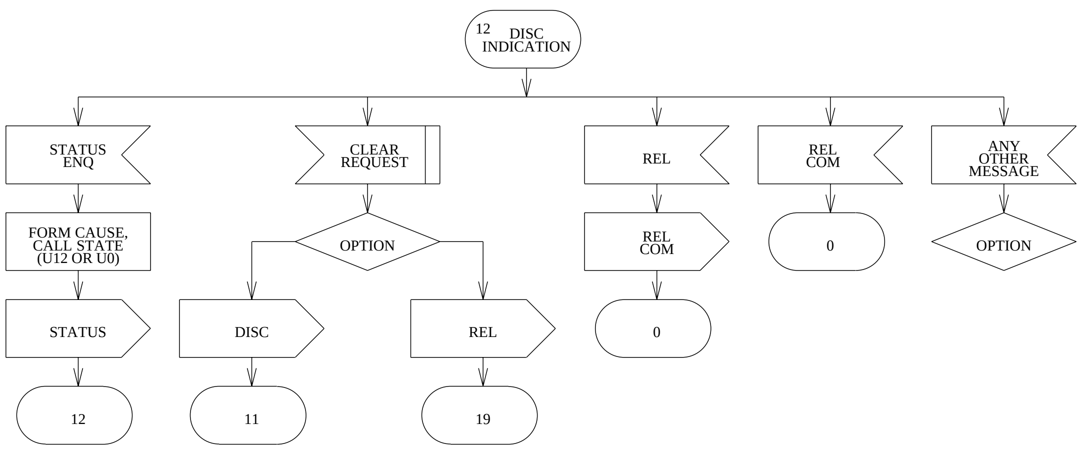


Figure 4.3.3-10 — Call Control—DISC INDICATION State (User Side)

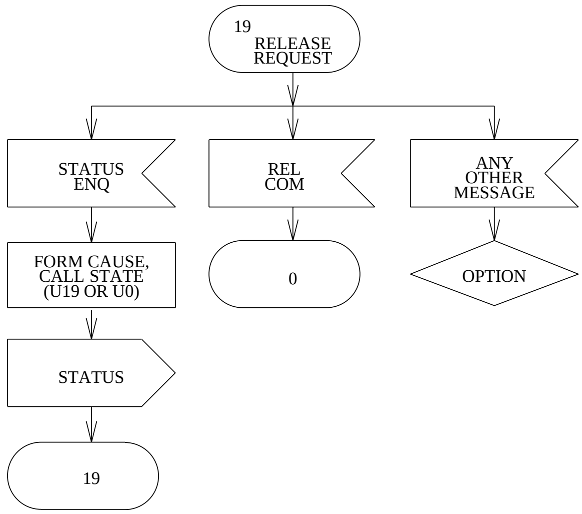


Figure 4.3.3-11 — Call Control—RELEASE REQUEST State (User Side)

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

5. NETWORK LAYER—SUPPLEMENTARY SERVICES

This section defines the Layer 3 procedures and protocol elements for invoking supplementary services at the user-network Integrated Services Digital Network (ISDN) basic rate interfaces. This section consists of three major sections. "Common Protocols and Procedures for Voice and Data Services," Section 5.1, describes the common protocols and procedures for invoking supplementary services. "Supplementary Voice Services," Section 5.2, describes the procedures for invoking supplementary voice services. "Supplementary Data Services," Section 5.3, describes the procedures for invoking supplementary data services for circuit transport mode calls.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

5.1 COMMON PROTOCOLS AND PROCEDURES FOR VOICE AND DATA SERVICES

About this Section

This section of the specification describes the common protocols and procedures for invoking supplementary services (features such as call forwarding and auto-callback). The procedures are defined in terms of messages exchanged over the D-channel of the basic rate interface structures defined in "Physical Layer," Section 2. The procedures and messages contained here use those of "Message Definitions," Section 4.1, and "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, as a basis.

"Supplementary Voice Services," Section 5.2, contains the supplementary services supported for circuit mode voice. "Supplementary Data Services," Section 5.3, contains the supplementary services supported for the National ISDN-1 (NI-1) interface for circuit mode data.

"General Telephony Interface Capability," Section 5.1.1.1, contains guidelines with respect to general interactions between a terminal and the network. "Stimulus Signaling Protocols Capability," Section 5.1.1.2, provides definitions and protocol procedures for stimulus signaling protocol capability. "Feature Invocation Scenarios," Section 5.1.2, provides examples of message flows that occur when an ISDN terminal invokes various features.

"Supplementary Voice Services," Section 5.2, contains definitions for the terminal types used for National ISDN. "Limits on Simultaneous Active Calls," Section 5.2.1.15.1, "Originating Multiple Calls," Section 5.2.1.15.2, and "Originating Calls," Section 5.2.1.15.3, contain information on originating individual calls, originating multiple calls, and limits on the number of simultaneously active calls. "Additional Call Offering," Section 5.2.1.5 through, provide definitions and protocol procedures for most of the services available with National ISDN. "Display Interface Capability," Section 5.2.2, describes the display capabilities for National ISDN. Specification Description Language (SDL) diagrams for supplementary voice services are contained in "Specification Description Language (SDL) Diagrams," Section 5.2.3.

Conventions

Some examples and diagrams in subsequent sections contain call references (see "Message Definitions," Section 4.1, for a definition). These examples *do not* include the "flag bit" field of the second call reference octet.

A B-channel is considered *reserved* if its availability is restricted. A B-channel may be reserved for a terminal(s) by the network. The reserved B-channel can be used by that terminal to answer an incoming call, to originate a new call, or to retrieve a held call.

5.1.1 CAPABILITIES

5.1.1.1 General Telephony Interface Capability

5.1.1.1.1 Inband Tones

For calls that involve a B-channel, the terminal may receive call progress tones from the network on the B-channel before the terminal receives a CONNect message. The network may apply these tones any time after a B-channel is selected. Except in some cases of non-ISDN interworking, D-channel messages are sent in addition to the inband tones. As a general guideline, if the network applies a sequence of audible tones to analog lines during some service scenario, the network applies the same sequence to ISDN B-channels. In general, the progress indicator information element (IE) of the PROGress message indicates to the user endpoint whether or not inband tones are applied.

5.1.1.1.2 Alerting Requirements

On a per-call basis, the network will send terminals receiving incoming voice calls a signal IE. The signal IE will contain the appropriate alerting pattern, whose coding is shown in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

The terminal will receive a signal IE containing the signal value "stop alerting" if the network concludes that alerting will be stopped. However, the network will not send such an IE following Alerting Pattern 4. Choices of specific physical methods of alerting, such as visual or audible, as well as choices of frequencies and cadences for audible alerting, are implementation decisions made by the terminal providers.

5.1.1.1.3 Busy Conditions

5.1.1.1.3.1 Terminal Busy

Standard busy treatment will not be applied as a result of a user response (or lack thereof) to an incoming SETUP message from the network. Neither will any other busy treatment (for example, call forwarding feature invocation) be applied as a result of such a response. Calling party treatment will be as in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

5.1.1.1.3.2 B-Channel Reservation

A B-channel may be reserved for an incoming call. If reserved, the channel may be used to answer only that call unless the channel is reassigned by the controlling terminal to answer or originate another call.

A channel allocated or reserved for a terminal may not be used by another terminal on the interface. There are, however, certain exceptions. Those exceptions include the following:

- Call forwarding between terminals on the same interface
- Answer by another electronic key telephone set (EKTS) member on the interface
- Remote hold retrieval between EKTS terminals on the same interface.

A channel will remain allocated to a terminal until all calls for that terminal are cleared; therefore, if a terminal disconnects from a call but has other alerting or held calls at their terminal, a channel will be reserved for the alerting or held calls until all calls are cleared for that terminal.

For outgoing calls requiring a B-channel, the channel will be reserved at the time that the network transmits the SETUP ACKnowledge or CALL PROCeeding message. If a B-channel is not available, the network will block the call.

5.1.1.1.3.3 Dual Tone Multifrequency (DTMF) Signaling with Call Reference Value (CRV)

It is strongly recommended that DTMF be sent to the network only when the state of the keypad control indicates nonnull call reference (for example, an INFOrmation message is being sent with a keypad element and a nonnull CRV). If the state of the keypad control indicates null call reference (for example, the network has sent an INFOrmation message with a keypad control IE containing a null call reference), keypad depressions will not apply DTMF across the B-channel.

5.1.1.1.4 Interworking with Dial-Pulse Signaling

The network will provide direct conversion from D-channel messages to dial-pulse for cut-through private facilities trunks.

5.1.1.1.5 Setup Collision

In addition to SETUP collision due to contention for B-channel resources (see "SETUP Collision," Section 4.2.1.3.4), SETUP collision can also occur when there is contention in the switch and/or the terminal for the same "call-appearance" (see "Feature Buttons and Feature Access Codes," Section 5.1.1.2.1.1). For example, SETUP collision can occur when the terminal transfers a SETUP message for Call Appearance 1 at the same time the switch transfers a SETUP message for Call Appearance 1. This is independent of B-channel selection.

In a similar fashion, SETUP collision can occur in key-system with the KEY SETUP message. For example, the terminal transfers a SETUP message for Call Appearance 2 at the same time the switch transfers a KEY SETUP message for Call Appearance 2. In both examples, the network will respond to the user's SETUP with a RELease COMplete message. Upon receipt of the network SETUP or KEY SETUP message, the user will assign the specified call appearance to the incoming call or associated call, respectively.

5.1.1.2 Stimulus Signaling Protocols Capability

5.1.1.2.1 Basic Feature Access

5.1.1.2.1.1 Feature Buttons and Feature Access Codes

The basic business or stimulus features can be invoked as follows:

1. A feature request with a specific feature identifier in the feature activation IE described in "Message Definitions," Section 4.1: the network knows the meaning of this feature identifier, but the meaning is not permanently fixed. The network will support a maximum of 64 feature identifier assignments per terminal up to 254 feature identifier assignments on a standard interface. The network will provide a means to assign and change a feature assignment to a feature identifier, through a service order process. The customer premises equipment (CPE) is required to initialize, using the initializing procedures described in "Terminal Initialization," Section 6, to use this mechanism.

2. A feature access code request, such as *72, transmitted in one or more messages containing the keypad IE.

3. A feature access code request, such as *72, transmitted in enbloc mode in the called party number as part of functional addressing.

4. Additional address information for certain features may be requested by the switch with the use of information request (IR) procedures [see "Feature Invocation Scenarios," Section 5.1.2, A (Items 4, 5, and 6)] and CPE should be able to provide the information in call States U2 through U10.

Terminals will transmit these types of feature requests to the network in INFOrmation messages or SETUP messages.

5.1.1.2.1.2 Digit Sending

"Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, describes two methods of sending address information:

- Overlap sending
- En-bloc sending.

This section describes how digit sending for *features* must occur. Both methods of sending address information are supported as described in the following paragraphs.

5.1.1.2.1.2.1 Additional Characters

The IA5 characters "#" and "*" will be considered digits for the purposes of this section. They will be used in accordance with the local dialing plan, for example, to serve as end-of-dialing or feature access code indicators.

5.1.1.2.1.2.2 Overlap Sending

As specified in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, if the terminal sends no digits in keypad IE in a SETUP message, the network gives initial dial tone on the B-channel when it sends the SETUP ACKnowledge message to the terminal. In addition, the network sends a signal IE to the terminal with value "dial tone on" in the SETUP ACKnowledge message. The terminal will then commence sending digits in INFOrmation messages to the network. After the network receives at least one digit, it sends the terminal a signal IE with value "tones off" in an INFOrmation message, and removes dial tone from B-channel.

If the network determines that the dialed digits make up a voice feature access code rather than a directory number, the network may require further input and may send the terminal a request for additional information. The terminal receives an INFOrmation message containing a signal IE with the appropriate value (for example, "recall dial tone on") when the network applies recall dial tone inband and sends an information request IE with the information request indicator set to "prompt." At this time when the network receives additional information, it removes dial tone and sends the terminal an INFOrmation message with a signal IE indicating "tones off." After the additional information received is complete, the switch will send an INFO message with information request IE with the information request indicator set to "complete." The sequence may be repeated as necessary in call States U2 through U10 (see "Feature Invocation Scenarios," Section 5.1.2).

If the network determines that the dialed digits make up a data feature access code rather than a directory number, the network may require further input and may send the terminal a request for additional information. The terminal receives an INFOrmation message containing an information request IE with the information request indicator set to "prompt." After the additional information received is complete, the switch will send an INFO message with information request IE with the information request indicator set to "complete." The sequence may be repeated as necessary in call States U2 through U10 (see "Feature Invocation Scenarios," Section 5.1.2).

As specified also in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, if the terminal does send digits in the SETUP message, the network will *not* return initial inband dial tone, and it will *not* include a signal IE indicating "dial tone on" in the SETUP ACKnowledge message it returns. Otherwise, terminal transmission of additional digits, and the network response to same, follows the procedures outlined in this section.

5.1.1.2.1.2.3 En-Bloc Sending with Keypad

As specified in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, the terminal may include in its SETUP message to the network *all* of the address information (digits) necessary for the network to process the call/feature request. In this case, the network will not provide to the terminal dial tone or any other intermediate prompt. Instead, the network will respond directly to the users call/feature request, as described in "Feature Invocation Scenarios," Section 5.1.2, without any additional input from the user. Note, however, that some features may generate information request procedures immediately followed by the appropriate call control messages toward the terminal reflecting the various stages of feature processing.

5.1.1.2.1.2.4 Functional Addressing

The functional addressing IEs are as follows:

- Called party number (CdPN)
- Operator services access (OSA)
- Transit network service (TNS).

The coding information for these IEs are covered in "Message Definitions," Section 4.1.

The network will support functional addressing (see "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2) and recognize the CdPN digits field information (see "Called Party Number," Section 4.1.3.2.5) as keypad equivalents.

5.1.1.2.1.2.4.1 Interpretation of TNS for Routing and Dialing Services

The switch will interpret the network identification digits contained in a user-specific TNS to identify private facility access and automatic route selection (TR 850 automatic flexible routing) access codes, based on translation tables associated with the dialing and routing features applicable to the originating directory number (DN). The network identification address for a network-specific TNS will be 1 to 5 digits long.

The TNS IE (with user-specific identification) can play the role of signaling the private-facility access code, automatic route selection code, or advanced service platform code to identify different private numbering plans. Routing requirements regulating the cases when a private facility is reached by dialing the user-specific TNS or the private CdPN are stated in Table 5.1.1-1.

This section provides the switch interpretation of codes signaled in functional addressing IEs where the calling user has supplementary dialing or routing features such as individual dialing plan, speed calling, private facilities access (PFA), advanced services platform (ASP), and automatic route selection (ARS).

If the user signals a public CdPN (international, national, local, or unknown), the switch will interpret the address digits as it would interpret keypad-dialed address digits from a DN that does not have supplementary routing or dialing features. If the calling DN is a member of an individualized dialing plan (IDP), the switch will assume as if the user has dialed the "POTS ACCESS" code (which can be 9 or *9, or even a null code) in some scenarios as illustrated in Table 5.1.1-1, where the term <PA> exists in the keypad equivalent column.

Table 5.1.1-1 — Keypad Equivalent of Functional Addressing with Private Dialing Plan

CASE	OSA	TNS	CdPN	KEYPAD EQUIVALENT
1	Alternate	—	—	<PA>00
2	Alternate	—	International	<PA>00 (Ignore CdPN)
3	Alternate	—	National	<PA>00 (Ignore CdPN)
4	Alternate	—	Local	<PA>00 (Ignore CdPN)
5	Alternate	—	Unknown	Clear Call
6	Alternate	—	Private	<PA>00 (Ignore CdPN)
7	Alternate	IEC	International	<PA>101XXXX+00 (Ignore CdPN)
8	Alternate	IEC	National	<PA>101XXXX+00 (Ignore CdPN)
9	Alternate	IEC	Local	<PA>101XXXX+00 (Ignore CdPN)
10	Alternate	IEC	Unknown	Clear Call
11	Alternate	IEC	Private	<PA>00 (Ignore CdPN)
12	Alternate	User-Specific	Don't Care	Clear Call
13	—	—	—	Keypad signaling
14	—	IEC	—	<PA>101XXXX (cut-thru to IEC)
15	—	User-Specific	—	X..
16	Principal	—	—	<PA>0
17	Principal	IEC	—	<PA>101XXXX+0
18	Principal	User-Specific	—	Clear Call
19	—	—	International	<PA>011+CC+NN
20	—	—	National	<PA>(1)+NPA+CO+xxxx OR N11
21	—	—	Local	<PA>CO+xxxx OR N11
22	—	—	Unknown	Keypad Signaling OR N11
23	—	—	Private	xxxx (Intercom number, AD, etc.)
24	—	IEC	International	<PA>101XXXX+011+CC+NN
25	—	IEC	National	<PA>101XXXX+(1)+NPA+CO+xxxx
26	—	IEC	Local	<PA>101XXXX+CO+xxxx
27	—	IEC	Unknown	Clear Call
28	—	IEC	Private	101XXXX+xxxx
29	—	User-Specific	International	X...+011+CC+NN
30	—	User-Specific	National	X...+(1)+NPA+CO+xxxx
31	—	User-Specific	Local	X...+CO+xxxx
32	—	User-Specific	Unknown	Clear Call
33	—	User-Specific	Private	X...+xxxx
34	Principal	—	International	<PA>01+CC+NN
35	Principal	—	National	<PA>0+NPA+CO+xxxx
36	Principal	—	Local	<PA>0+CO+xxxx
37	Principal	—	Unknown	Clear Call
38	Principal	—	Private	Clear Call
39	Principal	IEC	International	<PA>101XXXX+01+CC+NN
40	Principal	IEC	National	<PA>101XXXX+0+NPA+CO+xxxx
41	Principal	IEC	Local	<PA>101XXXX+0+CO+xxxx
42	Principal	IEC	Unknown	Clear Call
43	Principal	IEC	Private	Clear Call
44	Principal	User-Specific	Don't Care	Clear Call

To provide specific code interpretations, the following different combinations are identified in which the CdPN, TNS, and OSA can be signaled. Table 5.1.1-1 provides routing requirements for each possible combination of functional addressing IEs received from a calling DN that is subscribed to supplementary dialing or routing features. The switch will route the call as if it has received the address digits in the keypad equivalent corresponding to the functional addressing combination. The term XXXX [for interexchange carrier (IEC)] or X... (for user-specific TNS) in the keypad equivalent column represent the transit network identification digits that are present in the TNS IE. The term xxxx in the keypad equivalent column represents the line number (for public CdPN) or the private number (for private CdPN) contained in the address digits field of the CdPN IE.

This table applies to DNs that have supplementary dialing or routing features. The term <PA> refers to the POTS access code that a member of an individual dialing plan may need to signal to reach a destination outside the basic business group. The POTS access code may be a null code depending on the IDP. A private number means that the switch should analyze the number according to the user’s private dialing plan. Such private dialing plan may include public numbers as well as private numbers.

5.1.1.2.1.2.4.2 Interaction of Stimulus Signaling with Functional Addressing Elements

The following combinations of stimulus IEs and functional addressing IEs are allowed in the same message:

- Feature activation (FA) and keypad
- FA and CdPN
- TNS and CdPN (access code can be in TNS and supplemental information in CdPN)
- Use of OSA would be per basic call requirements.

When functional addressing is used in the context of stimulus signaling, the switch will treat the combination of keypad and CdPN in an INFOrmation message as invalid.

- If this invalid combination of IEs (keypad and CdPN) is received in an INFO message, during call establishment, the call will be cleared. The switch has the option to send signal IE = "reorder tone" when the call is cleared. The switch has the option to send a Cause 28, "invalid number format," in the clearing message for NI-1. This protocol error will be reflected in the protocol error record (PER).
- If this invalid combination of IEs (keypad and CdPN) is received in an INFO message, during the active state (that is, an INFO with a nonnull CRV), the call will not be cleared. However, the INFO message will be ignored. Even if a valid FA is present along with the keypad and CdPN in the received INFO message, the switch will ignore the INFO message.
- If an INFO is received with FA and keypad (or CdPN) and the feature does not need keypad (or CdPN), the keypad (or CdPN) information will be ignored and the FA will be processed normally.

5.1.1.2.1.2.5 Information Request Procedures

The information request procedures provide a mechanism for the ISDN switch to solicit additional feature related information (for example, destination address for call forwarding request) from the ISDN user. The information request procedures may be used to provide supplemental information for a feature regardless of whether it was invoked through dial access procedures or feature key management procedures through keypad, CdPN, or feature activation.

If an IR procedure is in progress for a call during call establishment and an INFO message is received by the switch, the message should contain only one FA or CdPN or keypad. If two of these IEs are in the INFO message, the call will be cleared and the protocol error will be reflected in the PER. The switch has the option to send a Cause 28, "invalid number format," in the clearing message for NI-1.

5.1.1.2.1.3 Feature Invocation and Network Responses

5.1.1.2.1.3.1 Choice of Call CR

This section describes considerations for choosing a CRV with which the terminal sends messages to the network when invoking features. In general, the network will process feature requests based upon only the information provided to it in the request.

Feature requests using access codes must be associated with an existing call reference or with a new call reference defined in the SETUP message conveying the feature request. The access code method can also be used in the en-bloc sending mode (see "Digit Sending," Section 5.1.1.2.1.2).

The remainder of this section discusses the selection of a CR in which to convey feature requests using the button number or feature identifier method of invocation. This method will always convey terminal feature identifiers to the network in feature activation IEs.

Terminals on a standard interface must observe the following rules in conveying the feature activation IE. These rules are dependent upon the terminal being able to identify the call (if any) to be associated with the feature request. It is important to understand that features will, in general, affect the operation of a call; therefore, the terminals will be able to identify the associated call if any calls exist on the interface.

a. If no calls exist on the interface, then the feature activation IE shall be conveyed in an INFOrmation message with the null call reference value (NCRV).

b. If no calls exist on the interface and the terminal wishes to associate the feature request with an originating call, then the feature activation element may be conveyed in the SETUP message for the originating call.

c. If calls exist on the interface, then the feature activation IE must be conveyed in an INFOrmation message using the CRV of an existing call. In the case where there are multiple calls on the interface, the terminal is responsible for determining which CRV is to be sent.

5.1.1.2.1.3.2 Choice of Bearer Capability (BC)

If a voice or a data feature is invoked in a SETUP message, the BC must be appropriately coded by the CPE.

5.1.1.2.1.3.3 Confirmation of Feature Activation

When the terminal requests a feature from the network and the request has been successfully executed, the terminal receives a D-channel indication of confirmation in addition to any confirmation applied to the B-channel. The terminal receives an INFOrmation message with a signal IE with the value "confirm tone on." This signal information may also be sent in a CALL PROCeeding message depending on whether the call needs to be completed. This signal information may also be sent in a PROGress message if tones and announcements apply.

In addition, if the terminal invokes the feature with a feature activation IE, the INFOrmation message will include a feature indication IE, if the feature status changes. The feature indication IE includes the appropriate feature identifier and the feature status. See "Feature Indication," Section 4.1.3.2.14, for coding of the feature indication IE.

If the feature was accessed with keypad IEs, and if the customer has subscribed to a feature identifier for the accessed feature, the terminal will receive a feature indication IE as previously mentioned.

5.1.1.2.1.3.4 Unsuccessful Feature Activation Attempts

In addition to any inband tones or announcements, the terminal receives an indication when the network cannot successfully carry out a feature request. This indication will be in the form of an INFOrmation message with a signal IE that will take the value "network congestion (reorder) tone on" as appropriate (see "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2). Under some conditions, the terminal will receive a subsequent signal IE containing the value "tones off." In other circumstances, a disconnect sequence will be used instead of "tones off."

Under the conditions of the previous paragraph, the network sends feature indication IEs to indicate the state of the feature at the time the message is sent. For example, if an attempt failed to activate a call forwarding feature because the feature was already active, the feature indication IE may indicate the status of the feature to be "active."

5.1.1.2.1.3.5 Other Feature Activations

Certain features may be used that result in no direct D-channel feedback (for example, entry of a portion of a number, for a speed-calling feature).

5.1.1.2.1.3.6 Unsolicited Feature Indications

The network may send feature indication IEs to a terminal at any time to update the terminal status or provide other information. These elements will be sent within INFOrmation messages with the null call reference, or with the call reference of an active call to which the information applies. For example, the network may send an element to a terminal to inform that messages are waiting for the terminal and the terminal should turn on the message waiting indicator.

5.1.2 FEATURE INVOCATION SCENARIOS

This section lists possible sequences of actions that may occur when an ISDN terminal invokes features.

These scenarios present an overview of possible ISDN usage. However, not every possible sequence is represented here, and not every scenario is allowed for every feature. The scenarios are referenced in the individual feature sections that follow. A more complete set of Q.931 message flows are included in Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12. Those distinguish the message exchanges for CSD and CSV features.

A. **New Call Reference Using a B-Channel**

These scenarios start from a condition in which no suitable call reference exists with which to associate a feature request. Other call references may exist at the terminal.

The terminal initiates a normal voice call by transmitting a SETUP message across the interface. The bearer capability IE indicates "speech." The terminal then receives a SETUP ACKnowledge message assigning a B-channel and including a signal IE indicating "dial tone on." The call reference is CR. The network applies dial tone to the B-channel. Following is an example flow diagram that illustrates the procedures.

USER	MESSAGE	NETWORK
	SETUP —————————->	
	SETUP ACK (CR, Channel Id., Signal) <—————————	
	<—————————	Network applies dial tone (for CSV feature only)

Feature invocation scenarios 1 through 7 all begin with the procedures shown in this diagram.

1. ***Feature Activation:*** The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a feature activation IE indicating a feature identifier. The network receives the message, and immediately removes dial tone from the B-channel and returns an INFOrmation message with call reference CR and the signal IE, which contains the value "tones off." After performing internal actions, the network sends another INFOrmation message that contains call reference CR, signal IE, and feature indication IE. The signal element contains the signal value "network congestion (reorder) tone on" for various unsuccessful outcomes, and "confirmation tone" if the operation was successful and no call is to be established (that is, if call establishment is required, then no confirmation tone is provided). The feature indication IE includes the

feature identifier, and indicates the current status of the feature. Suitable tones or announcements may be applied to the B-channel.

The following is an example flow diagram that illustrates the procedures described for this scenario. Optional IEs appear in [ ].

USER	MESSAGE	NETWORK
	INFO (CR, Feature Activation) ——————————->	
	INFO (CR, Signal) <——————————	
	INFO (CR, [Feature Indication], [Signal]) <——————————	

Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message with feature activation. See Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12 for more details.

2. ***Complete Access Code:*** The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a keypad or called party number IE with sufficient characters to specify a *complete* access code for a feature (for example, *72). The network receives the message, and immediately removes dial tone from the B-channel and returns an INFOrmation message with call reference CR and the signal IE, which contains the value "tones off." After performing internal actions, the network sends another INFOrmation message that contains call reference CR, feature indication IE, and may contain the signal IE with an appropriate value. Suitable tones or announcements may be applied to the B-channel. If the customer has subscribed to a feature identifier for this feature, then the INFOrmation message also contains a feature indication IE. The feature indication IE indicates the current status of the feature.

USER	MESSAGE	NETWORK
	INFO (CR, Keypad, or CdPN) ———————————>	
	INFO (CR, Signal) <———————————	
	INFO (CR, [Feature Indication], Signal) <———————————	
	<———————————	Network applies dial tone (for CSV feature only)

Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message from the user side. See Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12 for more details.

3. ***Partial Access Code:*** The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a keypad IE, but the terminal transmits insufficient characters to specify a network address or an access code for a feature. The network removes dial tone from the B-channel and sends an INFOrmation message for CR with a signal IE for "tones off." The network receives one or more subsequent INFOrmation messages for call reference CR containing keypad IEs. At some point, the total received keypad IEs make up a complete access code for a subscribed feature. The network performs internal actions and sends an INFOrmation message with call reference CR to the terminal. The INFOrmation message contains a signal IE with an appropriate signal value. Suitable tones or announcements may be applied to the B-channel. If the customer has subscribed to a button number for this feature, then the INFOrmation message also contains a feature indication IE. The feature indication IE indicates the current status of the feature (Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12).

USER	MESSAGE	NETWORK
	INFO (CR, Keypad) ——————————>	
	INFO (CR, Signal=Dial Tone Off) <——————————	
	INFO (CR, Keypad) ——————————>	
	• • •	
	<——————————	Network applies dial tone (for CSV feature only)

Note: Some features may result in the network sending CALL PROCeeding after receiving an INFOrmation message from the user side. See Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12 for more details.

4. ***Feature Activation/Interactive Using IR Procedures:*** This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a feature activation IE indicating a feature identifier. The network receives the message, performs internal actions, and determines that additional information is required before it can complete the scenario. The network will use the information request (IR) procedures to prompt the terminal using an INFOrmation message with an information request field coded to "prompt" (see "Q.931 Message Flows at the User-Network Interface for Feature Invocation," Section 5.1.2.1) for the required information. If a dial-tone prompt is appropriate (that is, for a CSV feature), the network will apply recall dial tone on the B-channel. When it receives additional information, the network will remove the recall dial tone and send an INFOrmation message containing a "tones off" signal IE for CSV feature only. The exact sequence of prompting and inputs depends on the feature being accessed. All messages associated with this feature access will be referenced with the same call reference CR. Ultimately, the network may determine that the scenario is complete and send the terminal an INFOrmation message containing signal, feature indication, and information request IEs. The signal IE contains an appropriate value. The feature indication IE includes the feature identifier and indicates the current status of the feature. The information request IE

contains the value "complete." Suitable tones or announcements may be applied to the B-channel. Note that en-bloc sending is not supported in this scenario.

5. ***Complete Access Code/Interactive Using IR Procedures:*** This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a keypad or called party number IE with sufficient characters to specify a *complete* access code for a feature (for example, *72). The network receives the message, performs internal actions, and determines that additional information is required before it can complete the scenario. The network may perform actions to prompt the terminal and/or user for the required information, as in scenario 4. See Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12 for Q.931 messages exchanged at the interface. Note that this scenario is an example of either a dual en-bloc or an en-bloc, followed by overlap sequence, similar to those scenarios shown in Figures 5.1.2-4 and 5.1.2-6.

6. ***Partial Access Code/Interactive Using IR Procedures:*** This scenario is relevant when the network determines that additional information is required before it can process the feature request. The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a keypad IE, but insufficient characters are transmitted to specify a network address or an access code for a feature. The network removes dial tone from the B-channel and sends an INFOrmation message for CR with a signal IE for "tones off." The network receives one or more subsequent INFOrmation messages for call references containing keypad IE. At some point, the total received keypad IEs make up a complete access code for a subscribed feature. The network performs internal actions and determines that additional information is required before it can complete the scenario. The network may perform actions to prompt the terminal and/or user for the required information, as in scenario 4. See Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12 for the Q.931 messages exchanged at the interface. Note that this scenario is an example of either a dual overlap or an overlap, followed by en-bloc sequence, similar to those scenarios shown in Figures 5.1.2-3 and 5.1.2-5.

7. ***Disconnect Before Network Response:*** For any of the preceding scenarios, a terminal may send a DISConnect message with call reference CR before the terminal receives a response to a requested feature from the network, even though such a response would normally be expected. This message may occur because of a human action at the terminal. When the network receives the DISConnect, the network shall attempt to include appropriate signal, feature indication, and display field IEs within the RELease message responding to the DISConnect.

B. Existing Call References Using a B-Channel

These scenarios start when a call is in the outgoing call proceeding (U3), call delivered (U4), active (U10) states. The call reference value is CR.

When the network receives a feature activation request with the call reference of an active call, it will attempt to invoke the feature within the context of that call.

1. ***Feature Activation:*** The terminal transmits an INFOrmation message across the interface with call reference CR. The INFOrmation message contains a feature activation IE indicating a button number. The network receives the message, performs internal actions, and sends an INFOrmation message with call reference CR to the terminal. The INFOrmation message contains signal and feature indication IEs. The signal IE contains an appropriate signal value. The feature indication IE echoes the button number used in the feature activation IE, and indicates the current status of the feature. No tones are applied inband, and the B-channel path is unaffected unless some action is part of the feature requested.

C. **Features Unrelated to an Active Call**

Terminals may send a message with the null call reference IE to invoke features bearing no direct relation to any existing calls. Such a call reference may be sent whether or not any other (nonnull) call reference IE is in effect at the terminal (see "Choice of Call CR," Section 5.1.1.2.1.3.1).

1. ***Feature Activation:*** This scenario is virtually identical to that of "Feature Invocation Scenarios," Section 5.1.2, B (Item 1) for an existing call reference using a B-channel. However, any feature that involves the use of a B-channel cannot be executed. The network responds to requests for such features by sending an INFOrmation message with a call reference IE indicating "null," signal IE indicating "network congestion (reorder) tone on," and a feature indication IE indicating "rejected."

5.1.2.1 Q.931 Message Flows at the User-Network Interface for Feature Invocation

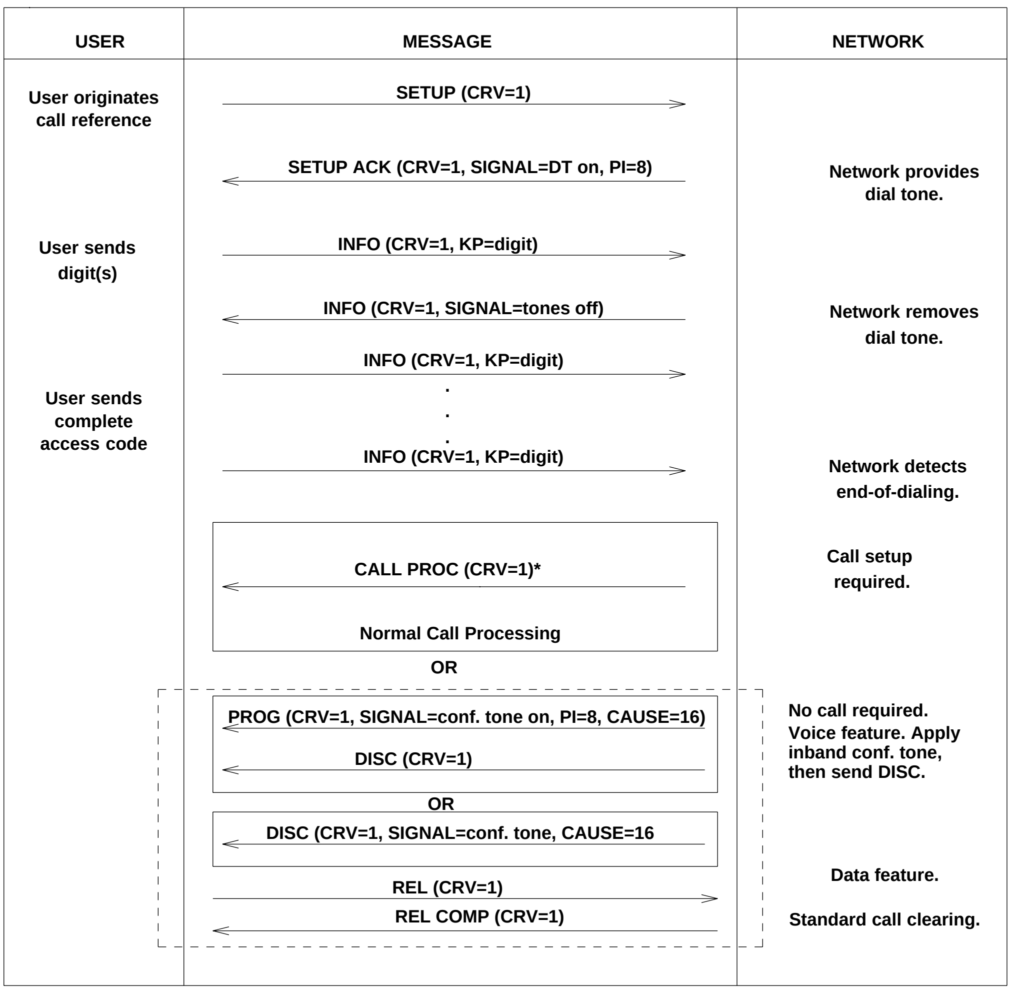
The following abbreviations are used in the line diagrams provided as Figures 5.1.2-1, 5.1.2-2, 5.1.2-3, 5.1.2-4, 5.1.2-5, 5.1.2-6, 5.1.2-7, 5.1.2-8, 5.1.2-9, 5.1.2-10, 5.1.2-11, and 5.1.2-12:

BN#	Button Number (same as feature identifier)
CdPN	Called Party Number IE
CRV	Call Reference Value
DT	Dial Tone
FA	Feature Activation IE
FI	Feature Indication IE
KP	Keypad IE
PI	Progress Indicator IE
TNS	Transit Network Selection IE

5.1.2.2 Feature Operations

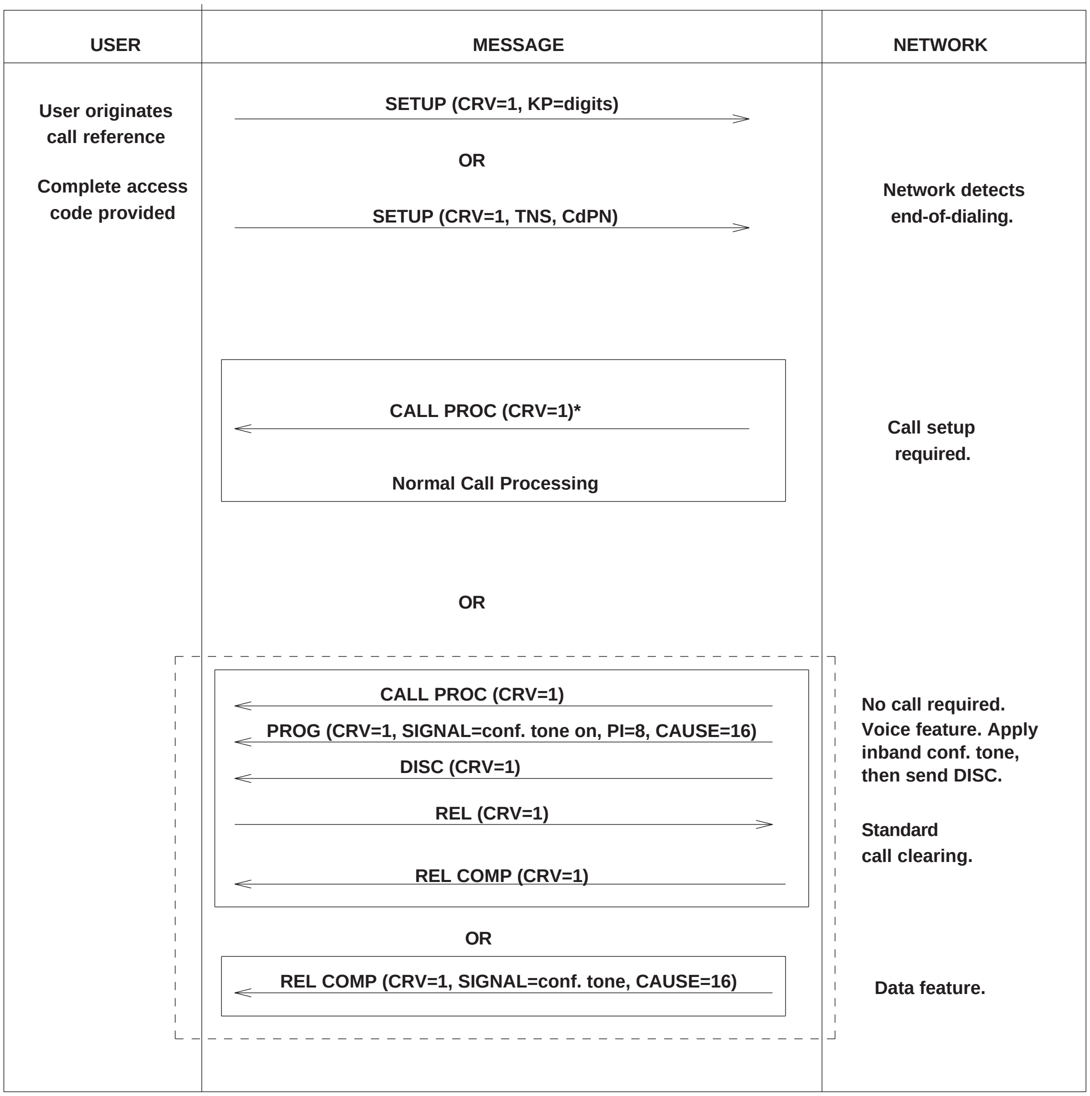
Features that are active or in progress will in some instances provide terminals with associated feature indication and/or signaling information. The terminal indicators and tones will be controlled by the network switch through the feature indication and signal IEs in INFOrmation messages. In addition, the switch may use the NOTIFY message (see "NOTIFY," Section 4.1.2.16) with null CRV.

One example of network signaling associated with feature operation would be in the case of call forwarding (All). When a call is redirected from the intended called party an appropriate alerting pattern would be provided to the intended terminal through the INFOrmation message with the signal IE while the terminal was in the null (U0) state.



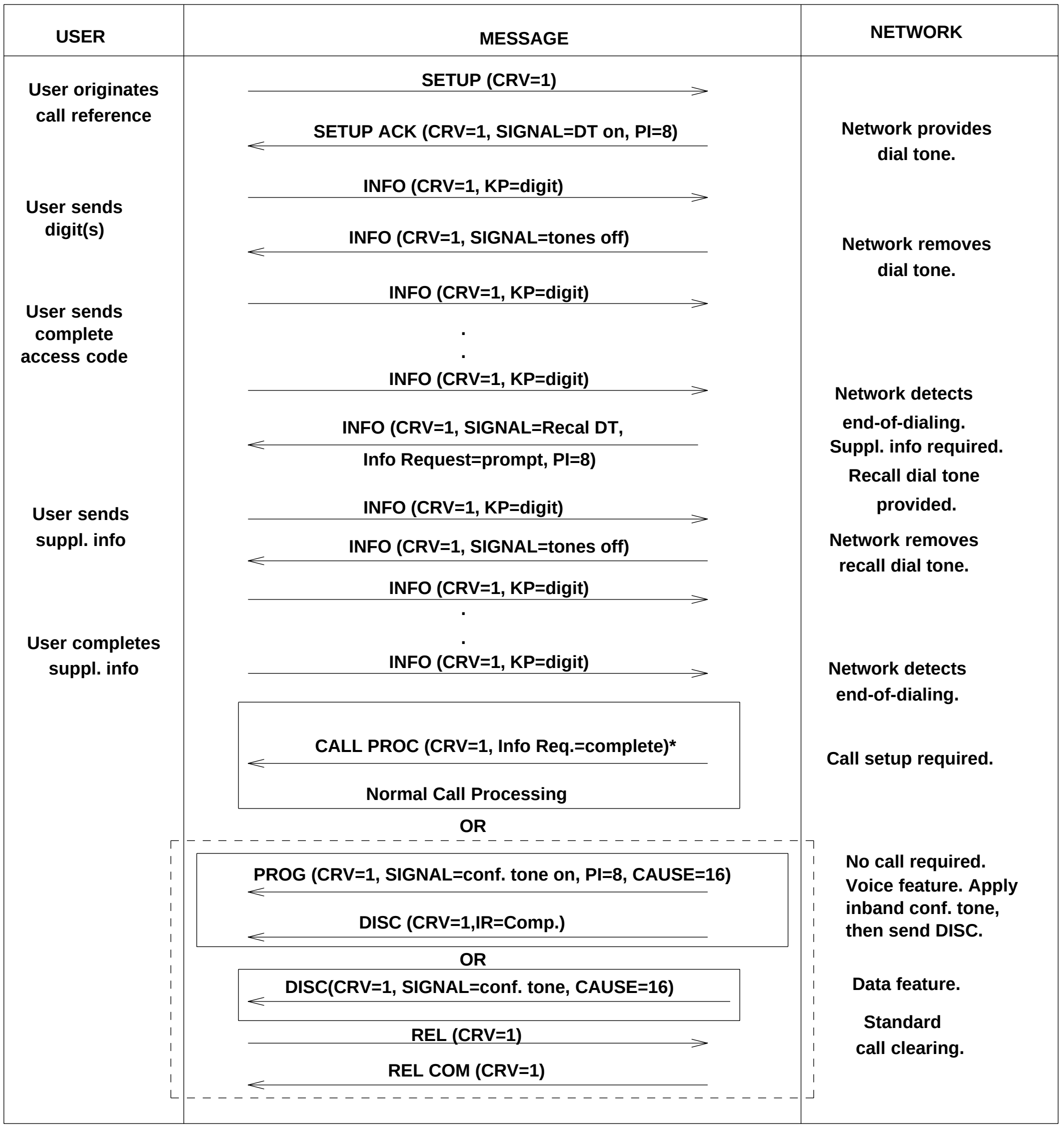
* If a feature button had also been assigned for the service requested through access code, then this message would also include a feature indication IE to provide the appropriate feature status information on the D-channel.

Figure 5.1.2-1 — Dial Access Signaling; Single Overlap Sequence



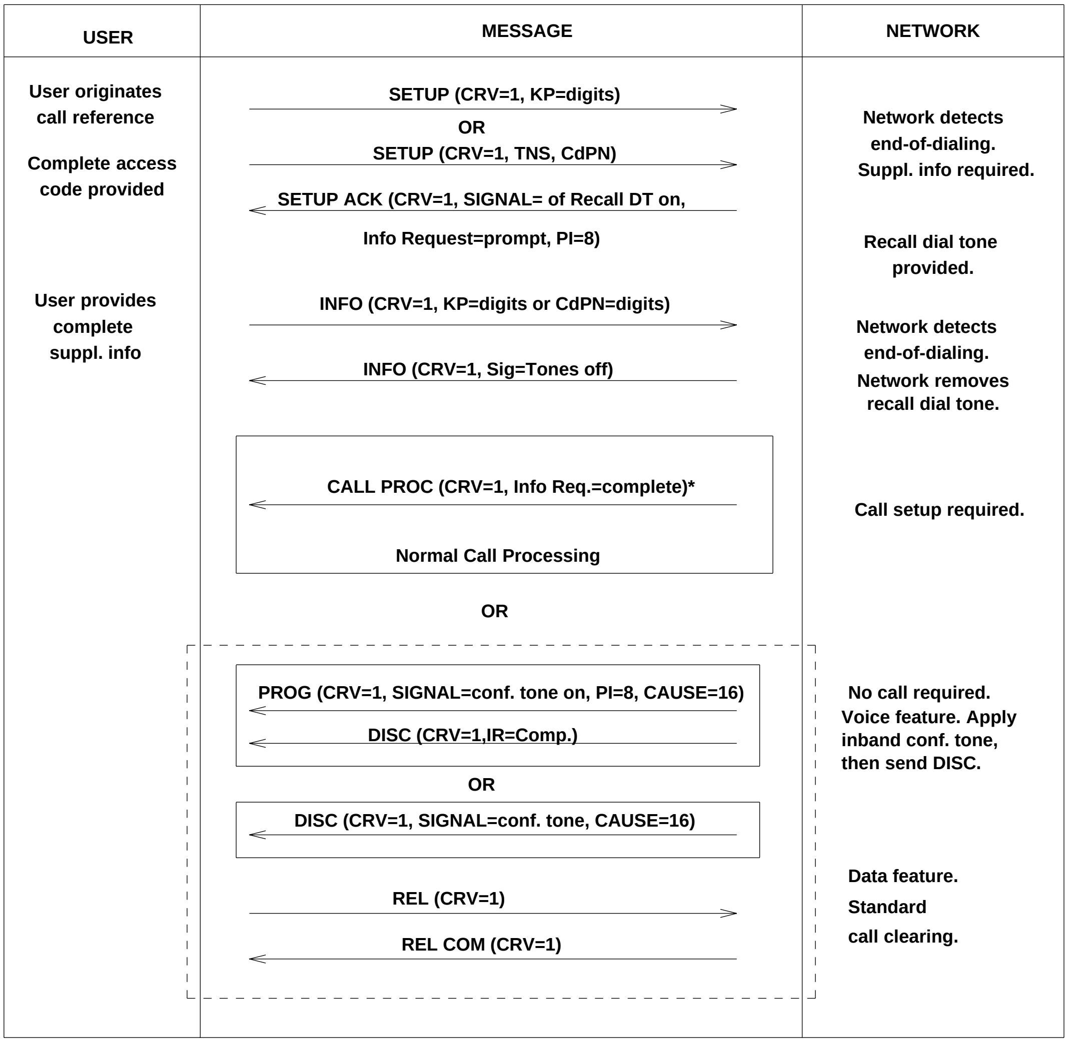
* If a feature button had also been assigned for the service requested through an access code, then this message would also include a feature indication IE to provide the appropriate feature status information on the D-channel.

Figure 5.1.2-2 — Dial Access Signaling; Single En-Bloc Sequence



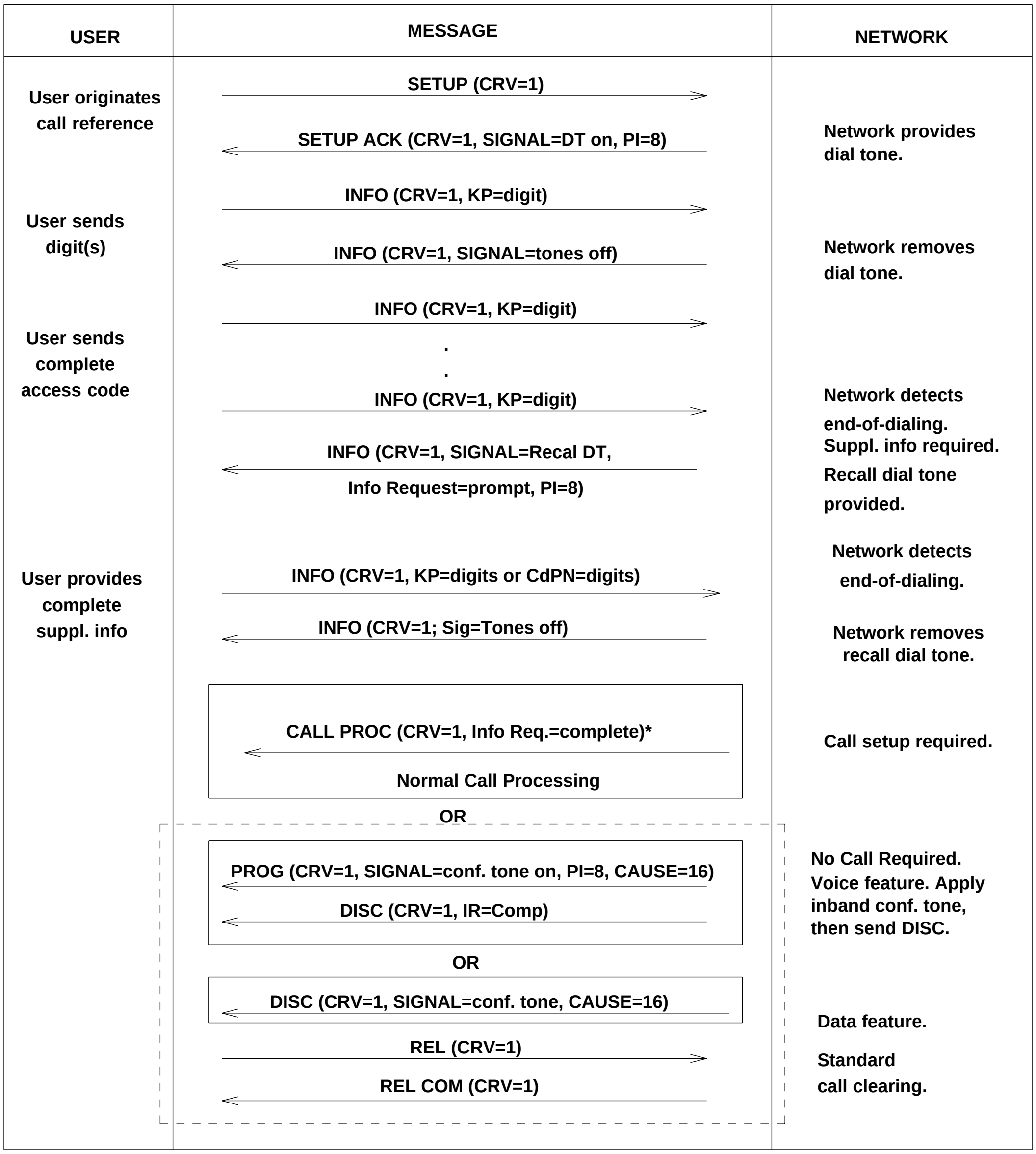
* If a feature button had also been assigned for the service requested through an access code, then this message would also include a feature indication IE to provide the appropriate feature status information on the D-channel.

Figure 5.1.2-3 — Dial Access Signaling; Dual Overlap Sequence



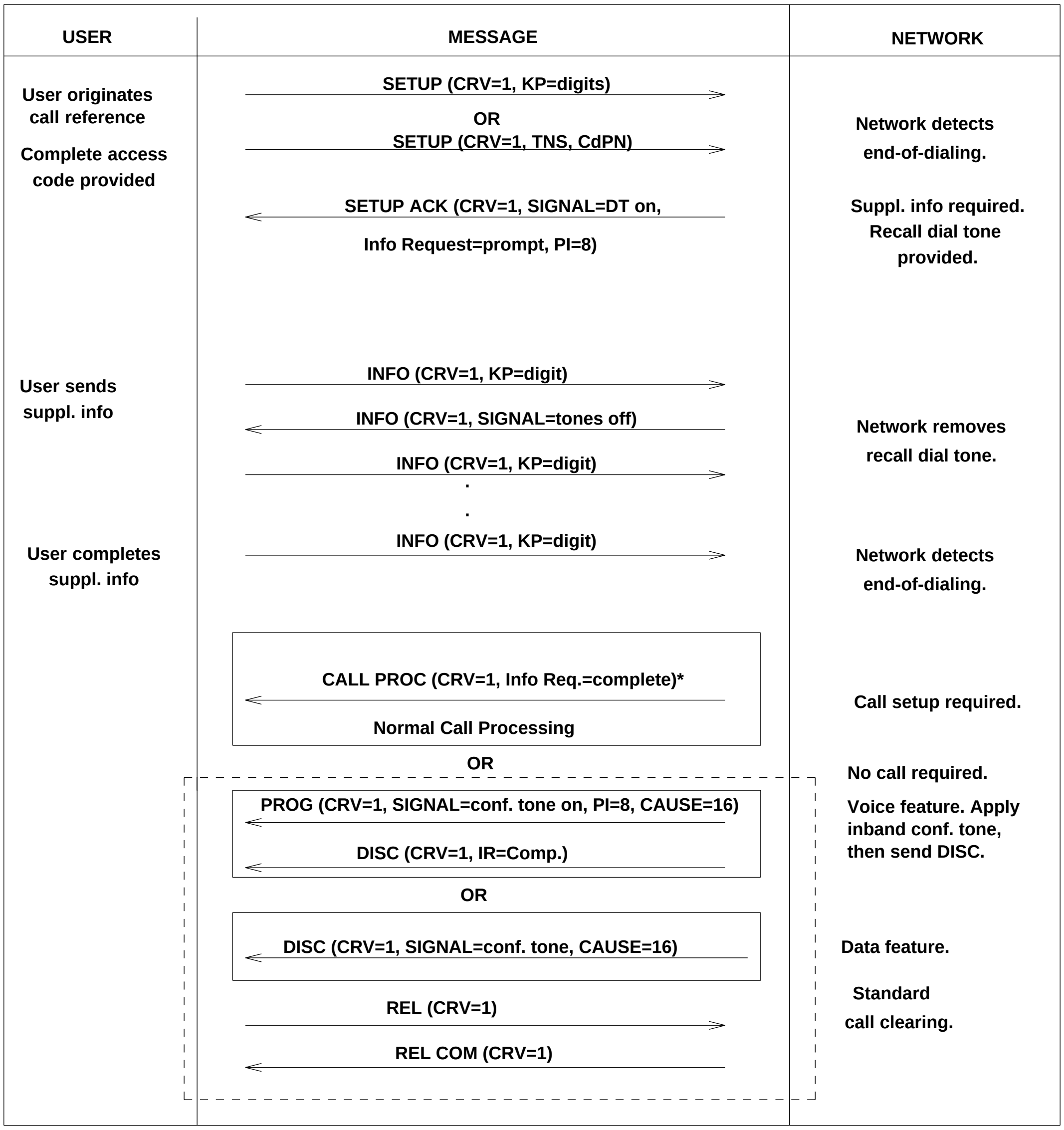
* If a feature button had also been assigned for the service requested through an access code, then this message would also include a feature indication IE to provide the appropriate feature status information on the D-channel.

Figure 5.1.2-4 — Dial Access Signaling; Dual En-Bloc Sequence



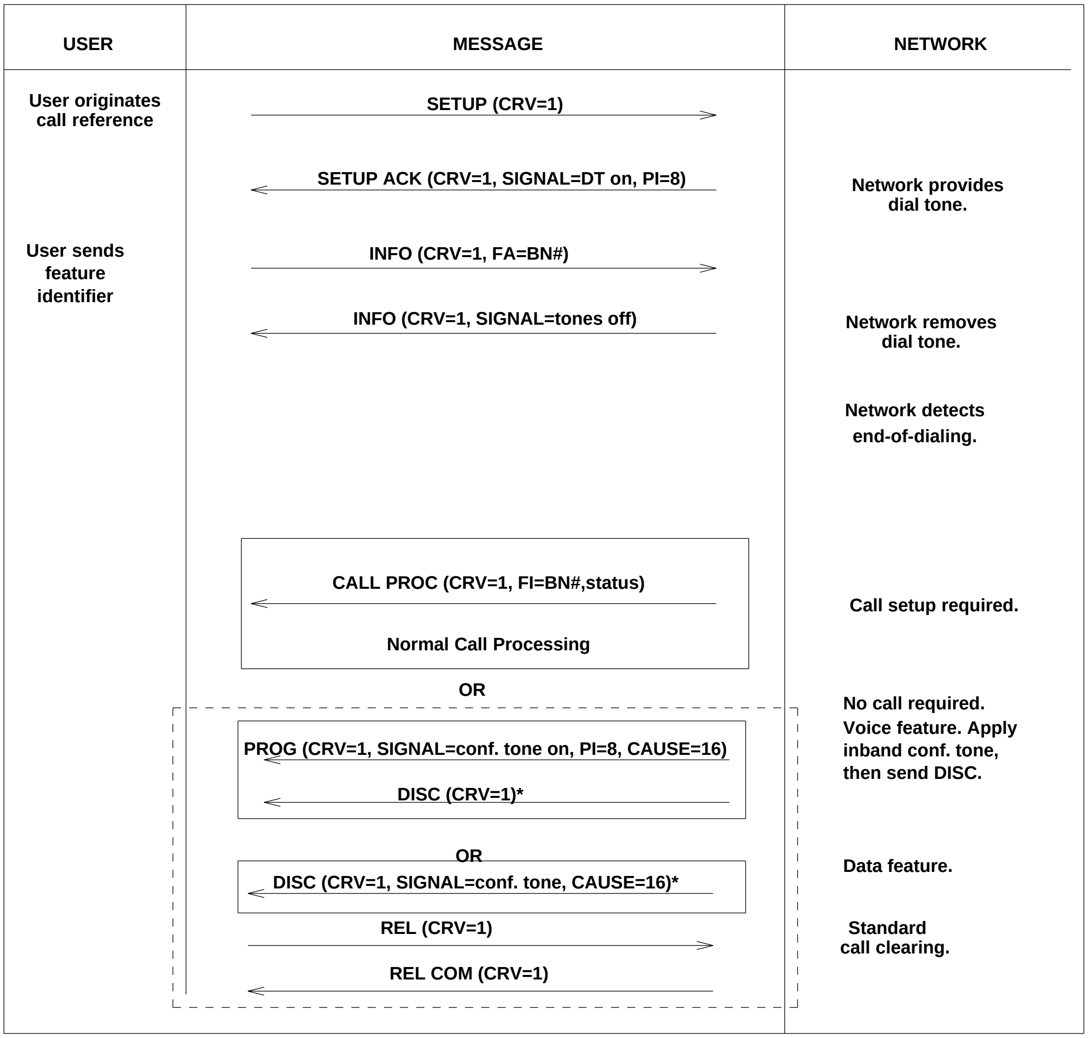
* If a feature button had also been assigned for the service requested through an access code, then this message would also include a feature indication IE to provide the appropriate feature status information on the D-channel.

Figure 5.1.2-5 — Dial Access Signaling; Overlap Followed by En-Bloc Sequence



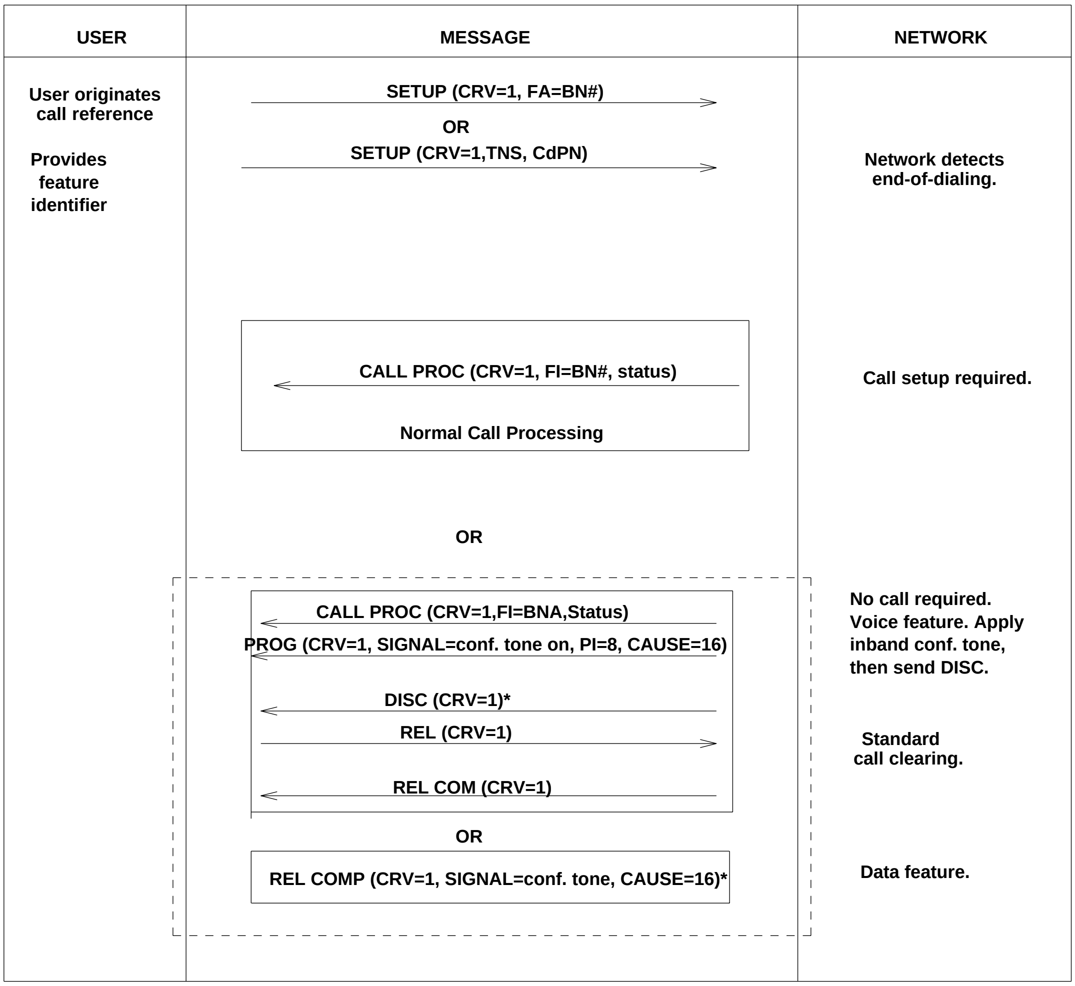
* If a feature button had also been assigned for the service requested through an access code, then this message would also include a feature indication IE to provide the appropriate feature status information on the D-channel.

Figure 5.1.2-6 — Dial Access Signaling; En-Bloc Followed by Overlap Sequence



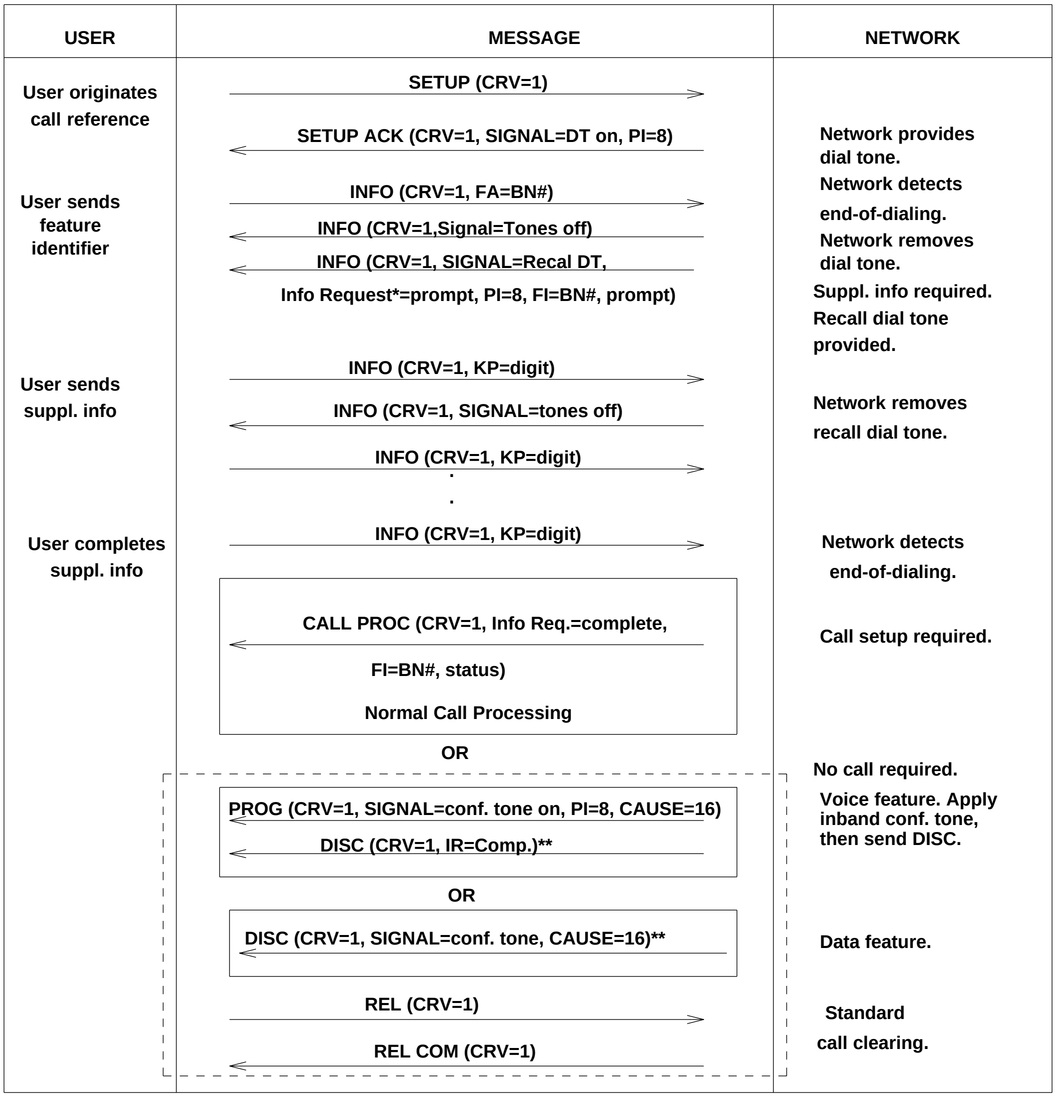
* An INFO message with feature indication element may be sent before sending the DISC. FI=Button #, status may alternatively be included in the DISC. In either case, FI should be sent to the CPE.

Figure 5.1.2-7 — Feature Button Signaling; Single Overlap Sequence



* An INFO message with feature indication element may be sent before sending the DISC. FI=Button #, status may alternatively be included in the DISC. In either case, FI should be sent to the CPE.

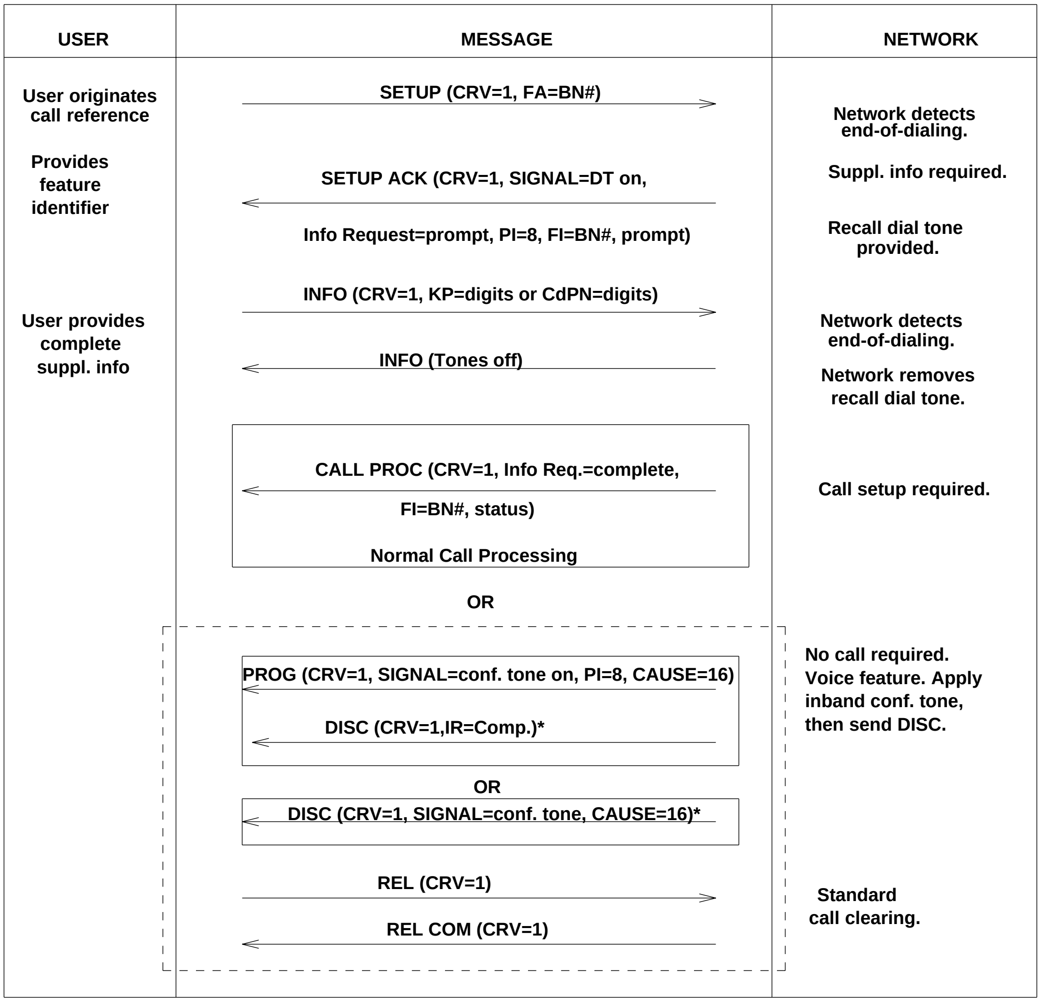
Figure 5.1.2-8 — Feature Button Signaling; Single En-Bloc Sequence



* Feature invocation using FB with IR procedures is supported only in state 2 for Y0.

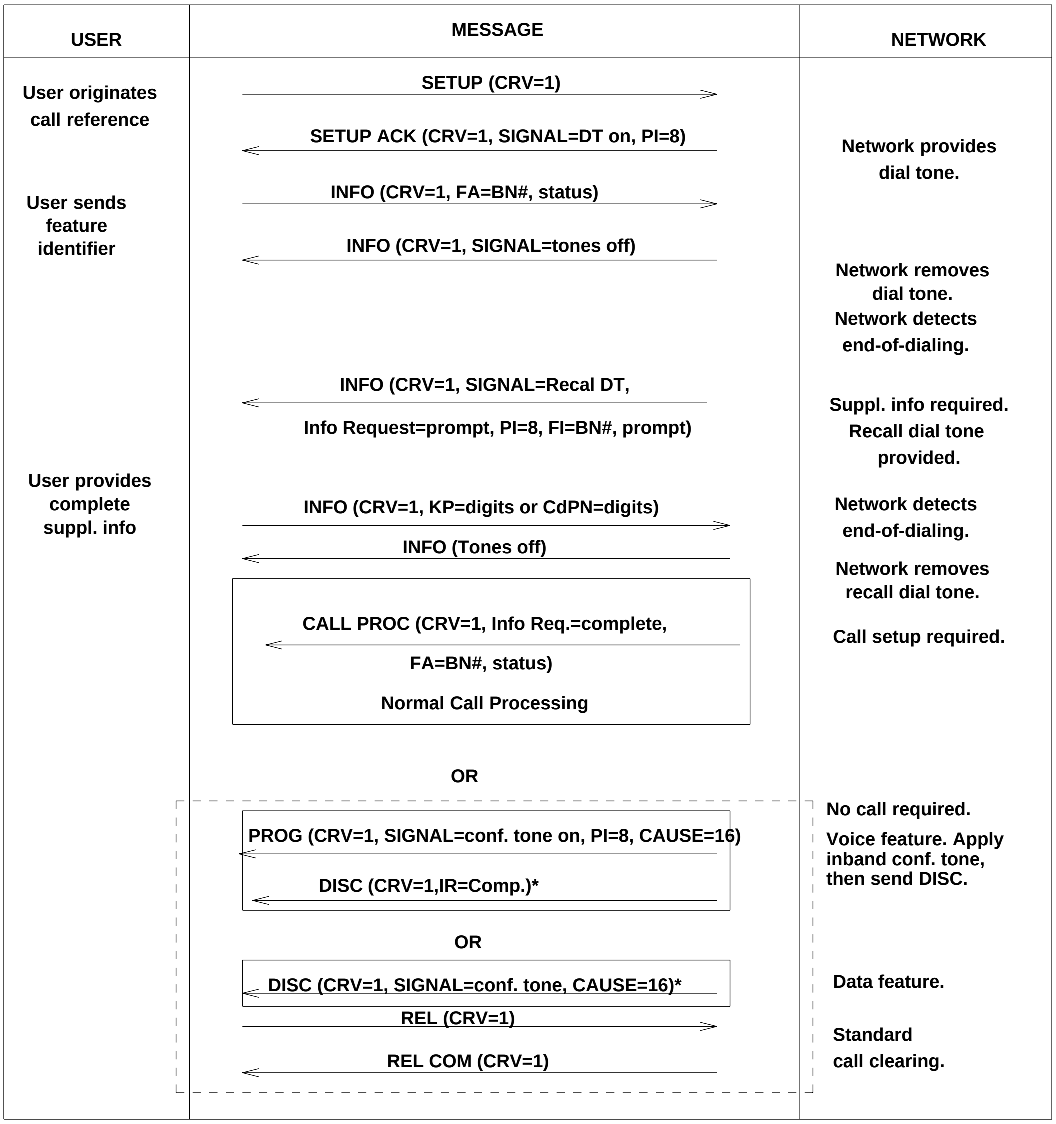
** An INFO message with feature indication element may be sent before sending the DISC. FI=Button #, status may alternatively be included in the DISC. In either case, FI should be sent to the CPE.

Figure 5.1.2-9 — Feature Button Signaling; Dual Overlap Sequence



* An INFO message with feature indication element may be sent before sending the DISC. FI=Button #, status may alternatively be included in the DISC. In either case, FI should be sent to the CPE.

Figure 5.1.2-10 — Feature Button Signaling; Dual En-Bloc Sequence



* An INFO message with feature indication element may be sent before sending the DISC. FI=Button #, status may alternatively be included in the DISC. In either case, FI should be sent to the CPE.

Figure 5.1.2-11 — Feature Button Signaling; Overlap Followed by En-Bloc Sequence

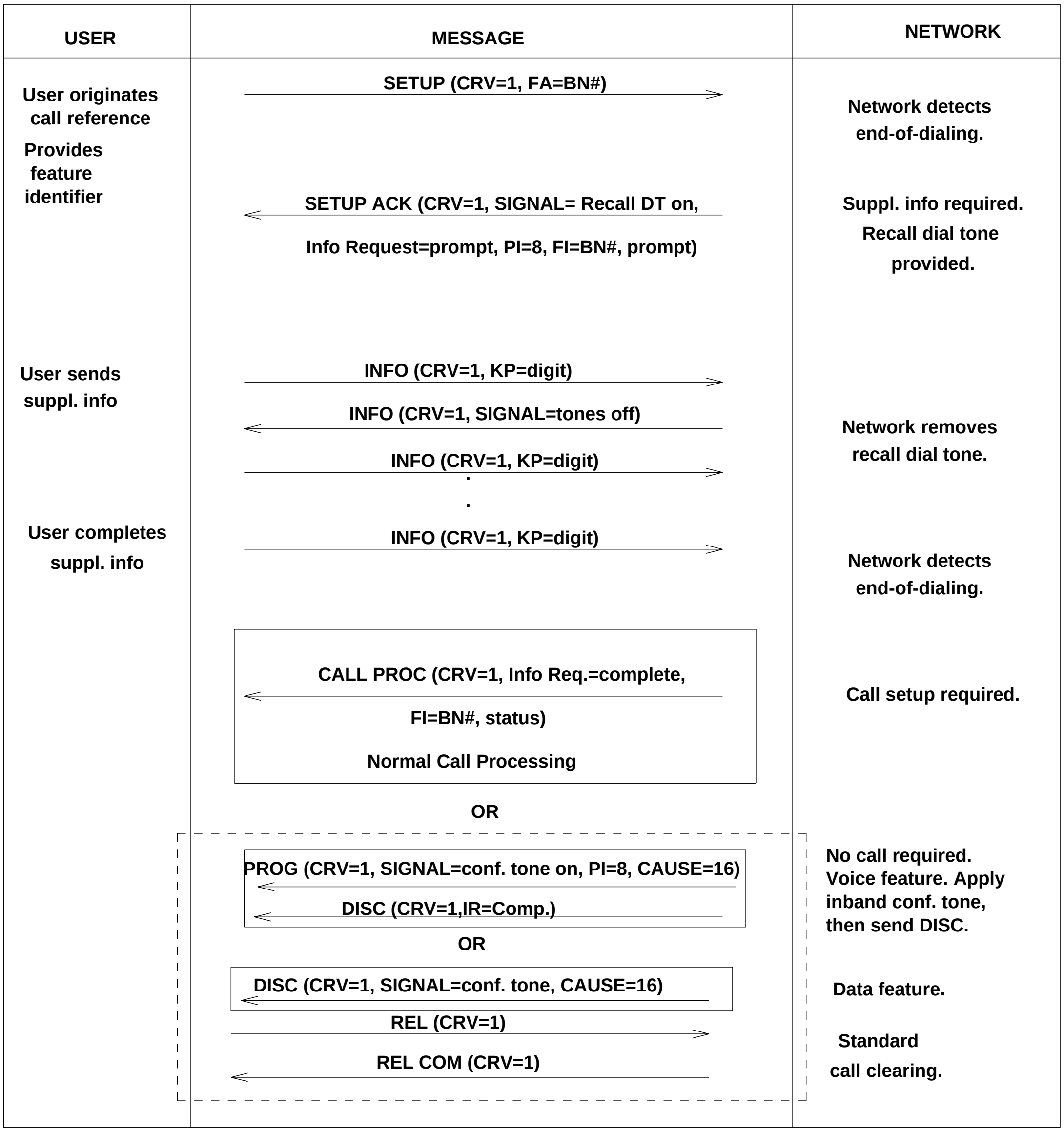


Figure 5.1.2-12 — Feature Button Signaling; En-Bloc Followed by Overlap Sequence

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

5.2 SUPPLEMENTARY VOICE SERVICES

This section describes the procedures used for voice services. The procedures are defined in terms of messages exchanged over the D-channel. The messages and procedures are built on those specified in "Message Definitions," Section 4.1, and "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2. In addition, this section lists all of the supplementary voice services available on the National ISDN (NI) interface.

Types of Supported Terminals

In NI, four terminal types are defined. The different terminals use different signaling procedures and have different capabilities. Generally, most features function with each terminal type; however, there are a few exceptions, and features will in some cases operate differently depending on the capabilities of the particular terminal. Where there are significant differences, they have been noted in the subsections of this section. During the service provisioning process, a given terminal will be identified as one of the following terminals:

a. ***Basic Call Terminal - No Additional Call Offering (ACO)***: A Basic Call terminal without ACO assigned.

b. ***ACO Terminal***: A Basic Call terminal that has ACO assigned.

c. ***Basic Electronic Key Telephone Service (EKTS)***: A given EKTS terminal that has access to only one call appearance of a particular directory number, and the call appearance can be shared.

d. ***Call Appearance Call Handling (CACH) EKTS***: A given EKTS terminal that has access to more than one call appearance of a particular directory number, and the call appearances can be shared.

From a service perspective, these assigned terminal types are mutually exclusive. A Basic Call or ACO Terminal may be either a Fully Initializing Terminal (FIT) or a Non-Initializing Terminal (NIT). An EKTS terminal must be a FIT.

A Basic Call or ACO terminal can only have a *single* directory number (DN) assigned for each terminal. By contrast, an EKTS (Basic and CACH) terminal can have multiple DNs.

Note: "Basic Call" refers to the terminal capabilities for originating and terminating basic voice calls, as specified in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

A user may subscribe to a particular terminal type only if the terminal has incorporated the necessary protocol elements to support that terminal type. For example, an ACO terminal is also a Basic Call terminal, but it must be designed to understand the particular information elements used by the ACO service. This ACO information goes beyond what is sent to a non-ACO Basic Call terminal. Another example, a terminal assigned as a CACH EKTS may have multiple call appearances and must include all call appearance information within the setup request. Besides the basic call protocol, it also must support the additional Network Layer protocol elements and procedures described in "LASS Customer Originated Trace (COT) Modular Feature," Section 5.2.1.34.

5.2.1 FEATURE CONTROL FOR SUPPLEMENTARY VOICE SERVICES

5.2.1.1 0+ and 1+ Dialing

This feature is available to a National ISDN interface, but it has no applicable dial access or feature button procedures. It is accessed through normal Basic Call originations.

5.2.1.2 900 Services

This feature is available to a National ISDN interface, but it has no applicable dial access or feature button procedures. It is accessed through normal Basic Call originations.

5.2.1.3 Access to 411, 611, and 811

This feature is available to a National ISDN interface, but it has no applicable dial access or feature button procedures. It is accessed through normal Basic Call originations.

5.2.1.4 Account Codes Modular Feature

The following subfeatures are available:

- Customer Dialed Account Recording
- ETS Account Code
- Account Code Deluxe
- Account Code Customer Control
- Account Code Group Control
- Account Code Feature Control.

Procedures for activating, deactivating, or accessing this feature follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1.

5.2.1.5 Additional Call Offering

The Additional Call Offering feature gives compatible standard terminals the ability to terminate new voice calls to a terminal that already has one or more other calls in various stages. The ACO-U options are as follows:

- ***Intra-ISDN-Terminal Group Only:*** This option allows an ACO-U subscriber to indicate that only calls originated from within the terminal group will be allowed as waiting calls.
- ***Incoming-to-ISDN-Terminal Group Only:*** This option allows an ACO-U subscriber to indicate that only calls originating from outside the terminal group will be allowed as waiting calls.
- ***All Calls:*** This option allows an ACO-U subscriber to indicate that all calls will be allowed as waiting calls.

The terminal group options apply to only an ACO-U subscriber that also is a member of a terminal group. Both of the options apply to Circuit Switched Voice and Circuit Switched Data.

The Notification Busy Limit (NBL) parameter, in conjunction with the existing call reference busy limit parameter (which limits the total number of originating and terminating calls for a terminal), limits the number of simultaneous terminating waiting calls for a terminal. There is an NBL parameter for Circuit Switched Voice and a separate one for Circuit Switched Data.

5.2.1.5.1 Overview

Additional Call Offering notifies an ISDN basic rate interface (BRI) user of a call directed to that user in a situation where the call would normally be cleared because the user's ISDN interface is busy. A standard terminal subscribed to Additional Call Offering will be an ACO terminal. Additional Call Offering is also based upon the network's ability to control multiple concurrent calls and the terminal's capability to recognize multiple concurrent Call References (see "Message Definitions," Section 4.1).

As specified in "Call Hold," Section 5.2.1.12, for proper interaction with this feature, each terminal is expected to have some method (for example, a button and corresponding lamps) for providing information to the end-user about each call. The presentation can be referred to as "call appearance."

Note: Throughout this section, every call to a terminal is independent of every other call, subject to only subscription-time service provisioning, the limitations of the terminal in maintaining Call References, and the conditions associated with B-channel availability on an interface. Originations and terminations may be in progress simultaneously, and calls may be offered when the user is in the process of dialing. Call references combined with the preceding concept of call appearances, give the end-user complete freedom of choice as to which call to handle next.

5.2.1.5.2 Originating Calls

With ACO, the total number of calls (originating/terminating) on a terminal can be up to CRBL.

5.2.1.5.3 Terminating Calls

If the network receives a call for an ACO terminal and finds (1) the CRBL is not exceeded, (2) no idle B-channel can be allocated to the call, (3) the ACO terminal group option (if assigned) has not been violated, and (4) the NBL is not exceeded, the call should be offered to the terminal as an ACO call. However, if no B-channel can be allocated to a terminal and currently no active or held call is on that terminal, then an ACO call will not be offered even if the CRBL is not exceeded.

If an incoming voice call arrives at the network addressed to a terminal that is alerting, the network will offer the call (based on B-channel availability conditions), unless the call would exceed the CRBL, violate an ACO terminal group option (if assigned), or exceed the NBL. Therefore, two or more calls can be simultaneously alerting.

5.2.1.5.3.1 Call Offering Procedures

The network will offer the terminal the call by means of a SETUP message. The channel identification IE should be coded as "No channel." The signal IE must be coded as "additional call tone."

As defined in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, when offering a terminating Basic Call, a channel will be allocated for the terminal.

Note: Basic Call may not allocate a channel that is reserved for another terminal on the interface.

Any other originations or terminations that occur while the Basic Call is in the alerting stage must use the channel allocated for the Basic Call assuming the B-channel subscription parameters have been reached for the terminal (as defined in "Organization," Section 1.3). For example, assume a CSV Basic Call is offered indicating B1 in the channel IE. Now assume an ACO call is offered with "no channel" in the channel IE. (This call would be offered as an ACO call since the terminal subscribes to one B-channel for CSV and that channel is already reserved.) The terminal may answer either call; however, if the terminal chooses to answer the ACO call before answering the Basic Call, it must use B1 (a CONNect message for the ACO call indicating exclusive B2 will be rejected even if B2 is idle). Another example assumes a terminal is being offered a CSD call through Basic Call on B1. The terminal wants to originate another data call exclusively on B2. The origination will be allowed if the B-channel subscription parameters for the terminal allows access to both B-channel for CSD.

After the call offered through Basic Call is cleared or placed on hold, a terminal is free to originate, connect, or retrieve other calls to other channels that are either: (1) already allocated to the terminal, or (2) idle, up to the B-channel subscription limits for that terminal, meaning that it is neither in-use nor reserved for other terminals on the interface. For example, assume a terminal is offered a Basic Call on B1 followed by an ACO call. The terminal may answer the Basic Call on B1, place the call on hold, and answer the ACO call on B2. If this occurs, B1 will be idled and B2 will be allocated for the terminal.

5.2.1.5.3.2 Alerting Treatment

In general, the incoming call specifications in "Call Establishment at Terminating Interface," Section 4.2.1.3, apply. The Signal information element should be coded as "additional call tone." How this signal value will be used to generate audible or visual alerting for incoming calls depends on what the CPE supports (such as flash light or generate tone).

A terminal receiving such a SETUP message may respond with CALL PROCeeding or ALERTing. At this point, the user has the following four options:

a. The end-user may choose not to answer the waiting call. The user waits for the caller or the switch to initiate call clearing.

b. The end-user may reject the waiting call. In this case, the CPE must be able to send a DISConnect, RELease, or RELease COMplete message when the waiting call is offered.

c. The end-user at the terminal may cause the terminal to send a HOLD message for one of its active calls. After receiving a HOLD ACKnowledge message from the network, the terminal issuing the HOLD message may send a CONNect message for the new call. It may indicate the freed channel in a Channel Identification information element. The user may exclusively request a B-channel in the CONNect message. If the user indicates an "exclusive" B-channel, the switch should select that channel to connect the call if the B-channel is available. If that channel is not available, the call should be cleared. If the user indicates a "preferred" channel, the switch should select that one if possible. Otherwise, the switch will select the channel that is available. If no Channel Identification information element is present or the Channel Identification information element is coded as "any," the network will assume "any channel" to be acceptable, and will use the freed channel. The network will respond with a CONNect ACKnowledge message containing a Channel Identification information element.

d. Instead of placing an active call on hold in order to answer a new call, an end-user may cause a terminal to disconnect an active call. The terminal may now accept the incoming call with a CONNect message. If no Channel Identification information element is present, the network will assume "any channel" to be acceptable, and will use the freed channel, indicating the same in its CONNect ACKnowledge response.

A channel designation in either a CALL PROCeeding or an ALERTing message as first response to the SETUP message during ACO operation should be ignored by the switch.

5.2.1.5.4 Service Restrictions on B-Channels

If a terminal requests a channel that is not provisioned at the network interface, and the terminal indicates "exclusive" in the Channel Identification information element, then the network will deny the request with a RELease COMplete message.

5.2.1.5.5 Calling a Terminal with Additional Call Offering

The calling party hears the standard inband tones that a subscriber with an analog station set would hear.

5.2.1.5.6 Clearing Treatment

From the viewpoint of the network, every call on a given logical link is an independent call and has a unique Call Reference known by the subscriber terminal. Therefore, the clearing treatment for each call, including ACO calls, follows the call clearing procedures of "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

5.2.1.5.7 Implications for Call References

Each ACO call is handled as if it were a normal incoming call. Each call is presented to the terminal according to the procedures of "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, as modified in this section. Therefore, to receive multiple calls, the subscriber terminal must be capable of keeping track of multiple Call References. End-users with terminals incapable of keeping multiple Call References should not subscribe to ACO.

5.2.1.5.8 Limits on Simultaneous Call References

As specified in "Call Hold," Section 5.2.1.12, the number of independent voice calls that may exist simultaneously for any DN on a BRI (that is, the number of calls supported concurrently) will be a customer subscription feature. If this CRBL is exceeded, the network shall not offer any additional calls to the terminal. In other words, ACO calls cannot be offered.

The network will not support simultaneously more than 16 voice Call References for any one DN.

Figures 5.2.1-1 and 5.2.1-2 give examples of ACO procedures.

User	Message	Network
Active call with Call Reference (CR=1)		
ACO call is offered to this user with (CR=3)	SETUP(CR =3, No-channel, additional call tone) <----------------------------	Network offers an ACO call
	Alerting (CR=3) ---------------------------->	
User requests hold of Call Reference (CR=1)	HOLD (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	. . .	
User requests to connect to the ACO call with (CR=3)	CONNECT (CR=3) ----------------------------> CONNECT ACK (CR=3) <----------------------------	Network connects the ACO call

Figure 5.2.1-1 — User Answers an ACO Call

User	Message	Network
Active call with Call Reference (CR=1)		
ACO call is offered to this user with (CR=3)	SETUP(CR =3, No-channel, additional call tone) <----------------------------	Network offers an ACO call
	Alerting (CR=3) ---------------------------->	
User requests to reject the ACO call (CR=3)	DISCONNECT (CR=3) ---------------------------->	
	RELEASE (CR=3) <----------------------------	Network releases the ACO call
	RELEASE COMP (CR=3) ----------------------------->	

Figure 5.2.1-2 — User Rejects an ACO Call

5.2.1.6 Advanced Service Platform (ASP) Services

The following subfeature is available:

- ASP Dialed Number Trigger (DNT) and Shared Interoffice Trunk Trigger, voice.

5.2.1.7 Attendant Features for NI-1 Interface via Custom Interface

Attendant features cannot be assigned to a Standard BRI. However, users on a Standard BRI will receive the same Attendant service as users on a Custom BRI, from both Analog and Custom ISDN Attendants.

The following features have some interaction between an attendant and a Standard BRI:

- ***Attendant Busy Verification - Originating:*** Assignable to only an attendant; can busy-verify lines in the same attendant group that have the ABV terminating feature assigned. **Can busy-verify a Standard BRI with the appropriate feature.** (See document 235-390-514, **5ESS®** *Switch Custom ISDN Features*.)

- ***Attendant Busy Verification - Terminating:*** Assignable to a BRI; the attendant must have the originating feature, and the line must have the terminating feature. **Can be assigned to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Control of Voice Terminals - Originating:*** Assignable to only an attendant; can change terminal restrictions on terminals with the corresponding terminating feature assigned. **Can control a Standard BRI with the appropriate feature.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Control of Voice Terminals - Terminating:*** Assignable to a BRI; the attendant must have the originating feature, and the line must have the terminating feature. **Can be assigned to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Emergency Override - Originating:*** Assignable to only an attendant; can override lines in the same terminal group that have the corresponding terminating feature assigned. **Can override a Standard BRI with the appropriate feature.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Feature*s.)
- ***Attendant Emergency Override - Terminating:*** Assignable to a BRI; the attendant must have the originating feature, and the line must have the terminating feature. **Can be assigned to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Call Forwarding:*** Assignable to only an attendant; allows the attendant to activate/deactivate call forwarding for the lead member of MLHGs and for stations associated with the attendant group. **Can control call forwarding a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Call Hold:*** Assignable to only an attendant; allows the attendant to place calls on hold. **The held call could be from a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Call Splitting:*** Assignable to only an attendant; allows the attendant to consult privately with a called party or a calling party without the other party hearing the conversation. **Either or both of the split parties may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Call Transfer:*** Assignable to only an attendant; allows the attendant to transfer a call to a directory number or another attendant position. **Both the transferred call and the transferred-to DN may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Camp-On:*** Assignable to only an attendant; alerts a busy DN that a transferred call from the attendant is waiting to be answered. **Both the incoming call and the DN being alerted may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Conference:*** Assignable to only an attendant; allows the attendant to set up conference calls with up to six parties (including the attendant), and drop

off to leave the parties talking. **Any of the parties involved in the conference may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)

- ***Attendant Control of Facilities:*** Assignable to either a Standard BRI or an attendant; allows an attendant to restrict other stations within the business group from dial access to dial access codes. **The station to be restricted may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Direct Station Selection/Busy Lamp Field:*** A Standard BRI has an RC option to permit monitoring of its status; the BLF allows the attendant to quickly distinguish whether a DN in the same business group is busy or idle; the DSS allows the attendant to select a DN whole busy/idle status is being displayed by the BLF feature without having to dial the station number. **If a Standard BRI has allowed monitoring, then an attendant may determine their status and select the BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Recall from Satellite:*** Assignable to a Standard BRI; allows the user to transfer a call to an attendant on another switch. **Can be assigned to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Through Dialing:*** Assignable to only an attendant; allows an attendant to access an outgoing facility for stations users having restrictions or difficulty in placing outgoing calls; uses senderized trunks, and the call is billed to originator. **The station user may be using a Standard BRI.** (See document 235-390-514,**5ESS** *Switch Custom ISDN Features*.)
- ***Attendant Timed Reminder:*** Assignable to only an attendant; alerts the attendant when a call has been on hold longer than a customer-specified amount of time, or was transferred to the attendant and has remained unanswered for longer than a customer-specified amount of time. **The held or transferred call may be from a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Call Transfer Attendant:*** Allows a business group member to transfer a call to the attendant. **Assignable to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Centralized Attendant Service:*** A variant of Main Satellite Service, this provides a multilocation Centrex/ESSX-1 customer attendant services for all locations at one location (called the main location). **A user on a Standard BRI may access a central attendant.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Dial Access to Attendant:*** Allows a customer group member dial access to an attendant for that group. **Assignable to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Dial Through Attendant:*** Assignable to only an attendant; allows a customer to request the attendant to connect the call to an outgoing facility, after which the customer may complete the dialing. **The customer line may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Emergency Access to ISDN Attendant:*** Assignable to only an attendant; provides priority handling of emergency calls from stations to attendants. **The**

station making the emergency call may be a Standard BRI. (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)

- ***Fixed Night Service:*** All calls to the DN may be routed to a preselected night station. **Assignable to a Standard BRI (but not commonly done).** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Flexible Night Service:*** Assignable to only an attendant; allows the attendant to selectively route each LDN in the attendant group to a different customer changeable remote location (by using Attendant Call Forwarding). **The remote DN may be a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Forced Release:*** Assignable to only an attendant; forcibly disconnects users from a conference with the attendant. **A user forcibly released may be using a Standard BRI.**
- ***ISDN Attendant Remote Busy Verify (TEMPO):*** The ISDN Attendant Remote Busy Verify feature is assignable to only an ISDN attendant; however, to busy verify a Standard BRI, the BRI must have the ISDN Attendant Busy Verify ISDN Line Terminating feature assigned (/CPUIVT), the same as for Attendant Busy Verify described previously. **A Standard BRI may be busy-verified by this feature.**
- ***ISDN Originating Permissions Display:*** Assignable to only an attendant; enables the attendant to identify the originating permissions of lines that have been routed to the attendant. **The originating permissions of a Standard BRI are available for display, the same as for a Custom BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Main Satellite:*** This capability allows a customer, who receives business group service provided by two or more separate switching machines in the same geographic area, to obtain the same service that would be received if all locations were served by a single switch. Attendant service would be provided from a single switch, considered the "main" location, with the other switches being "satellites." **A Standard BRI may be served by an attendant on another switch in a Main Satellite configuration.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Non-Data-Link Attendant Console:*** This is a particular type of attendant console interface. **A Standard BRI may be provided with attendant service from a non-data-link attendant console.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Satellite Attendant Transfer:*** Assignable to a Standard BRI (same as Attendant Recall from Satellite); allows the user to transfer a call to an attendant on another switch. **Can be assigned to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Toll Diversion to Attendant***: Intercepts toll or code calls from restricted business group lines and routes them to the attendant (or other designated line). **Can be assigned to a Standard BRI.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)
- ***Trunk Answer Any Station:*** Used in conjunction with Night Service on the attendant and Call Pickup on the line; incoming calls activate a night bell or other indicator, and are forwarded to a terminal where they can be picked up; they may

be answered from any station by dialing an answer access code for the call pickup feature. **A Standard BRI may be assigned the Call Pickup feature to pick up the Trunk Answer Any Station call.** (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)

- ***Power Failure Transfer:*** Assignable to either a Standard BRI or an attendant; provides for the routing of calls destined for the BRI or attendant to a preassigned directory number when a communication or power failure is detected by the central office. **Can be assigned to a Standard BRI**. (See document 235-390-514, **5ESS** *Switch Custom ISDN Features*.)

5.2.1.8 Authorization Codes Modular Feature

The following subfeatures are available:

- ETS Authorization Code
- Authorization Code Line Out of Service
- Authorization Code Group Control
- Authorization Code AMA Recorded.

Procedures for activating, deactivating, or accessing this feature follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1.

5.2.1.9 Automatic Route Selection (ARS)

5.2.1.9.1 Support of ARS Subfeatures

The following subfeatures are available:

- Deluxe Automatic Route Selection
- Expensive Route Warning Tone
- Facility Restriction Level
- Automatic Alternate Routing
- Uniform Numbering
- Traveling Class Mark
- Common Control Switching Arrangement (CCSA) Capability.

The ARS activation procedures using Access Codes and Feature Buttons will follow the procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1, for Stimulus Signaling. (See also "Stimulus Signaling Protocols Capability," Section 5.1.1.2.)

Information Request Procedures specified in "Information Request Procedures," Section 5.1.1.2.1.2.5, will be used for collecting address digits.

5.2.1.9.2 Expensive Route Warning Tone

Certain outgoing facilities may be designated as "expensive" by a customer. Expensive Route Warning Tone (ERWT) feature will be supported when those routes are selected. This gives the user the option to disconnect quickly if the call is not worth the expense.

5.2.1.10 BRI Access to Interexchange Carrier Services

This feature allows ISDN users on a Basic Rate Interface to access services provided by an Interexchange Carrier (IEC) for full end-to-end ISDN connectivity. This feature requires an SS7 Network Interconnection to exist between the local switch and the IC.

This includes support for Feature Groups A, B, C, and D described in the following paragraphs.

Feature Group A provides interconnection to inter-LATA carriers as a line appearance on local switches. The lines used by carriers are essentially the same as any other lines except that special AMA treatment is provided for calls terminating to them.

Feature Group B provides interconnections to inter-LATA carriers as a trunk type appearance on local tandem, end office, and tandem switches. Each carrier can be accessed on a uniform basis nationwide by dialing 950-XXXX, where XXXX is the Carrier Identification Code (CIC). Special AMA treatment is provided for calls incoming over these trunks.

In the case of Functional addressing, all the digits (950XXXX) should be in the CdPN digits field (see "Functional Addressing," Section 5.1.1.2.1.2.4). The Type of Number field should be coded as "unknown number in ISDN." The Numbering Plan Identification field should be coded as "unknown numbering plan."

Feature Group C is used for only access to operator services.

Feature Group D provides an interface between the local exchange and inter-LATA and international carriers. The customer dials a special code in the form 101XXXX to specify the carrier desired, or calls through a designated primary carrier by dialing in the 7- or 10-digit plan.

5.2.1.11 Call Forwarding Features

5.2.1.11.1 Support of Call Forwarding Features

This section defines the invocation procedures for Call Forwarding features (Figures 5.2.1-3, 5.2.1-4, 5.2.1-5, 5.2.1-6, 5.2.1-7, 5.2.1-8, 5.2.1-9, 5.2.1-10, 5.2.1-11, 5.2.1-12). Call Forwarding is a service that redirects calls intended for the DN requesting the feature (the base DN) to another DN (the remote DN). The network shall use certain criteria for determining the conditions under which forwarding applies. These invocation procedures apply to the following Call Forwarding features:

- Call Forwarding Variable (Voice and Data) (/CFV and /CFDV)
- Call Forwarding Variable Feature Button (Voice and Data) (/CFVFB and /CFDVFB)
- Call Forwarding Busy Line (Voice and Data) (/CFBLAC and /CFDBLAC)
- Call Forwarding Busy Line Feature Button (Voice and Data) (/CFBLFB and /CFDBLFB)
- Call Forwarding Don't Answer (Voice and Data) (/CFDAAC and /CFDDAAC)
- Call Forwarding Don't Answer Feature Button (Voice and Data) (/CFDAFB and /CFDDAFB)
- Call Forwarding Incoming Only (Voice and Data) (/CFIO and /CFDIO)
- Call Forwarding in a (Within) Group (Voice and Data) (/CFIAG and /CFDIAG)

- Call Forwarding Busy Line Incoming Only (Voice and Data) (/CFBLIO and /CFDBLIO)
- Call Forwarding Don't Answer Incoming Only (Voice and Data) (/CFDAIO and /CFDDAIO)
- Remote Call Forwarding (Voice Only) (/CFR)
- Call Forwarding for Multiline Hunt Group (Voice and Data)
- Call Forwarding for Dual Telephone Coverage (Voice Only)
- Call Forwarding - Inhibit Make Busy
- Call Forwarding - Inhibit Line Busy.

Note: The ISDN terminal does not impact the Remote Call Forwarding feature.

In addition to the features listed in the previous paragraph, the *5ESS* switch supports the following additional features that should be assigned for Bellcore Technical Reference (TR) service uniformity:

- ISDN Call Forwarding Variable with Courtesy Call Answer Required (Voice Only) (/CFIVCA)
- ISDN Call Forwarding Variable with Courtesy Call - No Answer Required (Voice Only) (/CFIVC)
- ISDN Call Forwarding Variable with No Courtesy Call (Voice) (/CFIV)
- ISDN Call Forwarding Busy Line (Voice) (/CFIBL)
- ISDN Call Forwarding Don't Answer (Voice) (/CFIDA)
- ISDN Call Forwarding Variable (Data) (/CFIDV)
- ISDN Call Forwarding Busy Line (Data) (/CFIDBL)
- ISDN Call Forwarding Don't Answer (Data) (/CFIDDA).

The *5ESS* switch supports the following additional features on the National ISDN BRI; these should be assigned for service uniformity in call forwarding over private facilities (CFPF):

- Call Forwarding Over Private Facilities for National ISDN-3 (/CFIPF)
- Call Forwarding Over Private Facilities (/CFPF)
- CFPF Feature Button (/CFPFFB)
- Call Forwarding Over Private Facilities/Don't Answer (CFPF/DA)

5.2.1.11.2 Feature Control Procedures

5.2.1.11.2.1 Activation

Activation of a Call Forwarding feature may require that the requester specify the DN of a remote ("forward-to") terminal. In addition, activation may require a courtesy call, where answer of that courtesy call is either required or not required for successful activation. See Figures 5.2.1-3, 5.2.1-4, 5.2.1-5, 5.2.1-6, 5.2.1-7, 5.2.1-8, 5.2.1-9, 5.2.1-10, 5.2.1-11, 5.2.1-12 for detailed Q.931 message exchanges at the interface.

Table 5.2.1-1 describes the various options that are used for activating Call Forwarding features:

Table 5.2.1-1 — Call Forwarding Activation Types

OPTION	ACTIVATION TYPE	COMMENTS
No Directory Number, No Courtesy Call	Dialed Code (CODE)	Activation procedures follow those described in Section 5.1.2, A (Items 1, 2, 3, and 7) and Section 5.1.2, C (Item 1).
Directory Number, No Courtesy Call	Customer Dialed Directory Number (CDDN)	Activation procedures follow those described in Section 5.1.2, A (Items 4, 5, 6, and 7).
Directory Number, Courtesy Call - No Answer Required	Customer Dialed DN - Courtesy Call (CDDNC)	Activation procedures follow those described in Section 5.1.2, A (Items 1, 2, and 3).
Directory Number, Courtesy Call - Answer Required	Customer Dialed DN - Courtesy Call with Answer (CDDNCA) Customer Dialed DN - Courtesy Call Compatible with the 1A *ESS*™ Switch (CDCA1A)	Activation procedures follow those described in Section 5.1.2, A (Items 4, 5, and 6). ***Note:*** This activation type is not an option for CFPF.

Note: If the requested Call Forwarding feature requires a courtesy call (see Figure 5.2.1-7) to the remote terminal, the network shall proceed with normal ISDN procedures and attempt to complete the call. If the call does not complete, the terminal shall receive no indication as to whether completion was successful or unsuccessful.

5.2.1.11.2.1.1 Redirection Number Information Element

When ISDN CF activation is performed with a null Call Reference or when the activation type does not require answer or setup of a courtesy call, the remote DN, as coded by the Redirection Number Information Element (IE), must be "echoed" back to the base DN upon successful feature activation. The Redirection Number IE must be included in one of the following messages under the indicated conditions:

- **CALL PROCeeding Message:** When activation is performed with ACTYP CDDNC, with setup of a courtesy call, or with ACTYP CDDNCA (or CDCA1A) when the remote DN is within the same terminal group
- **DISConnect, RELease, RELease COMplete (The First Clearing Message):** When activation is performed during call establishment with ACTYP CDDN with no setup of a courtesy call (or CODE during the "change forward-to DN" procedure)
- **INFOrmation Message:** When activation is performed outside the context of a call (with ACTYP CDDN).

Note: The access codes for NI-3 CFPF [that is, private facility access (PFA)/automatic route selection (ARS)] are not included in the Redirection Number IE; only the remote DN address digits are included.

The function and coding of the Redirection Number IE is specified in "Message Definitions," Section 4.1.

5.2.1.11.2.2 Deactivation

Deactivation procedures for Call Forwarding features follow those described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, 3, and 7), and C (Item 1). All deactivation procedures require a Deactivation Type of CODE.

5.2.1.11.2.3 Notification (Reminder Ring)

For both voice and data call types, the NOTIFY message (see "NOTIFY," Section 4.1.2.16) will be used to send an indication to the base station's equipment that a CF subfeature is active whenever a call is forwarded. The message is sent only when the "Base Station Ring Indicator" (BSRING) line parameter associated with the DN and CF subfeature is set to "Yes." Note that this message does not apply to CFDA features.

The switch will send a NOTIFY message point-to-point at the data-link layer (Layer 2) to the single terminal and the single interface on which the primary DN resides for EKTS shared DN arrangements for both Basic and CACH EKTS terminals. A Terminal Endpoint Identifier (TEI) must be included in this NOTIFY message at layer 2. The NOTIFY message will continue to be sent broadcast at Layer 3 to non-EKTS terminals.

In both software releases, this NOTIFY message contains call information as follows:

- Null CRV.
- The Bearer Capability IE must be included in the NOTIFY message indicating the Bearer Capability of the forwarded call.
- The signal information element coded to "alerting on, Pattern 4, reminder ring" must be included if the interface used by the base DN is not network-determined busy.
- The Called Party Number IE (see "Called Party Number," Section 4.1.3.2.5) must be included in the NOTIFY message. It will be populated with the "Base" station DN (original CPN for the first forwarding and forwarded to DN for subsequent forwardings). Without the Called Party IE in this NOTIFY message, a user with multiple DNs will not know which DN on the interface was called when the call was forwarded.
- Called Party Subaddress, if available at the switch (see "Message Definitions," Section 4.1, and "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2). This subaddress is associated with the base DN. This should be included if the subaddress was provided by the originating party.
- The Calling Party Number IE (see "Calling Party Number," Section 4.1.3.2.7) should be included in the NOTIFY message if calling number delivery is assigned to the base DN.
- Calling Party Subaddress, if it is available at the Switch (per Calling Number ID services).

This is available at the switch if calling party number delivery is assigned and subaddress was provided by the originating DN.

- Notification Indicator IE will also be included, with Notification Description coded to "Call Forwarded."

5.2.1.11.2.4 Display Text Information

The Display Text information elements for several of the protocol messages associated with CF Activation/Deactivation and forwarding are populated. Table 5.2.1-2 maps the I-CF activation/deactivation and incoming redirected call displays to the associated message(s) that will contain the display text information.

Table 5.2.1-2 — Mapping of Displays to Protocol Messages

DISPLAY TEXT	ACTYP/DACTYP/FORWARDING CALL CONDITION	MESSAGE
"Forward to:" (Prompt for Remote DN)	During Call Establishment	INFOrmation
	During Call Establishment (when FA and CF Access Codes are in same message)	SETUP ACKnowledge
	During Call Establishment (when FA and CF Access Codes are not in same message)	INFOrmation
	Outside the Context of a Call	INFOrmation
"Always forward-on," "Busy forward-on," or "No answer forward-on" (Act. Confirmation)	CDDNCA (when answer is received on the first attempt)	CONNect
	CDDNCA (on second attempt when the first attempt is abandoned or remote DN busy)	PROGress
	CDDNCA (when remote DN entered is within terminal group, so that courtesy call answer is not required)	CALL PROCeeding
	CDDNC (upon setting up courtesy call to remote DN)	CALL PROCeeding
	CDDN (or CODE) (during call establishment after remote DN is entered)	PROGress
	CDDN (or CODE) (when Outside the Context of a Call)	final INFOrmation
"Redo call forwarding" ("Redo" CF indication)	CDDNCA (when first attempt is abandoned or remote DN busy)	DISConnect RELease RELease COMplete
"Always forward-off," "Busy forward-off," or "No answer forward-off" (Deact. Confirmation)	CODE (during call establishment)	PROGress (where network subscribed)
	CODE (when Outside the Context of a Call)	final INFOrmation
Calling Number Display at Remote DN with redirecting number information	Incoming Forwarded Call	SETUP

5.2.1.11.2.5 National ISDN-3 (NI-3) CFPF Specific Procedures

CFPF as well as CFPF/DA shall conform to the following procedures:

1. During CFPF activation, the PFA or ARS access code may be encoded in a Key-pad IE or Called Party IE, as part of the supplemental CFPF remote address information, in a SETUP message or the PFA/ARS information may be sent completely in a subsequently received INFOrmation message, as needed. One or more address digits, but not the whole private address, may also be encoded in the Key-pad IE. However, if the PFA/ARS information is encoded in a Called Party IE, then the PFA/ARS information must be complete. (Whether the PFA address information is considered complete depends on the specific feature parameters associated with the PFA feature assigned to the line.) Figures 5.2.1-14, 5.2.1-16, and 5.2.1-18 show the dial access and feature button CFPF activation for the total en-bloc sequence and the dual en-bloc sequence.

2. During CFPF activation, a part of the PFA or ARS access code (or an ambiguous part of a completed call) may be encoded in the Key-pad IE in the SETUP message. The remaining part of the PFA or ARS Access Code will be sent through subsequent INFOrmation messages and encoded in the Key-pad IE of those messages.

   The en-bloc, overlap,en-bloc sequence for CFPF activation through dial access is shown in Figure 5.2.1-17.

3. When the PFA/ARS information is encoded in a Called Party IE, the "type of number and numbering plan" identification field may be coded as "network specific number in private numbering plan," "abbreviated number in private numbering plan" or "unknown."

   As stated previously, in all cases, if the PFA/ARS information is encoded in the Called Party IE, the information must be complete.

4. The CFPF Customer Originated Recent Change (CORC) procedure is compatible with all existing National ISDN Feature Indicator procedures for the CF subfeatures (with the exceptions noted in Item 7). A Feature Indication IE (usually sent in an INFOrmation message) allows the CPE to light the feature button lamp provisioned for the CFPF feature.

   After successful activation of CFPF, the CFPF feature lamp associated with CFPF on the station with the primary DN will be updated through the Feature Indication IE to indicate that CFPF is active. In addition, the lamp status will be updated (extinguished) upon successful deactivation.

   See Item 7 for description of the FI procedures for the ARS, PFA, auth code, and account code procedures during CFPF activation.

5. For CFPF, an Information Request IE is included in the appropriate message (generally an INFOrmation message with overlap sending, or a SETUP ACKnowledge message with en-bloc sending) in the following cases during an CFPF activation:

   - After receipt of the CFPF activation code to prompt for entry of remote DN address digits. (However, the user may enter other than remote DN address digits, that is, ARS, PFA, ACCT use, lead ACCT or ATH use access codes). The "type of information" field will be coded to "address digits."

- After receipt of the ARS access code for recall Dial Tone to prompt for entry of the remote DN address digits. (The user may also enter an ACCT use code or Lead ACCT here). The "type of information" field will be coded to "address digits."
- After receipt of the PFA access code for recall Dial Tone to prompt for entry of the remote DN address digits. The "type of information" field will be coded to "address digits."
- After receipt of the ACCT code with recall Dial Tone to prompt for entry of the remote DN address digits. The "type of information" field will be coded to "address digits."
- After receipt of an ATH code with recall Dial Tone to prompt for entry of the remote DN address digits. (However, after the ATH code, the user may also enter PFA/ARS access digits or ACCT use digits). The "type of information" field will be coded to "address digits."
- After receipt of the ACCT use code to prompt for entry of the Account Code. The "type of information" field will be coded to "undefined."
- After receipt of the Associated Code Sequence code to prompt for entry of the Account Code. The "type of information" field will be coded to "undefined."
- After receipt of the remote DN address digits to prompt for entry of the ATH code when the base DN’s Facility Restriction Level (FRL) is insufficient or for an AMA/MDR Restricted Authorization Code call. The "type of information" field will be coded to "authorization code."
- After receipt of the remote DN address digits to prompt for entry of the ACCT code for an AMA/MDR restricted Account Code call. The "type of information" field will be coded to "undefined."
- After receipt of any access code (that is, PFA/ARS/ACCT, or ATH) to prompt for entry of the ATH code when the base station DN is defined as Dialing Plan Access Treatment (DPAT) Restricted from dialing that access code without an ATH code. The "type of information" field will be coded to "authorization code."

See also Items 6 and 7, which specify the required "serial" IR procedures when multiple IR procedures are involved, and the restriction on multiple FI procedures.

6. With the CFPF feature, the *5ESS* switch will support only "serial" Information Request (IR) procedures; each IR procedure supported by the CFPF feature will not be "nested" within the original CFPF IR procedure or within any IR procedure initiated before it. For this reason, the following message sequence occurs to prevent "nested" IR procedures:

   A. An Information Request IE with an Information Request Indicator value of "prompt for additional information" is sent from the switch to the CPE in either an INFOrmation or a SETUP ACKnowledge message.

   B. An INFOrmation message or multiple INFOrmation messages are sent from the CPE to the switch, containing the PFA/ARS/ACCT or ATH access codes digits in the Key-Pad IE or Called Party IE, or in a PFA/ARS/ACCT/ATH feature identifier.

C. Immediately following the previously mentioned INFOrmation message, the switch sends an INFOrmation message including an Information Request IE with an Information Request Indicator value of "Information request completed" to close the IR procedure initiated in Step A.

D. An Information Request IE (initiated by the PFA/ARS/ACCT/ATH feature request) with an Information Request Indicator value of "prompt for additional information" is sent from the switch in an INFOrmation message.

7. With the CFPF feature, only one Feature Button lamp, the CFPF feature lamp (assuming it is provisioned), will be in the "prompt" state during the entire CFPF activation procedure. As soon as the first Feature Indication (FI) IE (the CFPF FI IE) with a feature status of "prompt" is sent, all subsequent Feature Indication IEs will be suppressed. As a result, when the switch sends any subsequent INFOrmation message (as indicated in Step D of Item 6 of the preceding list) with an Information Request IE IR Indicator value of "prompt for additional information," that INFOrmation message will not include a Feature Indication IE with a feature status of "prompt" when the previous CFPF Feature Indicator status value is still in the "prompt" state.

   If there is no CFPF lamp provisioned on the CPE, then no FI IEs will be sent, and thus, no feature lamps will ever be in the "prompt" or "active" state, during the entire CFPF activation procedure.

   This condition is applicable only when either an ARS or an AUTH dial access code or feature button is dialed or pressed (and either an ARS or an AUTH feature lamp is provisioned on the CPE) during a CFPF activation where a CFPF lamp is also provisioned on the CPE. Neither the PFA nor the ACCT features support feature lamps.

8. The CFPF Message Flow Diagrams (Figures 5.2.1-13, 5.2.1-14, 5.2.1-15, 5.2.1-16, 5.2.1-17, and 5.2.1-18) give some simplified examples of CFPF activation procedures. Specific Account Code, Authorization Code and Modular Queuing interactions are not shown. See Table 5.2.1-3 for the full range of possible activation call scenarios.

Table 5.2.1-3 — CFPF Activation Call Scenarios

CFPF ACTIVATION - PFA ACCESS CODE
CFPF act + [ACCT use] + [ACCT CODE] + [ATH use] + [ATH CODE] + PFA access + DN (C_TONE)
CFPF act + [ATH use] + [ATH CODE] + [ACCT use] + [ACCT CODE] + PFA access + DN (C_TONE)
CFPF ACTIVATION - PFA ACCESS CODE (WITH QUEUING)
CFPF act + [ACCT use] + [ACCT CODE] + [ATH use] + [ATH CODE] + PFAQ access + DN (C_TONE) + [OHQ]
CFPF act + [ATH use] + [ATH CODE] + [ACCT use] + [ACCT CODE] + PFAQ access + DN (C_TONE) + [OHQ]
CFPF act + [ACCT use] + [ACCT CODE] + [ATH use] + [ATH CODE] + PFAQ access + DN (C_TONE) + [RBQ]
CFPF act + [ATH use] + [ATH CODE] + [ACCT use] + [ACCT CODE] + PFAQ access + DN (C_TONE) + [RBQ]
CFPF ACTIVATION - ARS ACCESS CODE
CFPF act + ARS access + [lead ACCT] + [ACCT CODE] + DN + [ATH prompt] + [ATH CODE] (C_TONE)
CFPF act + [ACCT use] + [ACCT CODE] + ARS access + DN + [ATH prompt] + [ATH CODE] (C_TONE)
CFPF act + [ACCT use] + [ACCT CODE] + [ATH use] + [ATH CODE] + ARS access + DN (C_TONE)
CFPF act + [ATH use] + [ATH CODE] + [ACCT use] + [ACCT CODE] + ARS access + DN (C_TONE)
CFPF act + ARS access + [lead ACCT] + [ACCT CODE] + DN + [ATH prompt] + [ATH CODE] (C_TONE) + [OHQ]
CFPF act + [ACCT use] + [ACCT CODE] + ARS access + DN + [ATH prompt] + [ATH CODE] (C_TONE) + [OHQ]
CFPF act + [ACCT use] + [ACCT CODE] + [ATH use] + [ATH CODE] + ARS access + DN (C_TONE) + [OHQ]
CFPF act + [ATH use] + [ATH CODE] + [ACCT use] + [ACCT CODE] + ARS access + DN (C_TONE) + [OHQ]
CFPF act + ARS access + [lead ACCT] + [ACCT CODE] + DN + [ATH prompt] + [ATH CODE] (C_TONE) + [RBQ]
CFPF act + [ACCT use] + [ACCT CODE] + ARS access + DN + [ATH prompt] + [ATH CODE] (C_TONE) + [RBQ]
CFPF act + [ACCT use] + [ACCT CODE] + [ATH use] + [ATH CODE] + ARS access + DN (C_TONE) + [RBQ]
CFPF act + [ATH use] + [ATH CODE] + [ACCT use] + [ACCT CODE] + ARS access + DN (C_TONE) + [RBQ]
CFPF ACTIVATION - Auto-ARS
auto-ARS + CFPF act + [lead ACCT] + [ACCT CODE] + DN + [ATH prompt] + [ATH CODE] (C_TONE) + [OHQ]
auto-ARS + CFPF act + [lead ACCT] + [ACCT CODE] + DN + [ATH prompt] + [ATH CODE] (C_TONE) + [RBQ]
KEY: ACCT use = Account Code use code (or Feature Button) ACCT CODE = Account Code (or Feature Button) ARS ACCESS = Automatic Route Selection use code (or Feature Button) auto-ARS = Automatic Route Selection - auto entry ATH use = Authorization Code use code (or Feature Button) ATH CODE = Authorization Code (or Feature Button) C_TONE = Confirmation Tone CFPF act = CFPF Activation Code (or Feature Button) DN = Directory Number lead ACCT = lead Account Code Digit (or Feature Button) OHQ = Off-Hook Queuing (Routine or Priority) PFA Access = PFA Access Code (or Feature Button) PFAQ Access = PFA Queuing Access Code (or Feature Button) RBQ = Ring-back Queuing

USER	MESSAGE	NETWORK
User originates Call	SETUP →	
	← SETUP ACK (SIGNAL=DT, PI=8)	Network provides dial tone
User sends Call Forward All Calls digit	INFO (KP=digit) →	
	← INFO (SIGNAL=tones off)	Network removes dial tone
User sends remaining Call Forward All Calls code	INFO (KP=digit) →	
	⋮	
	INFO (KP=digit) →	
	← INFO (SIGNAL=Recall DT, Info Request=prompt, [FI status=prompt], PI=8)	Network detects end-of-dialing, Suppl. Info required Recall dial tone provided
User sends Forward-to No.	INFO (KP=digit) →	
	← INFO (SIGNAL=tones off)	Network removes recall dial tone
	INFO (KP=digit) →	
	⋮	
User completes Forward-to No.	INFO (KP=digit) →	
	← INFO (Info. Req=complete)	Network detects end-of-dialing
	← INFO (FI=CF, status=pending or active)*	Feature Lamp is Lit for CDDNC/CDDN
		Courtesy Call Established
	← CALL PROC	Answer Required (CDDNCA)
	OR	OR
	← CALL PROC (SIGNAL=conf. tone on, PI=8, Display)	No Answer Required (CDDNC or CDDNCA when Remote DN within same terminal group); network plays confirmation tone
	COURTESY CALL	
	OR	
		No Courtesy Call Established
	← PROG (SIGNAL=conf. tone on, PI=8, Display)	Confirmation tone (ACTYP CDDN)
	← DISC	
	REL →	Network Initiates Call Clearing
	← REL COM	

*Assume that there is an associated I-CF Feature Button (that is, FI) with the CFAC Code. Feature Status (Feature Indication IE) will be provided in an INFOrmation message prior to the CALL PROCeeding CONNect, and call clearing messages.

Figure 5.2.1-3 — ISDN Call Forwarding Activation (Dial Access) (CSV)

USER	MESSAGE	NETWORK
User originates Call	SETUP →	
	← SETUP ACK (SIGNAL=DT, PI=8)	Network provides dial tone
User sends feature identifier	INFO (FA=CF) →	Network detects end-of-dialing
	← INFO (SIGNAL=Recall DT, Info Request=prompt, PI=8, FI=CF, FI status=prompt)	Suppl. Info required Recall dial tone provided
User sends forward-to No.	INFO (KP=digit) →	
	← INFO (SIGNAL=tones off)	Network removes recall dial tone
	INFO (KP=digit) →	
	• • •	
User completes forward-to No.	INFO (KP=digit) →	
	← INFO (Info Req.=complete)	Network detects end-of-dialing
		Courtesy call Established
	← INFO (FI=CF, pending)	Answer Required (CDDNC)
	← CALL PROC	
	OR	OR
	← INFO (FI=CF, active)	No Answer Required (CDDNC, or CDDNCA when Remote DN within same terminal group); network plays confirmation tone
	← CALL PROC (SIGNAL=conf. tone on, PI=8, Display)	
	Courtesy Call	
	OR	
		No Courtesy Call Established (CDDN)
	← INFO (FI=CF, active)	
	← PROG (SIGNAL=conf. tone on, PI=8, Display)	Confirmation tone
	← DISC	Network Initiates call clearing
	REL →	
	← REL COM	

Figure 5.2.1-4 — ISDN Call Forwarding Activation (Feature Button) (CSV)

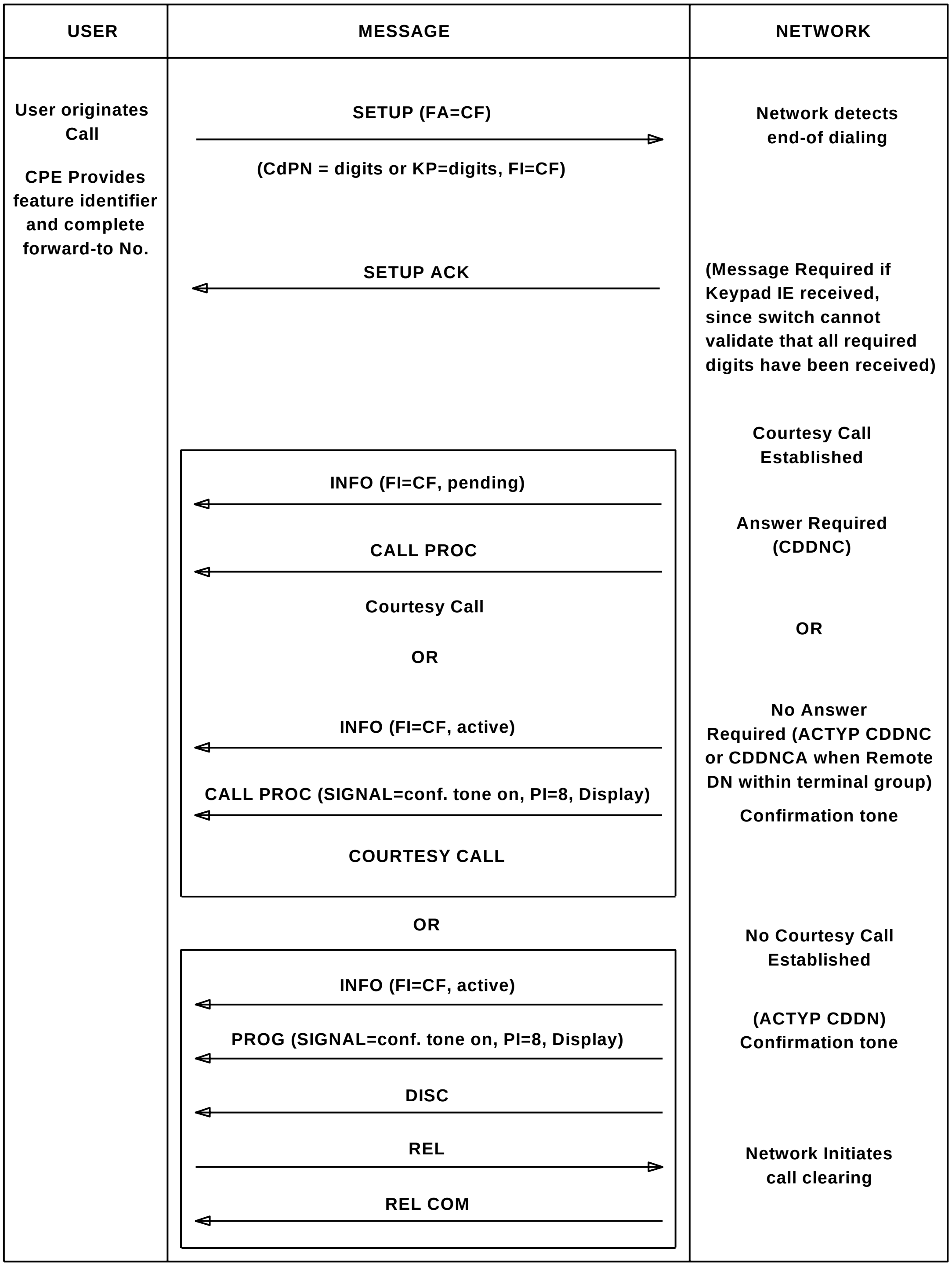
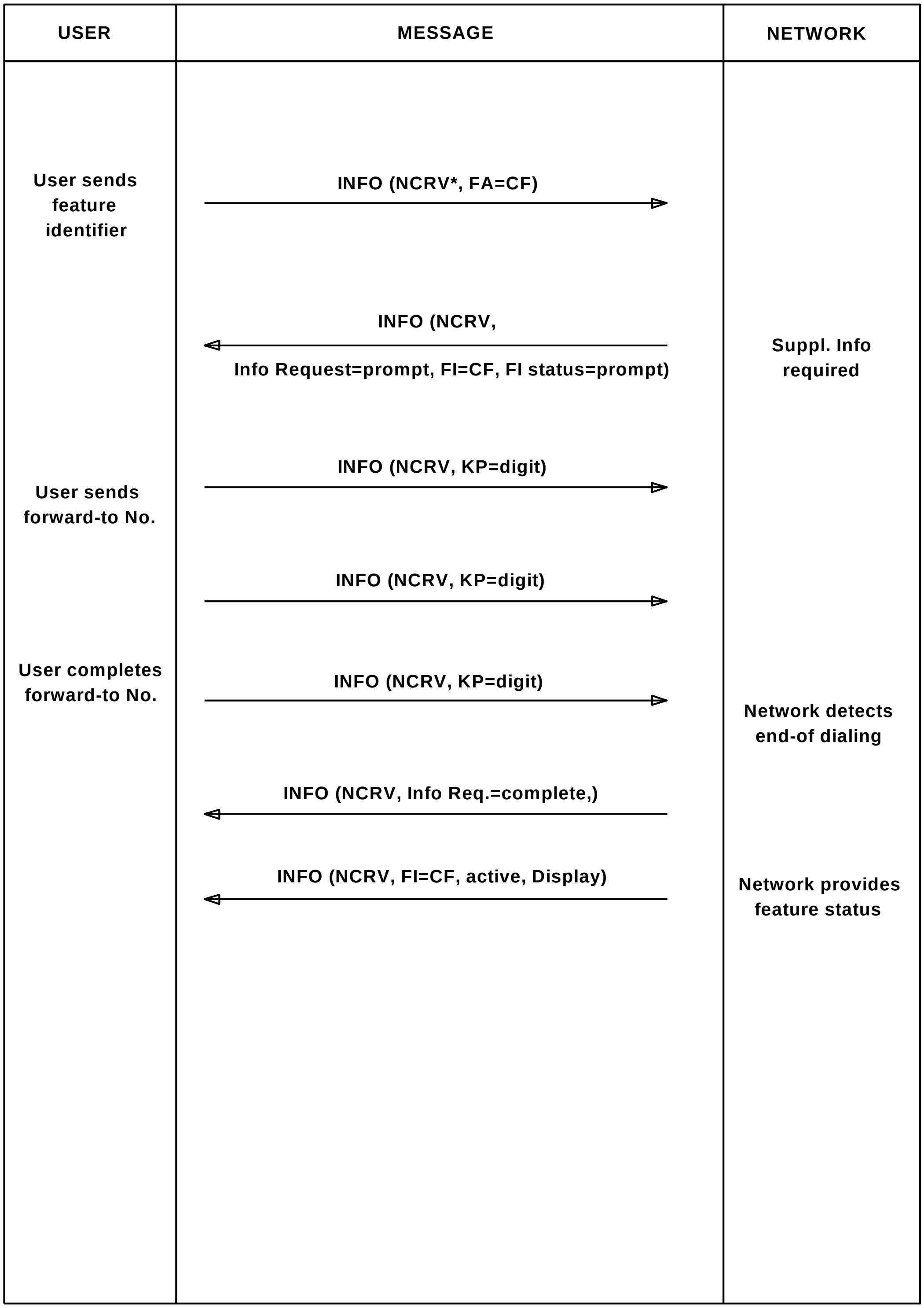


Figure 5.2.1-5 — ISDN Call Forwarding Activation (Feature Button)—Single En-Bloc Sequence (CSV)



*NCRV=Null Call Reference Value

Figure 5.2.1-6 — ISDN Call Forwarding Activation (Feature Button)—Outside the Context of a Call

USER	MESSAGE	NETWORK
	ALERT (SIGNAL=Ring-back) ←	Network provides audible ringing to User
	INFO (CF status=Active)* ←	Call Answered
	CONN ←	Network provides activation to lead terminal in EKTS group
	OR	
	INFO (CF status=idle)* ←	Courtesy call continuously rings or fails (e.g. busy) Network initiates call clearing and starts 2-minute timer
	OR	
	PROG (Tone-User Busy) ←	
	DISC (SIGNAL=DT) ←	
	(START 2 MINUTE TIMER)	
User initiates same request before 2-minute Timeout	SETUP →	Stop 2-Minute Timer Network activates feature
User dials CFAC or Feature identifier and provides forward-to DN	Switch collects CFAC/feature identifier in INFO messages, returns Info. Req. procedures and forward-to DN information in INFO messages	Functions like CDDN Activation
	INFO (Info Request=complete, CF status=active)* ←	
	PROG (SIGNAL=conf. tone on, PI=8) ←	
	DISC ←	Network initiates call clearing
	REL →	
	REL COM ←	

*Feature Status (Feature Indication IE) will be provided in an INFOrmation message prior to the Call PROCeeding, CONNect and call clearing messages.

Figure 5.2.1-7 — ISDN Call Forwarding Activation Courtesy Call (Answer Required) (1 of 2)

USER	MESSAGE	NETWORK
	OR	
	INFO (CF status=idle)* ←	Courtesy Call failed
	DISC (SIGNAL=DT) ←	Network initiates call clearing
	(START 2-MINUTE TIMER)	Network starts 2-Minute Timer
	SETUP →	Stop 2-Minute Timer
User Initiates different request (enters different remote DN) before 2-minute timeout	Switch collects CFAC/feature identifier in INFO messages, returns Info. Req. procedures, and collects forward-to DN in INFO messages	
	← INFO (SIGNAL=Ring-back CF status = Pending)*	Network proceeds as new attempt courtesy call required
	← CALL PROC Courtesy Call	
	18OR	Courtesy Call failed
	INFO (CF status=idle)* ←	Network initiates call clearing and starts 2-Minute Timer
	DISC ←	
	(START 2-MINUTE TIMER) • • •	
	2-MINUTE TIME-OUT	Timer Expires
User initiates request after 2-minute timeout	SETUP →	Network proceeds as new attempt courtesy call required
	← INFO (SIGNAL=Ring-back CF status = Pending)*	

*Feature Status (Feature Indication IE) will be provided in an INFOrmation message prior to the Call PROCeeding CONNect and call clearing messages.

Figure 5.2.1-7 — ISDN Call Forwarding Activation Courtesy Call (Answer Required) (2 of 2)

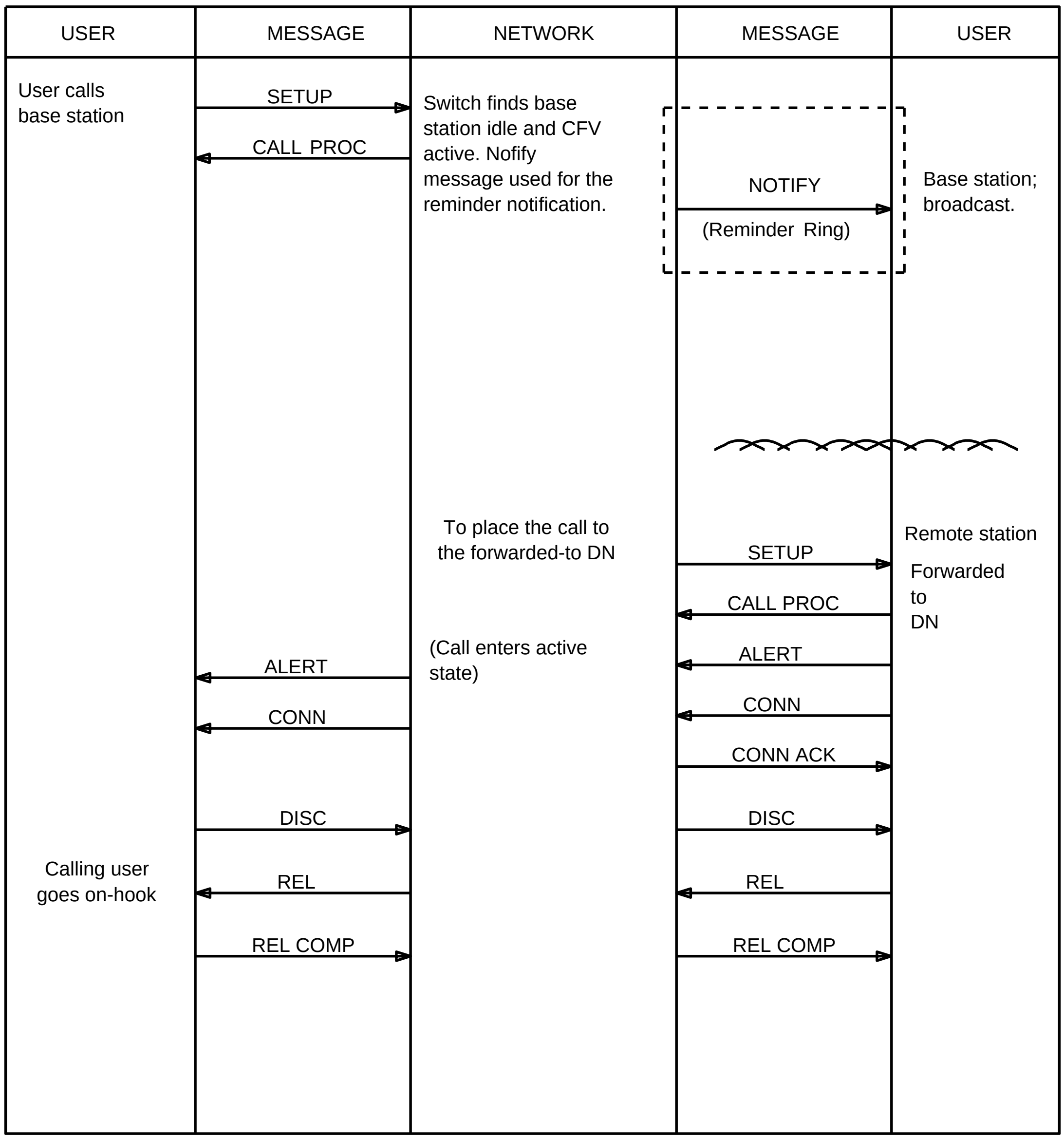


Figure 5.2.1-8 — ISDN Call Forwarding Variable (Terminating)

ORIG. USER	MESSAGE	NETWORK	MESSAGE	USER
USER ORIGINATES CALL	SETUP →	NETWORK PROVIDES DIAL TONE		
	← SETUP ACK (SIG=DT, PI=8)			
USER SENDS BASE DN	INFO (kp=digit) →			
	← INFO (SIG=TONES OFF)			
USER SENDS REMAINING DIGITS	INFO (kp=digit) → . . .	NETWORK REMOVES DIAL TONE		
	INFO (kp=digit) →	NETWORK DETECTS END OF DIALING		
	← CALL PROCEEDING	START CF-T2 (DON'T ANSWER TIMER)	SETUP →	BASE USER
			← CALL PROCEEDING	
			← ALERTing	
ORIG. USER RECEIVES ALERTING	← ALERTing (SIG=Ringback)	NETWORK RETURNS AUDIBLE RING		
		CF-T2 TIMER EXPIRES		
		NETWORK INITIATES CLEARING TO BASE USER	RELease →	BASE USER
			← RELease COMplete	
		NETWORK FORWARDS CALL TO REMOTE DN	"NETWORK SETUP" →	REMOTE USER
			SETUP (Display) →	
			CALL PROCEEDING	
			← ALERTing	
ORIG. USER CONNECTED TO REMOTE DN	← CONNECT	MESSAGE PASSED TO ORIG. USER	← CONNECT (FI = active)	CONNECTION TO REMOTE DN CALL COMPLETED

Figure 5.2.1-9 — ISDN Call Forwarding Don't Answer—CSV and CSD Forwarding to Nonbusy Remote DN—Intraswitch or Interswitch

ORIG. USER	MESSAGE	NETWORK	MESSAGE	USER
USER ORIGINATES CALL	SETUP →	NETWORK PROVIDES DIAL TONE		
	← SETUP ACK (SIG=DT, PI=8)			
USER SENDS BASE DN	INFO (kp=digit) →	NETWORK REMOVES DIAL TONE		
	← INFO (SIG=TONES OFF)			
USER SENDS REMAINING DIGITS	INFO (kp=digit) → . . .	NETWORK DETECTS END OF DIALING		
	INFO (kp=digit) →			
	← CALL PROCEEDING	START CF-T2 (DON'T ANSWER TIMER)	SETUP →	BASE USER
		NETWORK RETURNS CALL TERM. TREATMENT TO ORIG USER	← CALL PROCEEDING	
			← ALERT (SIG=Ringback)	
	← ALERT (SIG=Ringback)	CF-T2 TIMER EXPIRES		
		NETWORK BEGINS CALL CLEARING TO BASE USER	RELease →	BASE USER
			← RELease COMplete	
USER CONTINUES TO HEAR ALERTING		NETWORK FORWARDS CALL TO REMOTE DN		
		NETWORK DETERMINES REMOTE DN BUSY OR SCREENING FAILS	"NETWORK SETUP" →	REMOTE USER
			← "NETWORK RELEASE" CAUSE VALUE = "USER BUSY"	
		NET. CONTINUES TO RETURN SAME TERM. TREATMENT TO ORIG. USER		
		NETWORK AWAITS FOR USER ABANDONMENT		
ORIG. USER ABANDONS	DISConnect →			
	← RELease			
	RELease COMplete →			

Figure 5.2.1-10 — ISDN Call Forwarding Don't Answer—CSV Remote DN Busy or Remote DN Fails I-CFDA Screening

ORIG. USER	MESSAGE	NETWORK	MESSAGE	USER
USER ORIGINATES CALL	SETUP →	NETWORK PROVIDES DIAL TONE		
	← SETUP ACK (SIG=DT, PI=8)			
USER SENDS BASE DN	INFO (kp=digit) →			
	← INFO (SIG=TONES OFF)			
USER SENDS REMAINING DIGITS	INFO (kp=digit) →	NETWORK REMOVES DIAL TONE		
	. . .			
	INFO (kp=digit) →	NETWORK DETECTS END OF DIALING		
	← CALL PROCEEDING	START CF-T2 (DON'T ANSWER TIMER)	SETUP →	BASE USER
			← CALL PROCEEDING	
			← ALERTing	
	← ALERTing (SIG=Ringback)	NETWORK RETURNS AUDIBLE RING		
		CF-T2 TIMER EXPIRES		
		NETWORK INITIATES CLEARING TO BASE USER	RELease →	BASE USER
			← RELease COMplete	
		NETWORK FORWARDS CALL TO REMOTE DN	"NETWORK SETUP" →	REMOTE USER
ORIG. USER RECEIVES BUSY TONE FROM REMOTE SWITCH			← "NETWORK RELEASE" CAUSE VALUE = "USER BUSY"	

Figure 5.2.1-11 — ISDN Call Forwarding Don't Answer—CSV Forwarding to Busy Remote DN—Interswitch/Non-CCS

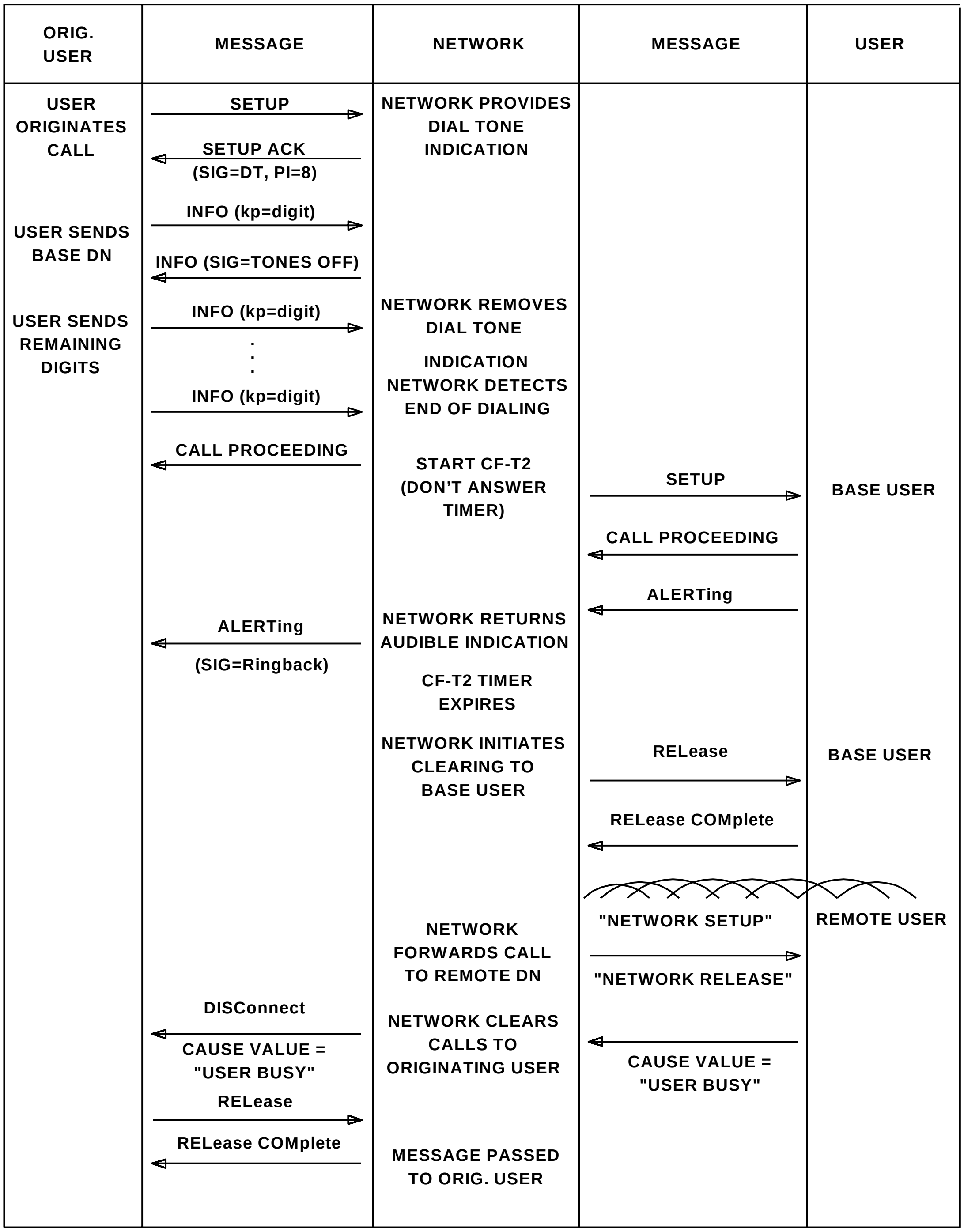


Figure 5.2.1-12 — ISDN Call Forwarding Don't Answer—CSD Forwarding to Busy Remote DN—Intraswitch or Interswitch with CCS

USER	MESSAGE	NETWORK
User originates Call Reference	SETUP (CRV=1) →	
	← SETUP ACK (CRV=1, SIGNAL=DT, PI=8)	Network provides Dial tone
User sends CFAC digit	INFO (CRV=1, KP=digit) →	
	← INFO (CRV=1, SIGNAL=tones off)	Network removes dial tone
User sends remaining CFAC code	⋮	
	INFO (CRV=1, KP=digit) →	Network detects end-of-dialing
	← INFO (CRV=1, SIGNAL=Recall DT, Info. Req.=prompt, [CFPF FI status=prompt],PI=8)	Suppl. info required Recall dial tone provided
User sends PFA/ARS code ACCT use, lead ACCT or ATH use	INFO (CRV=1, KP=digit) →	
	← INFO (CRV=1, SIGNAL=tones off)	
	⋮	
	INFO (CRV=1, KP=digit) →	
	← INFO (CRV=1, Info. Req=complete)	
	← INFO (CRV=1, SIGNAL=Recall DT, Info.Req.=prompt, PI=8)	Suppl. info required Recall dial tone provided
User sends Forward-to No.	INFO (CRV=1, KP=digit) →	Network removes recall dial tone
	← INFO (CRV=1, SIGNAL=tones off)	
	INFO (CRV=1, KP=digit) →	
User completes Forward-to No.	⋮	
	INFO (CRV=1, KP=digit) →	Network detects end-of-dialing
	← INFO (CRV=1, Info. Req=complete)	
	← INFO (CRV=1, CFPF FI status=active)* CFPF Feat. Id.=BN#	CFPF Feature Lamp is Lit
	← CALL PROC (CRV=1, SIGNAL=conf. tone on, PI=8) Courtesy Call	Courtesy Call Established If No Answer **Required** (ACTYP CDDNC) Confirmation tone.
	OR	
	← PROG (CRV=1, SIGNAL=conf. tone on, PI=8)	No Courtesy Call Established (ACTYP CDDN) Confirmation tone.
	← DISC (CRV=1)	
	REL (CRV=1) →	
	← REL COM (CRV=1)	Network Initiates Call Clearing

(Network provided tones and announcements apply.)

*Note: Assuming that there is an associated CFPF Feature Button (i.e., Feat.Id) with the Access Code CFPF Feature Status (Feature Indication IE) will be provided in an INFOrmation message prior to the CALL PROCeeding CONNect, and call clearing messages as per the resolution to PDA Issues 215,216,219 and 220.

Figure 5.2.1-13 — CSV CFPF Activation (Dial Access); Total Overlap Sequence

USER	MESSAGE	NETWORK
User originates Call Reference Complete CFAC code provided	SETUP (CRV=1, KP=digits) →	
	← SETUP ACK (CRV=1, SIGNAL=Recall DT, Info Req.=prompt, [CFPF FI status=prompt],PI=8)	Suppl. info required Recall dial tone provided
Complete PFA/ ARS Code provided	INFO (CRV=1, KP=digits or CdPN=digits) →	
	← INFO (CRV=1, SIGNAL=tones off)	Network removes dial tone
	← INFO (CRV=1, Info Req=complete)	Network detects end-of-dialing
	← INFO (CRV=1, SIGNAL=Recall DT, PI=8) (Info. Req.=prompt)	Suppl. info required Recall dial tone provided
User provides complete forward-to No.	INFO (CRV=1, KP=digits or CdPN=digits) →	
	← INFO (CRV=1, SIGNAL=tones off)	Network removes dial tone
	← INFO (CRV=1, Info Req=complete)	
	← INFO (CRV=1, CFPF FI status=active)* CFPF Feat. Id. =BN#	CFPF Feature Lamp is Lit
	← CALL PROC (CRV=1, SIGNAL=conf. tone on, PI=8) Courtesy Call	Courtesy call Established If No Answer Required (CDDNC) Confirmation tone.
	OR	
	← PROG (CRV=1, SIGNAL=conf. tone on, PI=8)	No Courtesy Call Established Confirmation tone. (ACTYP CDDN)
	← DISC (CRV=1)	
	REL (CRV=1) →	Network Initiates call clearing
	← REL COM (CRV=1)	

(Network provided tones and announcements apply.)

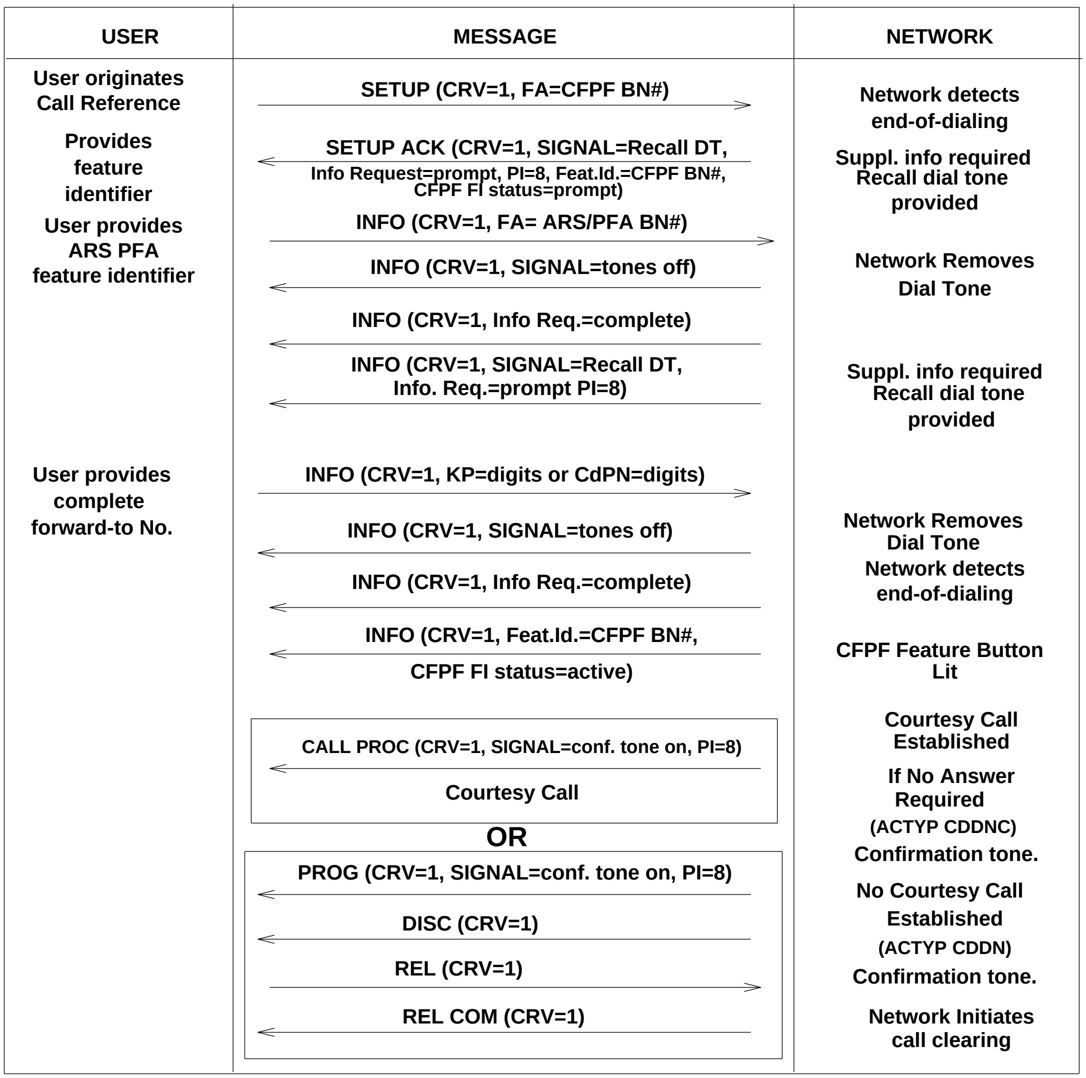
*Note: Assuming there is an CFPF Feature Button associated with the Access Code. Feature Status (CFPF Feature Indication IE) will be provided in an INFOrmation message prior to the CALL PROCeeding, CONNect, and call clearing messages as per the resolution to PDA Issues 215, 216, 219 and 220.

Figure 5.2.1-14 — CSV CFPF Activation (Dial Access); Total En-Bloc Sequence

USER	MESSAGE	NETWORK
User originates Call Reference	← SETUP (CRV=1)	
	← SETUP ACK (CRV=1, SIGNAL=DT, PI=8)	Network provides Dial tone
User sends CFPF feature identifier	INFO (CRV=1, FA=CFPF BN#) →	
	← INFO (CRV=1, SIGNAL=tones off)	Network removes recall dial tone
	← INFO (CRV=1, SIGNAL=Recall DT, Info. Req.=prompt, PI=8, Feat. Id.= CFPF BN#, CFPF FI status=prompt)	Suppl. info required Recall dial tone provided
User sends ARS/PFA feature identifier	INFO (CRV=1, FA=ARS/PFA BN#) →	
	← INFO (CRV=1, SIGNAL=tones off)	Network removes recall dial tone
	← INFO (CRV=1, Info Req.=complete)	
	← INFO (CRV=1, SIGNAL=Recall DT, Info Req.=prompt, PI=8)	Suppl. info required Recall dial tone provided
User sends forward-to No.	INFO (CRV=1, KP=digit) →	
	← INFO (CRV=1, SIGNAL=tones off)	Network removes recall dial tone
	INFO (CRV=1, KP=digit) →	
	⋮	
User completes forward-to No.	INFO (CRV=1, KP=digit) →	Network detects end-of-dialing
	← INFO (CRV=1, Info Req.=complete)	
	← INFO (CRV=1, Feat. Id.=CFPF BN#, CFPF FI status=active)	CFPF Feature Lamp Lit
	← CALL PROC (CRV=1, SIGNAL=conf.tone on, PI=8) Courtesy Call	Courtesy call Established Confirmation tone.
	OR	
	← PROG (CRV=1, SIGNAL=conf. tone on, PI=8)	No Courtesy Call Established (ACTYP CDDN) Confirmation tone.
	← DISC (CRV=1)	
	REL (CRV=1) →	Network Initiates call clearing
	← REL COM (CRV=1)	

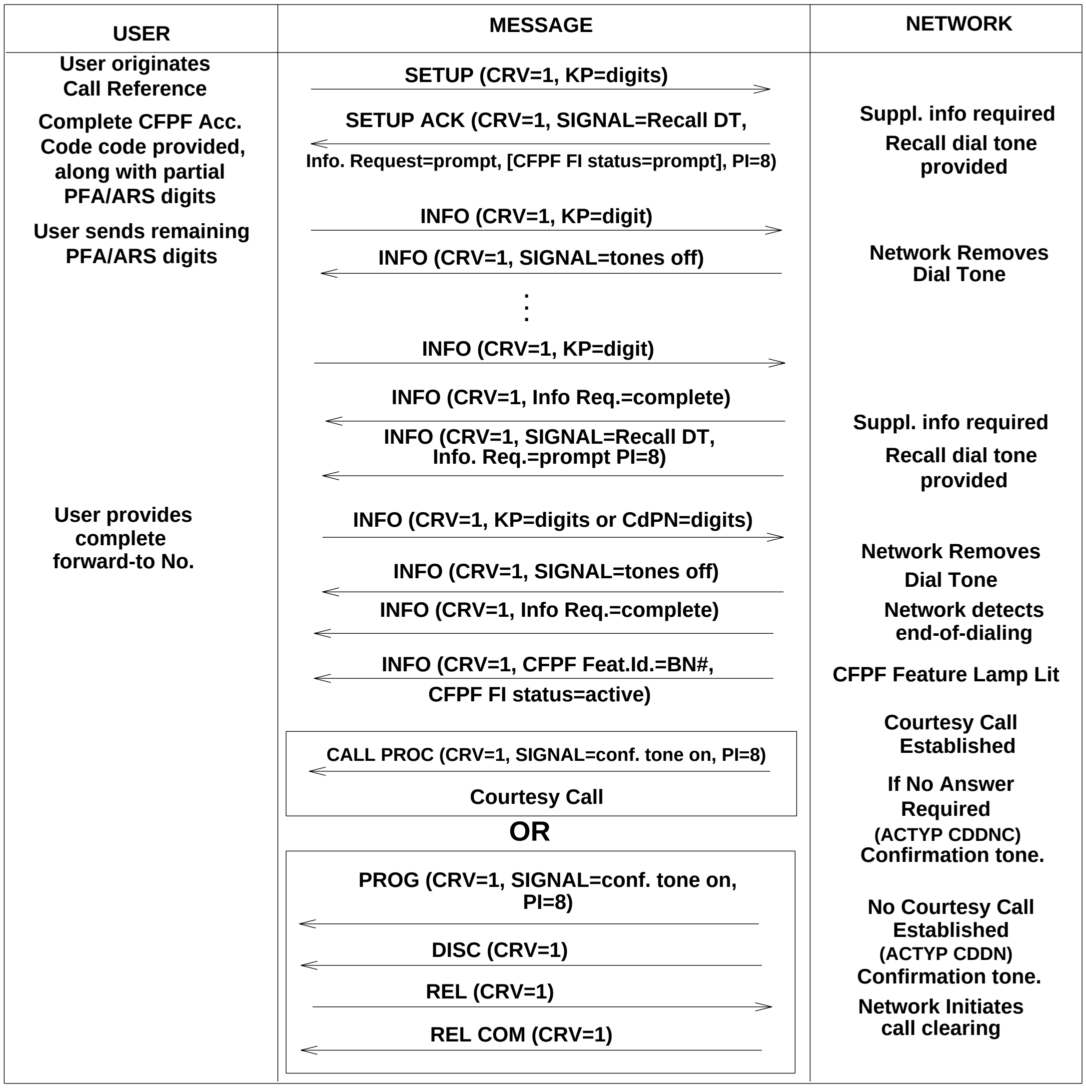
(Network provided tones and announcements apply.)

Figure 5.2.1-15 — CSV CFPF Activation (Feature Button); Total Overlap Sequence



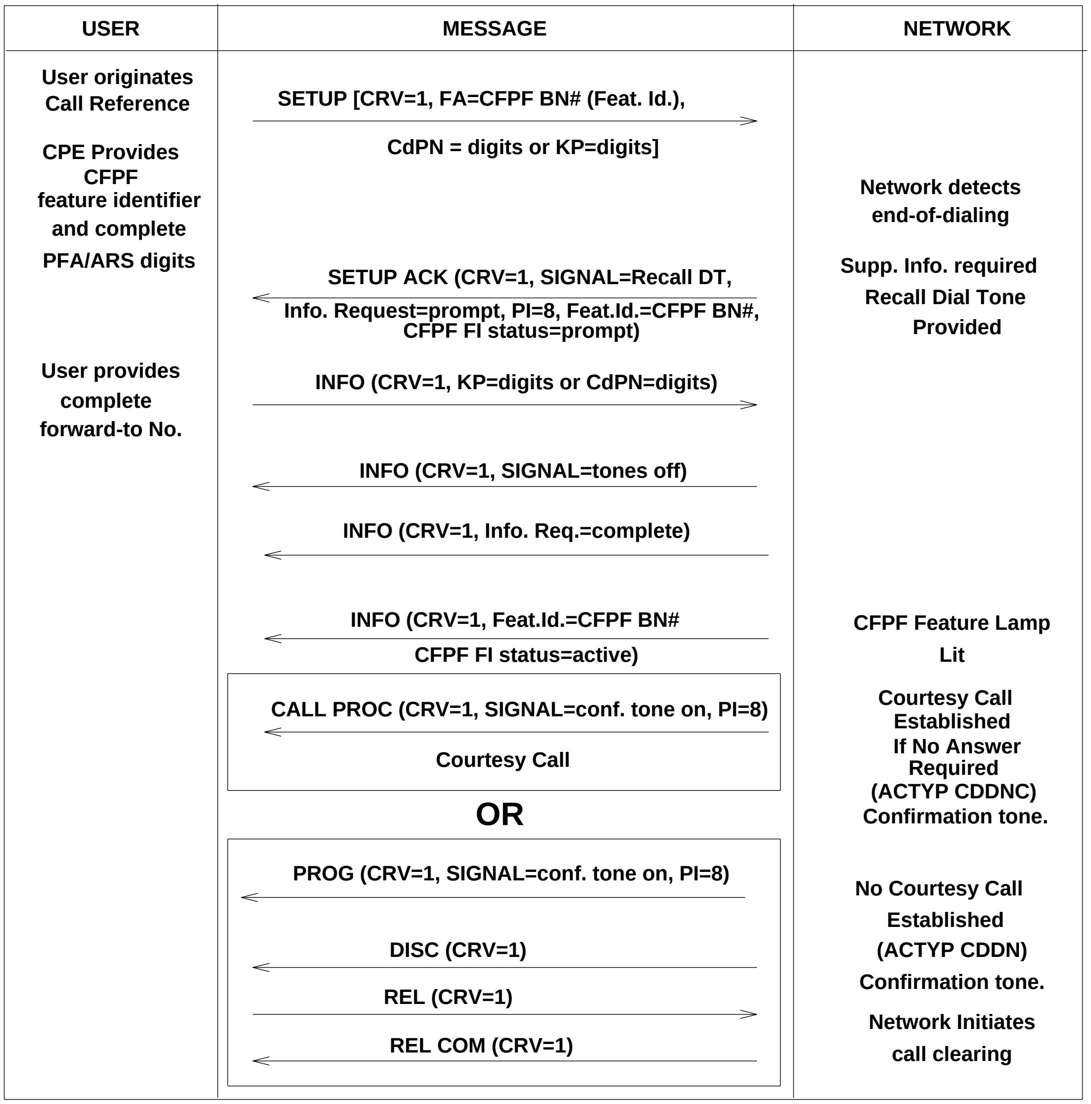
(Network provided tones and announcements apply.)

Figure 5.2.1-16 — CFPF Activation (Feature Button); Total En-Bloc Sequence



(Network provided tones and announcements apply.)

Figure 5.2.1-17 — CFPF Activation (Dial Access); En-Bloc, Overlap, En-Bloc Sequence



(Network provided tones and announcements apply.)

Figure 5.2.1-18 — CFPF Activation (Feature Button); Dual En-Bloc Sequence

5.2.1.12 Call Hold

5.2.1.12.1 Definition

A call is on hold when the network has made the B-channel associated with that call available for originating or answering another call at the invoking terminal. Following a hold operation, the B-channel is not in use, but it is reserved for that terminal. The held call remains available within the network and can be reconnected. All ISDN lines have the Call Hold feature assigned.

Music on Hold is available as a special feature.

5.2.1.12.2 Feature Control Procedures

To place a call on hold, the terminal sends a HOLD message to the network with the Call Reference of the call to be held. If the terminal receives a HOLD ACKnowledge message in reply, then the call has been placed on hold. If the terminal receives a HOLD REJect message, then the network has not placed the call on hold.

When a call is placed on hold, the network reserves a B-channel for subsequent activity for that particular terminal (for example, to answer an incoming call or originate a new outgoing call). Channel reservation guarantees that a terminal placing a call on Hold will have a B-channel available to reconnect to the held call.

To retrieve a call from hold, the terminal will send the network a RETrieve message containing the Call Reference of the held call to be retrieved. If the terminal receives a RETrieve ACKnowledge message, then the call has been retrieved. The RETrieve ACKnowledge message will contain a Channel Identification information element indicating the B-channel to be used. The terminal must not connect to the B-channel until this RETrieve ACKnowledge message is received. A held call can be retrieved with any B-channel (not necessary to be the one the call is put hold against). After receiving the RETrieve message, the switch should select a B-channel for the call as follows:

1. If the user exclusively requests a B-channel to reconnect the call, the retrieve request will be honored if the requested B-channel is available (that is, idle or not in-use or reserved for another terminal on the interface).
2. If the user indicates that a B-channel is preferred, the switch should select that B-channel if it is available. Otherwise, any channel will be selected.
3. If the user does not indicate exclusive or preferred, the switch will select any available B-channel.

If the terminal receives a RETrieve REJect message, then the network has *not* retrieved the call. In this case, the call remains in its current state.

If the terminal wishes to release a call on hold without retrieving it, the terminal may send the network a DISConnect (or RELease) message with the appropriate Call Reference, and standard clearing procedures (see "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2) will commence for that call. The network can initiate clearing of a held call using the appropriate clearing procedures (that is, RELease message). For example, the network may initiate clearing because of far-end disconnect (Figure 5.2.1-19). Note that the RELease message may be used to initiate clearing of calls that are not associated with any B-channel.

Figures 5.2.1-20, 5.2.1-21, and 5.2.1-22 give examples of hold procedures, using the HOLD message to place a call on hold and the RETrieve message to retrieve the call.

USER	MESSAGE	NETWORK
Call on hold (CR=1)		
	REL (CR=1) <----------------------------	
	REL COM (CR=1) ---------------------------->	

Figure 5.2.1-19 — Hold—Far-End Disconnect

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests hold of Call Reference (CR=1)	HOLD (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	. . .	
User requests return to call held with Call Reference (CR=1)	RETRIEVE (CR=1) ---------------------------->	
	RETRIEVE ACK (CR=1) <----------------------------	Network reconnects to the call

Figure 5.2.1-20 — Hold—Retrieve

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests hold of Call Reference (CR=1)	HOLD (CR=1) ----------------------------->	
	HOLD REJ (CR=1) <----------------------------	Network does not place call on hold

Figure 5.2.1-21 — Hold—Failure

USER	MESSAGE	NETWORK
Active call with Call Reference (CR=1)		
User requests hold of Call Reference (CR=1)	HOLD (CR=1) ---------------------------->	
	HOLD ACK (CR=1) <----------------------------	Network places call on hold
	. . .	
User requests return to call held on Call Reference (CR=1)	RETRIEVE (CR=1) ----------------------------> RETRIEVE REJ (CR=1) <----------------------------	Network does not reconnect call

Figure 5.2.1-22 — Hold—Retrieve Failure

5.2.1.13 Calling Name for BRI (CNAM-B)

5.2.1.13.1 Support of CNAM-B

The following CNAM-B subfeatures are supported for Circuit Switched Voice calls on National ISDN BRI lines:

- Calling Name Delivery (CNAM)
- Electronic Directory Service Calling Name Display (EDS CND)
- Name Privacy

These sub-features are applicable simultaneously to both CSV and CSD calls. That is, if CNAM or EDS CND is active for circuit-switched voice calls, it is also active for circuit-switched data calls to the subscribed DN. Name privacy may be invoked by a subscribed terminal or in a generally available environment for either a CSV or a CSD call. The CNAM-B feature is described in "Calling Name for BRI (CNAM-B) Displays," Section 5.2.2.5.

5.2.1.13.2 Feature Control Procedures

The CNAM and EDS CND sub-features may be activated or deactivated through dial code, feature buttons, recent change, or the Time of Day feature. Feature control procedures for dial code and feature button activation of Name Privacy and CNAM or EDS CND display activation/deactivation (that is, I-DF) follow the stimulus signaling procedures described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. Single feature button operation is supported for I-DF activation/deactivation.

5.2.1.14 Call Pickup Features

5.2.1.14.1 Call Pickup

Call Pickup allows a user to answer a call to another DN (Figures 5.2.1-23, 5.2.1-24, 5.2.1-25, and 5.2.1-26).

5.2.1.14.1.1 Feature Control Procedures

Invocation procedures for Call Pickup follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, and 3). When a feature request is successful, the picked-up terminal shall receive release procedures and the requesting terminal shall receive first a CALL PROCeeding message, then a CONNect message.

5.2.1.14.2 Directed Call Pickup with or without Barge-In

5.2.1.14.2.1 Definition

This feature allows the requesting DN to indicate the specific ringing DN to be picked up. Directed Call Pickup with Barge-In allows the requesting DN to bridge onto the established conversation when the terminal to be picked up has already answered the call. In this case, the network may apply a brief inband tone to the original called party and simultaneously transmit to that party an INFOrmation message with a Signal information element (barge-in tone on).

5.2.1.14.2.2 Feature Control Procedures

Invocation procedures for Directed Call Pickup features follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 4, 5, and 6). Upon a successful feature request, the requesting terminal shall receive a CALL PROCeeding message, then a CONNect message. The picked up terminal shall receive release procedures unless the terminal has already answered the call.

5.2.1.14.3 Loudspeaker Paging

5.2.1.14.3.1 Definition

This feature allows dial or feature button access to customer-owned loudspeaker paging equipment. The paged party may optionally dial an access code or press a feature button and be connected to the calling party; the paging equipment shall then be released.

5.2.1.14.3.2 Feature Control Procedures

The procedures are as follows:

a. ***Activation:*** To activate the signaling device, the terminal follows the procedures in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. (Loudspeaker paging equipment is a special type of Private Facility.)

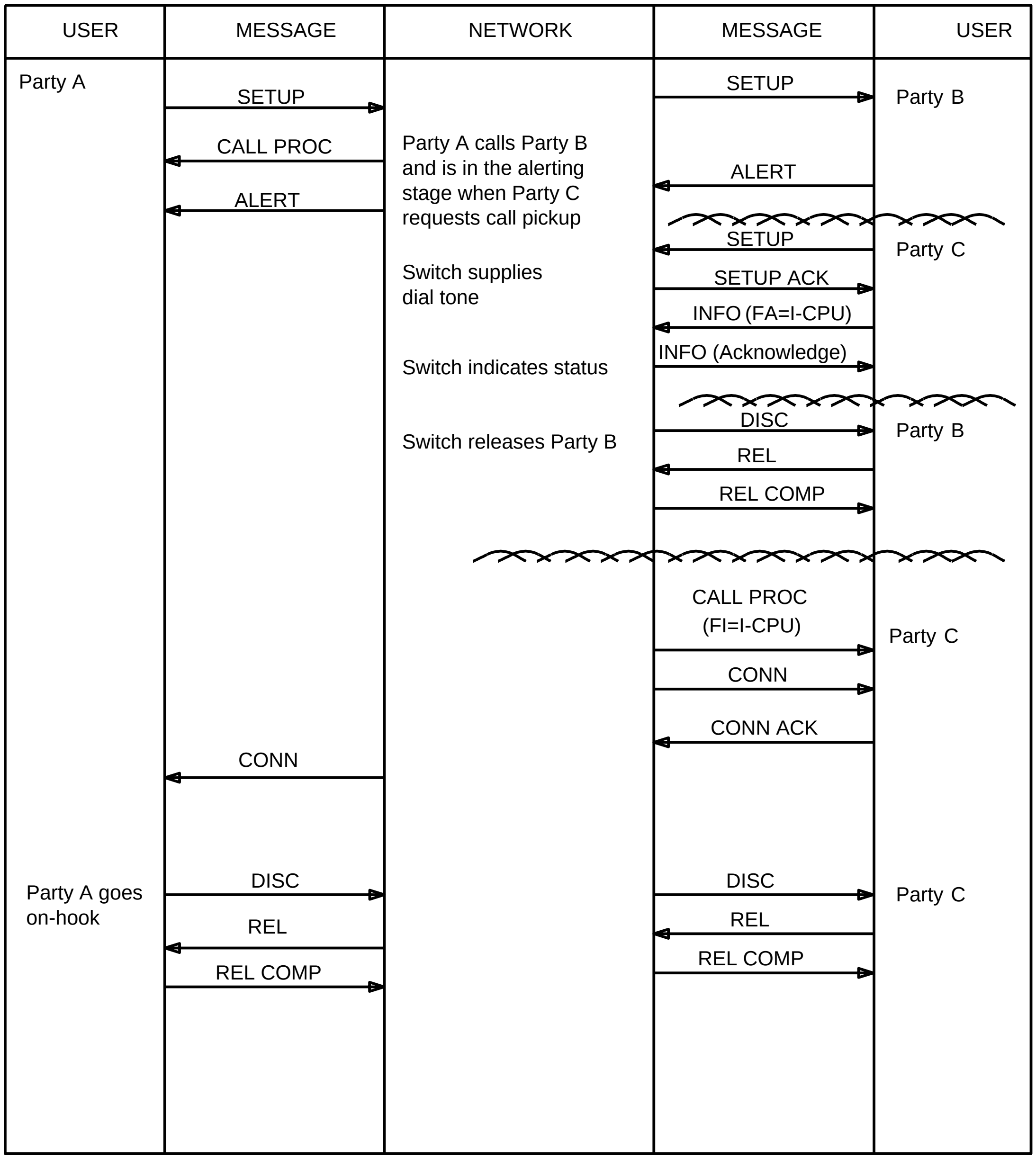
b. ***Pickup Procedures:*** This feature follows the procedures described previously in Call Pickup.

5.2.1.14.4 Code Calling

The Code Calling feature allows station users to dial an access code and a 2- or 3-digit called party code to activate signaling devices (such as bells, gongs, or horns) with a coded signal corresponding to the called code. The called party can then be connected to the calling party when the called party dials an answering code from any station with the appropriate access treatment within the customer group. Procedures for accessing this feature follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1.

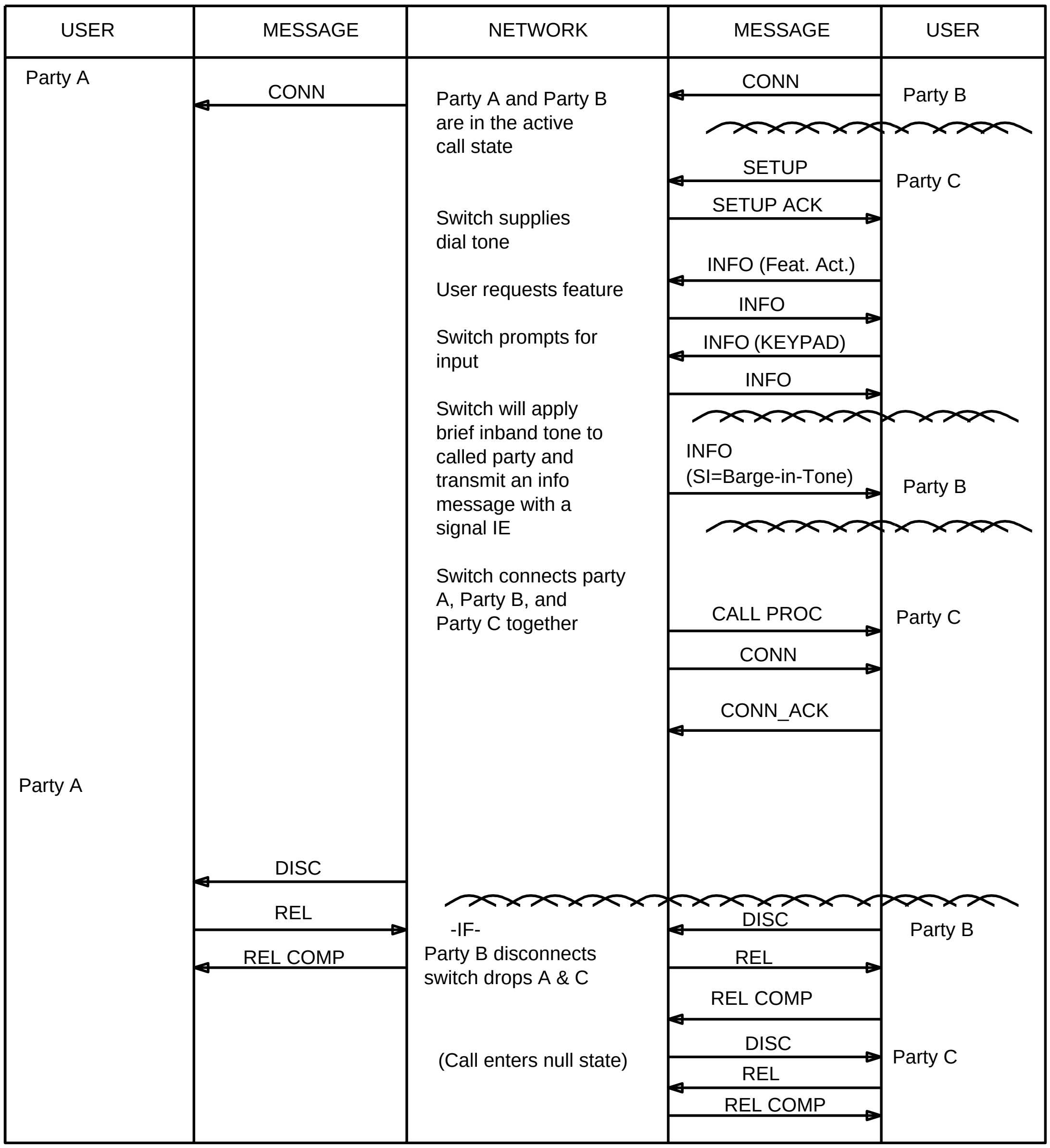
5.2.1.14.5 Trunk Answer Any Station

The Trunk Answer Any Station feature permits an individual at any business group station to dial a code and be connected to an incoming call to the listed DN. This feature is used in conjunction with night service, audible alarms, or lights to make users aware that a call has come in that needs to be answered. Procedures for accessing this feature follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1.



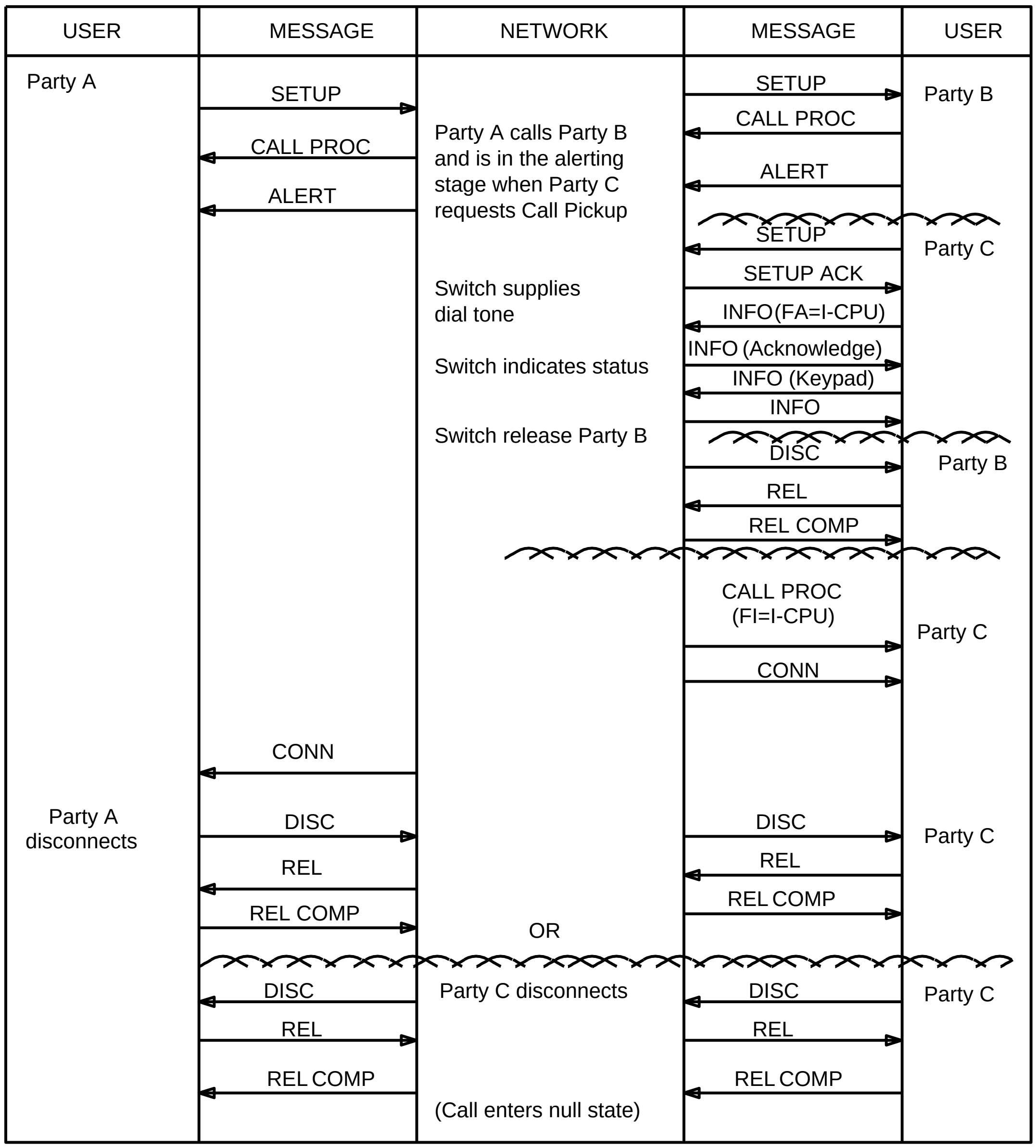
Note: Party A calls Party B. Party B is alerting. Party C is in the same pickup group as Party B and initiates Call Pickup on Party B.

Figure 5.2.1-23 — Call Pickup



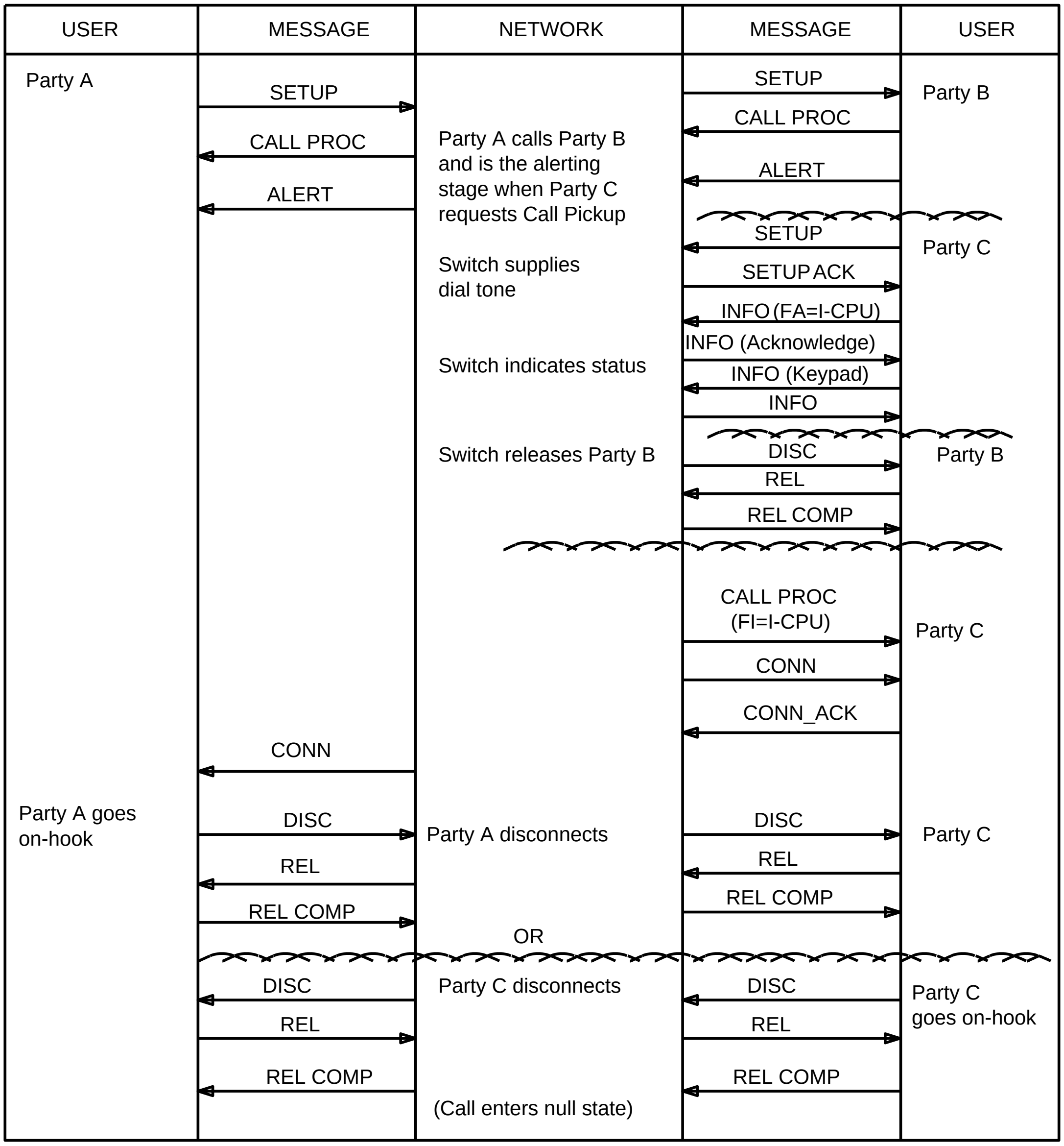
Note: Party A called Party B. Parties B and C belong to the same business group. Party C requests Directed Call Pickup with Barge-In.

Figure 5.2.1-24 — Directed Call Pickup with Barge-In (Active Call)



Note: Party A calls Party B. Party C requests Call Pickup. Parties B and C belong to the same business group.

Figure 5.2.1-25 — Directed Call Pickup with Barge-In (Ringing Call)



Note: Party A calls Party B. Party C requests Call Pickup. Parties B and C belong to the same business group.

Figure 5.2.1-26 — Directed Call Pickup without Barge-In

5.2.1.14.6 Call Park Features

5.2.1.14.6.1 Directed Call Park

5.2.1.14.6.1.1 Definition

Directed Call Park allows station users to park a call against their own DN, or direct the call to be parked against another DN in the terminal (Centrex) group. The user presses a Call Park feature button while on an active call; the switch interrupts communications between the two parties and prompts the subscriber for digit entry of a DN to park the call against.

Note: Bellcore documentation refers to this capability as "Call Park."

5.2.1.14.6.1.2 Feature Control Procedures

If there is an active call in State 10[1] and if the switch receives an INFOrmation message with a Feature Activation Information Element (IE) indicating Directed Call Park with the null CRV or the CRV of the call in State 10 and no or partial address digits, then the switch sends an INFOrmation message to the terminal coded as follows:

- CRV received in the INFORMATION message requesting park
- The Information Request IE has the IR indicator field set to "Prompt for additional information" and the type of information field set to "address digits"
- The Feature Indication IE is an identifier indicating directed call park with the status field set to prompt
- The Display Text IE provides a display prompt for parking the call
- The Signal IE is set to recall dial tone.

The switch then interrupts the talking path, removes the active call from the B-channel, and provides recall dial tone over the B-channel. The switch also starts critical inter-digit timing (usually four seconds).

If the INFOrmation message requesting Directed Call Park contained address digits constituting a complete DN in the Called Party Number IE, then the switch proceeds as described below.

Upon receipt of an additional INFOrmation message with address digit(s), the switch sends an INFOrmation message to the terminal with the Signal IE set to "tones off" and the CRV set to the same value as received in the INFOrmation message requesting call park. The switch begins partial digit timing, usually around 20 seconds, upon receipt of the first address digit.

Upon receipt of the DN that the call is to be parked against, the switch provides a confirmation tone, followed by silence, and initiates call clearing by sending a PROGress message to the terminal with the following information:

- The CRV of the call being parked
- The Progress Indicator IE equal to 8, "in-band information or appropriate pattern now available"
- The Cause IE equal to 16, "normal clearing"
- The Display Text IE that provides a display indicating the call has been parked
- The Signal IE equal to "confirmation tone."

If the switch has not received any call clearing messages from the terminal, then the switch continues with call clearing procedures by sending a DISConnect message to the terminal. The switch also provides a Display Text IE in the last call clearing message it sends to the terminal that indicates the display should be cleared. If the terminal initiates call clearing with a RELease COMplete message, the switch provides this display clearing text in a subsequent INFOrmation message to the terminal.

---

1. Call states indicated here are from the network perspective. Terminals are not required to implement the full set of call states. Refer to "Call Control States," Section 4.1.1.2, for further information about call states.

If the switch, instead of receiving digits representing a DN, receives a "#" entry, or receives a DISConnect, RELease, or a RELease COMPLETE message, then the switch parks the call against the DN from which the park request was made.

If the switch sent an INFOrmation message requesting Information Request procedures, then the switch sends the following information to the parking terminal in one of the call clearing messages or in a subsequent INFOrmation message upon successful parking of the call:

- An Information Request IE with the request indicator field equal to "information request complete" and the type of information field equal to "address digits"
- A Feature Indication IE with the feature identifier equal to the button number associated with directed call park and the status equal to idle.

Once the call is successfully parked, if the terminal whose primary DN the call has been parked against—provided that the DN is primary at some terminal—has a button configuration that includes an Answer Back feature button, then the switch sends an INFOrmation message to that primary DN terminal with a Feature Indication IE equal to the Answer Back button number and a status indication equal to "active."

Figure 5.2.1-27 illustrates the procedures of Directed Call Park.

5.2.1.14.6.2 Answer Back

Answer Back allows a parked call to be answered back from any station set with a DN in the terminal group. The user goes off-hook, receives dial tone, enters an answer back code or presses an answer back feature button, receives recall dial tone, and then dials the DN at which the call is parked.

Note: Bellcore documentation refers to this capability as "Call Park Retrieve."

5.2.1.14.6.2.1 Feature Control Procedures

When a call is in State 2, if the switch receives an INFOrmation message with a Feature Activation IE indicating Answer Back with the null CRV or the CRV of the call in State 2, or if the switch receives digits representing the access code for Answer Back, the switch provides recall dial tone over the B-channel. Similarly, if the switch receives a SETUP message with the Keypad IE or Called Party Number IE containing the digits for the Answer Back feature code, and no or partial address digits, the switch provides recall dial tone over the B-channel. The switch also sends the terminal an INFOrmation message that carries the following information:

- The null CRV or the CRV received of the call in State 2
  - — The CRV the switch sends is the CRV the switch received in the INFOrmation message. (If the switch received a null CRV, it sends the terminal a null CRV.)
- The Information Request IE with the IR indicator field set to "Prompt for additional information" and the type of information field set to "address digits"
- The Feature Indication IE including an identifier that indicates Answer Back with the status field set to prompt, if the terminal has an Answer Back feature button
- The Progress Indicator IE equal to 8, "in-band information or appropriate pattern now available"
- The Signal IE set to recall dial tone

- The Display Text IE that provides a prompt for answering back a parked call.

Upon receipt of the first INFOrmation message with address digit(s), the switch sends an INFOrmation message to the terminal with the Signal IE set to "tones off." Upon receipt of the first address digit, the switch also starts partial interdigit timing.

If the switch receives a SETUP message with the Keypad IE containing the digits for the answer back feature code, and a complete DN in the Keypad IE, then the switch proceeds as follows. Upon receipt of the DN that the call is parked against, the switch establishes a talking connection on the in-use CRV between the party doing the answer back and the parked party. The switch does this by sending a CALL PROCeeding message, followed by a CONNect message, to the terminal. In the CALL PROCeeding, INFOrmation, or CONNect message, the switch includes a Display Text IE, indicating the call has been retrieved. The switch includes in the CALL PROCeeding, INFOrmation, or CONNect message an Information Request IE with the request indicator field equal to "information request complete" and the type of information field equal to "address digits."

Once the call has been successfully answered back, if the terminal whose primary DN the call had been parked against—provided that the DN is primary at some terminal—has a button configuration that includes an Answer Back feature button, then the switch sends an INFOrmation message to that primary DN terminal with a Feature Indication IE equal to the Answer Back button number and a status indication equal to idle.

If the switch receives a "#" entry instead of digits representing a DN, then the switch attempts to answer back a parked call against the DN from which the Answer Back request was made.

Figure 5.2.1-28 illustrates the procedures of Answer Back.

5.2.1.14.6.3 Call Park Ring-back

After a specified time-out value expires, Call Park Ring-back allows parked calls that have not disconnected to be rung back at the DN from which the call was parked.

Note: Bellcore documentation refers to this capability as "Call Park Timed Recall."

5.2.1.14.6.3.1 Feature Control Procedures

If the Answer Back timeout limit is applicable and the CP-T1 timer expires, then the switch will offer the Parked call back to the terminal that originally parked the call on the DN from which the call was parked. The switch sends, in the SETUP message:

- A Signal IE value indicating Alerting Pattern 2
- A Display Text IE indicating that the call is a ring-back of a parked call.
- A Redirecting Number IE with the DN the call was parked against, and a redirecting reason of "unknown."

The switch provides this ring-back to all associated terminals that share the parking DN. If the parking DN is not idle (for example, no terminating call appearances are available) at the time of the ring-back attempt, then the switch resets the timer and the call will remain parked for another interval. An EKTS station with Multiple Call Appearances (MCA) must have at least one available call appearance at the parking DN, or the switch will not to consider the line idle. An ACO terminal must be within its call reference busy limit.

The ring-back attempts continue for up to three intervals. If the parking DN is still not idle after three ring-back attempts, then the switch routes the call to a DN, usually an attendant defined for the terminal group on the 4.4 Recent Change View.

If the switch receives a CONNect message in response to offering the ring-back call, then the switch will send the terminal answering the call a CONNect ACKnowledge message.

Note: The switch is likely to receive an ALERTing message from the terminal before receiving the CONNect message.

Once the switch begins applying ring-back, if an ISDN terminal exists whose primary DN the call has been parked against has a button configuration that includes an Answer Back feature button, then the switch sends an INFOrmation message with the null CRV to that primary DN terminal. This message contains a Feature Indication IE equal to the button number associated with Answer Back, with a status indication equal to idle.

Figure 5.2.1-29 illustrates the procedures of Call Park Ring-back.

5.2.1.14.6.4 Call Park Re-route

If a parking station is unable to accept a ring-back attempt, then the call is re-routed to a specified DN, usually the attendant, for the terminal group.

Note: Bellcore documentation refers to this action as "forwarding" the timed recall call.

5.2.1.14.6.4.1 Feature Control Procedures

The switch applies the ring-back of a parked call to the parking party, when applicable, for 30 seconds. If, after 30 seconds, the ring-back call has not been answered, then the switch attempts to route the call to the attendant defined for the terminal group. The switch treats the re-routed call to the attendant as a normal termination with normal ringing. If no attendant is defined, then the switch initiates call clearing and ensures that billing records associated with the call are not deleted.

If a parked call is re-routed to a DN associated with a National ISDN terminal, then the switch proceeds as follows:

- The call is treated as a normal terminating call
- The SETUP message sent to the re-route DN terminal carries information elements as follows:
  - — The Called Party Number IE containing the re-route DN
  - — The Calling Party Number IE containing the parked party's DN, if an appropriate Line ID feature is assigned
  - — The Redirecting Number IE containing the parking DN, with the reason set as follows:
    - Set to "call forwarding busy" if the call has been re-routed due to the parking party being busy
    - Set to "call forwarding no reply" if the call has been re-routed due to the parking party not answering the ring-back, provided that the appropriate Line ID feature is assigned.

Figure 5.2.1-30 illustrates the procedures of Call Park Re-route.

5.2.1.14.6.5 Call Park Flow Diagrams

Figures 5.2.1-27, 5.2.1-28, 5.2.1-29, and 5.2.1-30 provide flow diagrams that illustrate the Call Park feature.

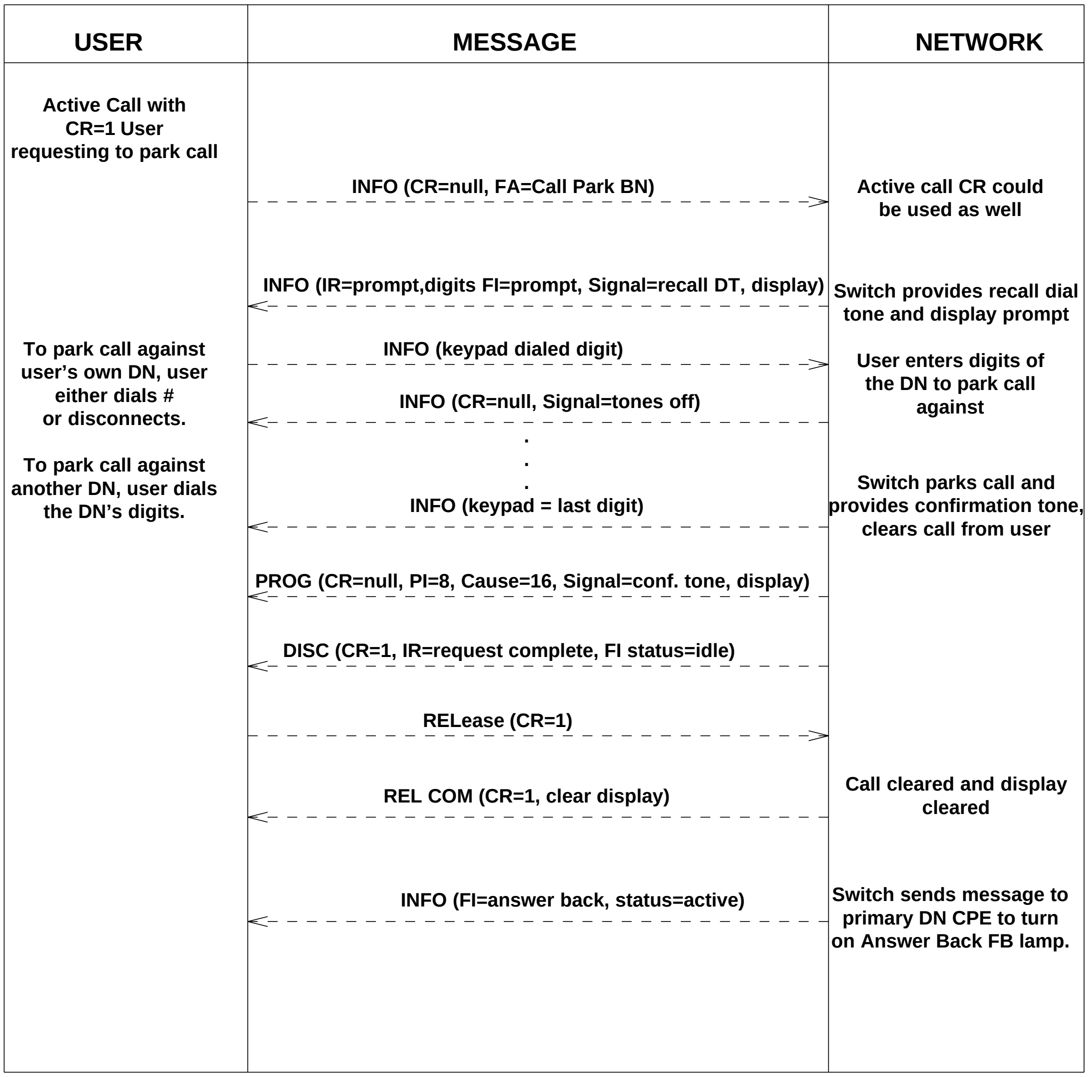


Figure 5.2.1-27 — National ISDN Directed Call Park

Figure 5.2.1-28 — National ISDN Answer Back

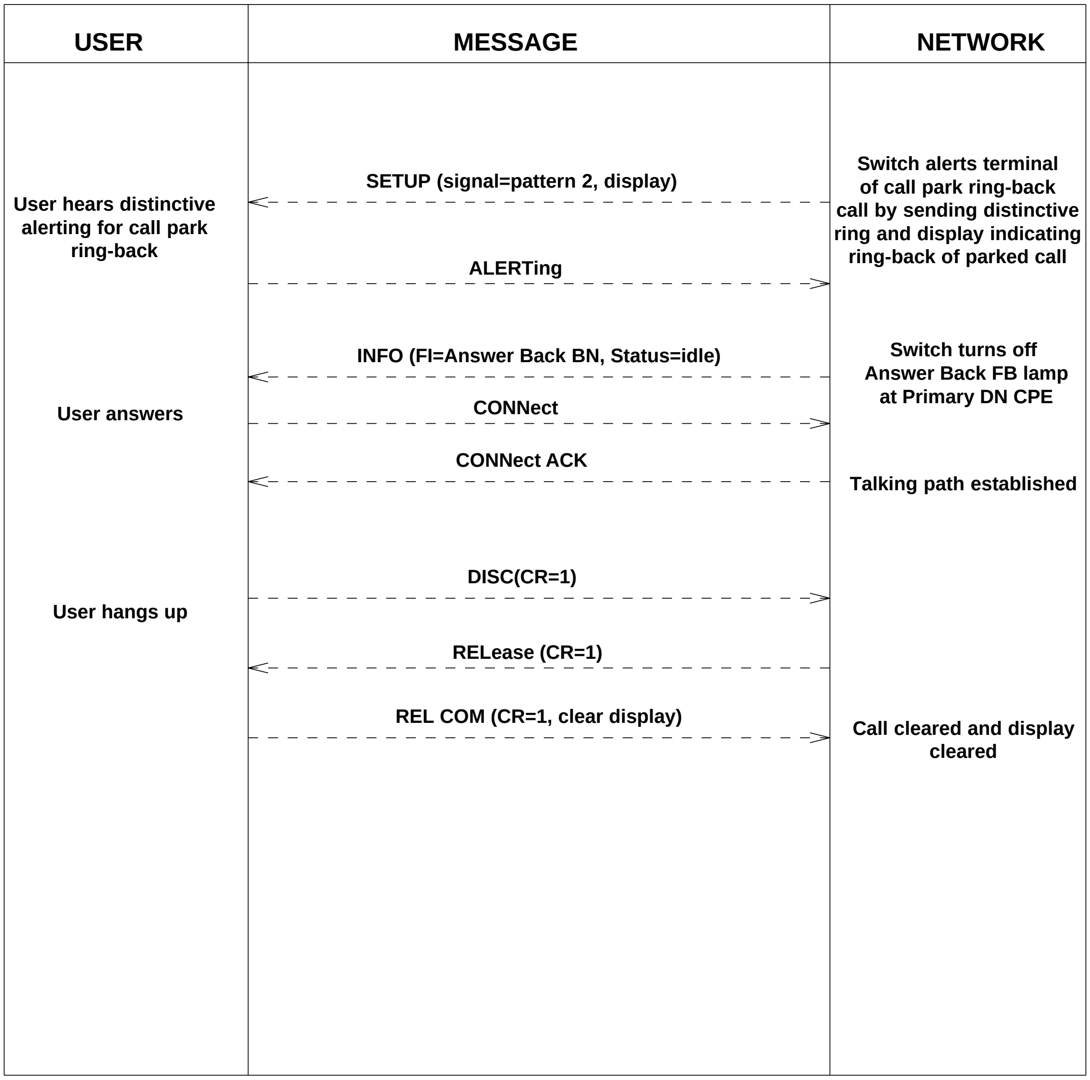


Figure 5.2.1-29 — National ISDN Ring-back of Parked Call

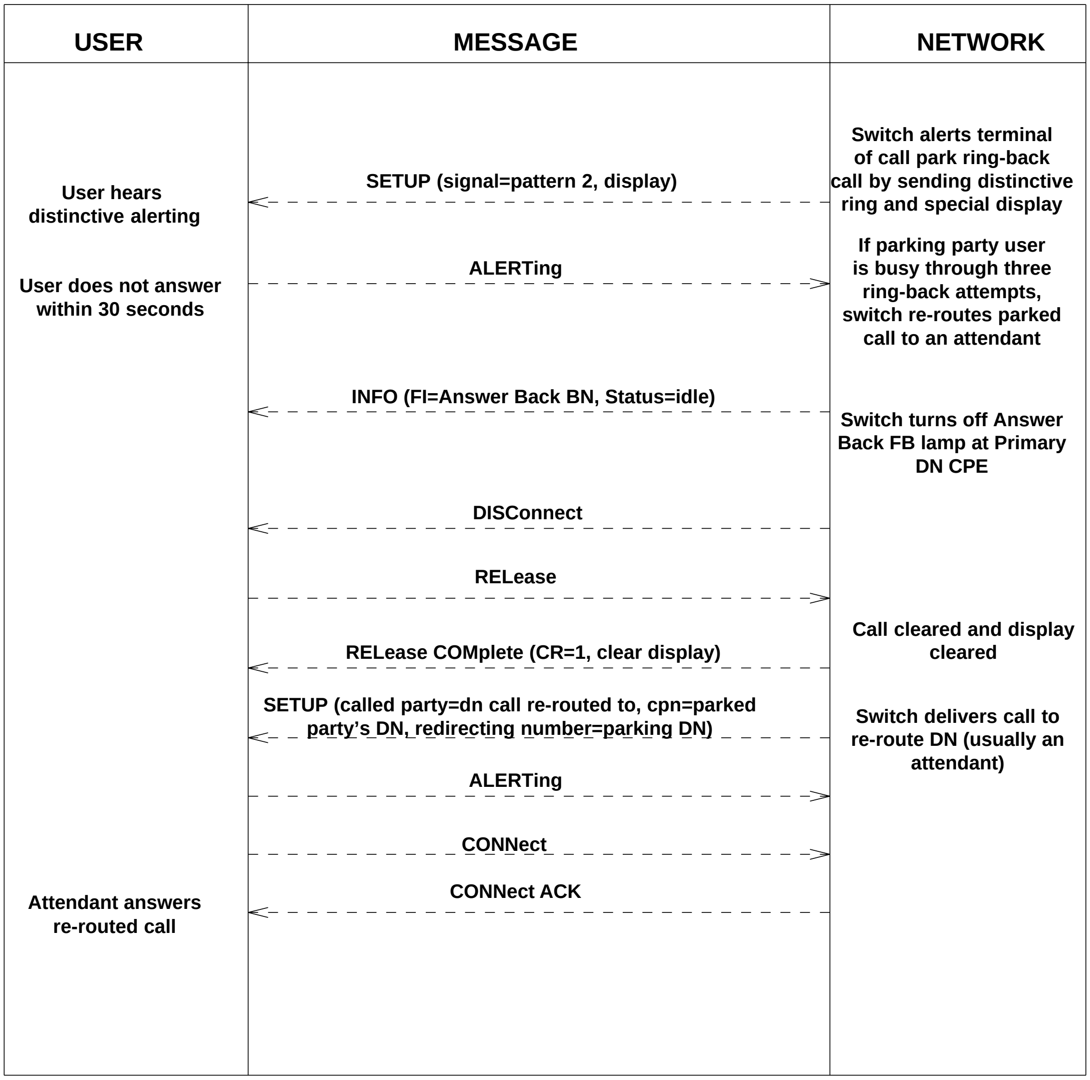


Figure 5.2.1-30 — National ISDN Re-route of Ring-back Call

5.2.1.15 Call Reference Busy Limit

5.2.1.15.1 Limits on Simultaneous Active Calls

The number of independent voice calls that may be active simultaneously for any DN on a terminal is a customer subscription feature. For a non-EKTS terminal, the parameter used to define this number is called the Call Reference Busy Limit (CRBL). For an individual DN of an EKTS terminal, the parameter is called the Call Appearance Quantity (CAQ). Since a DN on a Basic EKTS terminal can have only one call appearance, CAQ must be set to one for a Basic EKTS terminal DN.

If the maximum subscribed number of simultaneously active voice calls is exceeded, the network shall deny an attempt for a terminal to originate calls. If ACO is not subscribed for a non-EKTS terminal, terminating calls will be offered only up to the number of B-channels available for that terminal. On the other hand, for a non-EKTS terminal subscribed to ACO, terminating calls will be offered up to the CRBL. Similarly, terminating calls will be offered to an EKTS terminal up to the CAQ.

The network will not support more than 16 voice calls for any one DN. In other words, the range for CRBL or CAQ is 1 to 16. Terminals capable of retaining only one call will be unable to invoke conferencing services, to use the ACO features, or to invoke call transfers.

5.2.1.15.2 Originating Multiple Calls

When Call Hold is combined with the CRBL non-EKTS or CAQ (CACH EKTS, the combination allows users to originate multiple concurrent calls. For a non-EKTS terminal, it is also based upon the terminal's capability to recognize multiple concurrent Call References (see "Message Definitions," Section 4.1). In contrast, the CACH EKTS terminal must be able to recognize the call appearance information.

As indicated in the previous section, a DN of a Basic EKTS terminal can have only one call appearance. As a result, a DN of a Basic EKTS terminal cannot support multiple concurrent calls. A Basic EKTS terminal, however, can have multiple DNs and the user may originate multiple concurrent calls on different DNs by using Hold feature. Since multiple calls are supported on multiple DNs, a Basic EKTS terminal must send the calling party number (CgPN) information in the SETUP message when a call is originated.

For proper interaction with this feature, each standard terminal is expected to have some method (for example, a button and corresponding lamps) for providing information to the end-user about each call. For example, the presentation of this information to the end-user for an EKTS terminal will be a "call appearance." For a non-EKTS terminal, the presentation can also be referred to as a "call appearance." A terminal with six call appearances could simultaneously provide the user with information about six independent calls. These six call appearances may represent only one directory number (DN). For a Basic EKTS terminal, a call appearance will map one-to-one to a single DN.

5.2.1.15.3 Originating Calls

If the network allows establishment of a new Call Reference, procedures for originating calls are as discussed in the following paragraphs. If not, the network will respond to the origination request with a RELease COMplete message, per the procedures of "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

5.2.1.15.3.1 B-Channel Available

If a B-channel is available when a call is originated, the standard procedures of "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, apply. When the network responds to the originating SETUP, the B-channel is considered to be in use for the call. The terminal may connect to this channel so that the user may monitor it for tones and announcements.

5.2.1.15.3.2 Originations with Channel Negotiation

Some originations may encounter blocking when an active or alerting call at another terminal on the same interface or an incoming voice call has previously reserved the needed B-channel.

5.2.1.16 Call Tracing

The following subfeatures are available:

- In-Progress Call Trace

- Nuisance Call Trace
- Terminating Call Trace (includes End-to-End Call Trace)
- Tandem Call Trace
- Interoffice Call Trace (Outgoing Call Tracing).

This feature is controlled by Central Office personnel. It has no protocol interaction.

5.2.1.17 Code Restriction

This feature is controlled by Central Office personnel. It has no protocol interaction.

5.2.1.18 Denied Origination

This feature is controlled by Central Office personnel. It has no protocol interaction.

5.2.1.19 Denied Termination

This feature is controlled by Central Office personnel. It has no protocol interaction.

5.2.1.20 Distinctive Ringing (DR) Modular Feature

The following subfeatures are available:

- Attendant and Multiway DR
- Call Waiting Originating DR
- Dial Call Waiting DR
- Incoming Only DR
- Call Forwarding Night Service DR.

Procedures for changing the Distinctive Alerting pattern, or for activating or deactivating this feature follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1.

5.2.1.21 EKTS Features

5.2.1.21.1 Overview of EKTS Features

The EKTS features provide the user access to multiple directory numbers (DNs) and special telephone features. The EKTS terminal must be initialized.

Two types of EKTS terminals are supported: Basic and Call Appearance Call Handling (CACH).

The features provided are as follows:

a. ***Shared Call Appearance:*** The feature provides the capability for multiple users in an EKTS group to share call appearances (CAs) that belong to a single DN.

b. ***Multiple DNs:*** The feature provides the capability for a single terminal to make and receive calls on more than one DN. Terminals that can receive calls for more than one DN may be in more than one EKTS group. Multiple CAs for a DN must be sequentially ordered.

c. ***Bridging:*** The feature provides the capability for third-party-initiated bridging onto a shared CA. For example: Party A is talking to Party B; Party C may bridge onto the call (for example, by pressing a CA button) if Party C shares a call appearance with Party A. No action is required from the original parties (A and B). The EKTS bridging allows one other associated terminal to join an active 2-party call. If Bridge onto conference is available, EKTS bridging allows up to six users active on a call.

d. ***Remote Hold Retrieval:*** If a terminal places a call on hold, any member of the EKTS group (that is, any terminal that has a call appearance of the held call) can retrieve the held call provided that a B-channel is available.

e. ***Bridged Call Exclusion:*** A user may activate this feature to restrict other users in the same group from bridging onto an active call or retrieving a held call remotely. Two options are available for Bridged Call Exclusion: Automatic and Manual.

f. ***Intercom Calling:*** For intercom calling, a user may press an intercom call appearance and dial one or two digits to originate an intercom call. If auto-ICOM is supported, only the call appearance needs to be pressed to establish the call.

g. ***Abbreviated and Delayed Ringing:*** A user may receive abbreviated or delayed ringing treatment when an incoming call is present on one or more of the DNs assigned to that terminal.

h. ***Bridge Onto Conference:*** Shared DN users may bridge onto a conference call that was established at another shared EKTS terminal.

i. ***Executive Ringer Cutoff:*** This feature is offered as a special feature and will allow a user to press a feature button to turn audible ringing on and off for all incoming calls except intercom calls and ringbacks from 911, ACBC, AC, AR, and ringback queuing.

j. ***Call Appearance Reservation and Priority Calling for NI:*** These features, available with both Basic and CACH EKTS, allow one or more call appearances (that is, subaddresses) of a DN assigned to an EKTS group to be reserved for one of the following categories of calls:

    1. originations only
    2. terminations only
    3. originations and priority incoming terminations.

    If a user has call appearances reserved for originations and priority incoming terminations, calls terminating from outside the user’s terminal group will be treated as priority calls. A DN may have CAs reserved in more than one of the categories.

5.2.1.21.2 Endpoint Initialization Procedures

The procedures for Endpoint Initialization are defined in "Terminal Initialization," Section 6.

For calls offered to an EKTS terminal, the Endpoint Identifier IE will be included in the SETUP message.

5.2.1.21.3 Feature Control Procedures

5.2.1.21.3.1 EKTS Terminals

Calls offered to EKTS groups are offered to all terminals in the group. Calls originated by any EKTS terminal are accessible by any other EKTS terminal in its group. An EKTS DN can be shared with only one analog member. An analog DN must be the primary DN and the other shared member can have only one CA for this DN. In comparison, if the primary terminal for a shared DN is a basic EKTS terminal, then the associate terminals in this EKTS group can have only one CA for this DN.

Procedures for originating calls for EKTS follow the procedures specified in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, and in "Basic Feature Access," Section 5.1.1.2.1. Procedures for terminating calls and other additions for call originating procedures are as follows:

a. For shared DNs, a call will be offered if the lead terminal of the EKTS group has an idle CA (CA QTY for that DN/terminal is not exceeded).

b. For nonshared DNs, a call will be offered if the terminal has an idle CA (CA QTY for that DN/terminal is not exceeded) and either an acceptable channel (as defined by the B-channel subscription parameters for the terminal) is idle or an established call exists at the terminal.

c. For basic EKTS termination, the switch will include the CdPN (called party number) DN in the called party number information element in the SETUP message.

d. For CACH EKTS termination, the switch will include the proper Call Appearance number in the CA IE.

e. For basic EKTS call origination, the CgPN (Calling Party Number) DN must be included in the SETUP message.

f. For CACH EKTS call origination, the terminal must include a Call Appearance information element. This call appearance indicates the call appearance to which the call is related.

g. KEY SETUP messages containing the originator’s DN in the Called Party Number information element will be sent to all Basic EKTS group members (CdPN is not populated for CACH terminals). Each terminal within the EKTS group (except the originating terminal) will receive a KEY SETUP message.

h. If a user has reserved CAs, the user may originate calls on only CAs reserved for originations or for originations and priority incoming terminations (or nonreserved CAs). The user is not allowed to originate a call on CAs reserved for terminations only.

   When terminating a call to a user with reserved CAs, the switch will offer the call as follows:

   1. If there are no nonreserved CAs available for termination, the call may be offered on a CA reserved for terminations only.

   2. If there are no nonreserved CAs or termination only reserved CAs available, the call may be offered on a call appearance reserved for originations and priority incoming terminations, assuming the offered call originated from outside the user’s terminal group. Otherwise, the call will not be offered.

Every voice call existing at a terminal is associated with a unique DN of the Basic EKTS terminal and a unique call appearance of the CACH EKTS terminal.

When calls are offered to a shared DN, an attempt is made to reserve a B-channel at each interface containing members of that shared DN. If the reservation can be made, the EKTS terminal will receive an alerting pattern in the signal information element. If the reservation cannot be made, the terminal will receive "silent" alerting, that is, "alerting off" in the signal IE. This alerting treatment provides an indication to a terminal that a B-channel is available for their call at the time of call offering.

An EKTS call will be offered for shared DNs even if a channel cannot be reserved.

For nonshared DN, a B-channel will be allocated for the call if the terminal currently does not have other active or held calls. If a channel cannot be allocated, the call will not be offered and busy treatment will apply.

A. Call Origination

When a EKTS terminal originates a call, the network notifies the other terminals in the EKTS group of the call. The network does this by sending each of the other terminals in the group a KEY SETUP message. Only terminals responding with a KEY SETUP ACK message are considered to be associated users for this call. In order to support multiple EKTS terminals, the KEY SETUP message will contain the Endpoint IDentifier. Each terminal within the EKTS group (except the originating terminal) will receive a KEY SETUP message. The network begins notification immediately after the call request. After sending the KEY SETUP message, the network initializes Timer T303 (default value 2.5 seconds). If a given terminal on the BRI does not respond before T303 expires, the KEY SETUP message is retransmitted to that terminal. This retransmission is done by sending the KEY SETUP message containing the Endpoint IDentifier to the terminal that did not respond. If the timer expires once again before the network receives a response, the call reference for the call at that terminal will be cleared. Furthermore, the terminal may be taken out of service by the network.

Upon receipt of the KEY SETUP message, the terminal will respond with a KEY SETUP ACKnowledge message and will retain the Call Reference for subsequent messages related to this call. The network sends the terminal subsequent call progress messages to inform it of the status of the call (that is, ALERTing and CONNect). The call is in a key-held condition since a Call Reference exists, but no B-channel is associated with this call. Such EKTS group terminals, being aware of a call on a particular DN but is not active on that call, are known as "associated" terminals.

If an associated terminal that has sent a KEY SETUP ACKnowledge message sends a DISconnect or RELease message to the switch, the switch will send a KEY RELease message to this terminal and still keep the call reference. In so doing, the terminal may join the call later. On the other hand, if an associated terminal that has sent a KEY SETUP ACKnowledge message sends a RELease COMplete message to the switch, the switch will disassociate this terminal for this call. The terminal will not be able to join the call later.

B. Incoming Call Procedures

When a call is destined for a shared call appearance, the network sends all terminals sharing that call appearance a SETUP message. The network starts Timer T303 and follows standard terminating call procedures per "Call Establishment at Terminating Interface," Section 4.2.1.3, except as follows. When the first terminal responds with the CONNect message, the switch connects the B-channel for that terminal and sends that terminal a CONNect ACKnowledge message. The network sends all other terminals receiving terminating treatment in the EKTS group KEY HOLD messages.

After sending the KEY HOLD message, the switch will check to distinguish whether another terminal had already responded with a CONNect message. If so, the switch will process this CONNect message as an attempt to bridge onto the call. For those terminals who did not connect or bridge onto the call, the call is now in a key-held condition, since a Call Reference exists but no B-channel is associated with the call.

An EKTS terminal may choose to originate, answer, retrieve, or bridge calls on any channel assuming the channel is idle (and does not violate the B-channel subscription parameters for the terminal) and is not in-use or reserved for other terminals on the interface.

If a terminal attempts to connect to an incoming call when there is no available B-channel on the interface (for example, all B-channels are reserved for other terminals on the interface) or the channel the user requests exclusively is not available, the network will return a KEY HOLD message. This KEY HOLD message will also contain a Cause information element with Cause 34, "no channel available," or Cause 44, "requested channel not available," and a Signal information element (value = "alerting off") if alerting is being applied.

If after sending the KEY HOLD message to a CPE when a B-channel was not available, a RETrieve message is received from the same CPE and no other EKTS member has answered the call, the switch will process the RETrieve message as a request to answer the call.

Upon receipt of the KEY HOLD message, the terminal is on key-hold. No action is taken by the network at other associated terminals.

If a terminal responds to the SETUP with a RELease COMplete message, the call at that interface will be moved into the null state. However, the network will not clear the call while another member is receiving terminating treatment.

C. Clearing Procedures

If a terminal that was active on the call sends a DISConnect message, but clearing is not appropriate, the network sends the terminal the KEY RELease message. This is an indication to disconnect and release the B-channel, but to retain the Call Reference (that is, the call goes to the key-hold condition). The terminal will not respond with any message.

When the last terminal in the EKTS group that is active on the call disconnects, the network will initiate clearing by sending a RELease message to all terminals in the EKTS group.

When all far-end terminals disconnect, all EKTS terminals involved on the call receive call clearing message, regardless of their individual active or key-hold conditions.

D. EKTS Terminal with Circuit-Switched Data (CSD) Capabilities

An EKTS terminal may also subscribe to CSD capabilities. An EKTS terminal is allowed one CSD call. The CSD call must be originated as per Basic Call using a DN in the SETUP message, and originated from only the terminal where that DN is primary. Likewise, a terminating CSD call will be delivered as per Basic Call to the terminal where the DN is primary. No ACO data capabilities can be assigned to an EKTS terminal. A CSD call may be placed on hold to answer/originate an EKTS voice call.

5.2.1.21.3.2 EKTS Group

An EKTS terminal supports multiple DNs and shared CA capabilities. The detail of how these two capabilities can be used is covered in "EKTS Terminals," Section 5.2.1.21.3.1.

A. Bridging

To initiate bridging, an associated terminal sends a RETrieve message (with the appropriate Call Reference value) to the network. If bridging occurs, the network sends the terminal a RETrieve ACKnowledge message and connects the B-channel to the in-progress call. If a terminal sends a RETrieve message and the network cannot honor the bridge request (for example, no channel available), the network returns a RETrieve REJect message. Note that these procedures are the same as retrieving a call from hold, since a call at an associated terminal is in a key-held condition. In addition to sending a RETrieve ACKnowledge message to the user if bridging occurs, the switch will send a NOTIFY message with a notification indicator (user bridged on) to each active user in the EKTS group.

A bridged call may be placed on hold. If the switch receives a HOLD message from an EKTS member bridged onto a call, the switch will honor the request and place ***that*** user's connection to the call on hold.

B. Hold Retrieval

If a call on a shared call appearance is placed on hold (that is, no terminal is active on the call), the associated terminals in the EKTS group receive a NOTIFY message indicating "call on hold" regardless of the privacy status of the call. When one terminal retrieves a held call, the network sends the associated terminals in the EKTS group a NOTIFY message indicating "call retrieved from hold."

A terminal follows standard hold retrieval procedures to retrieve a call that was placed on hold in an EKTS group (that is, the terminal sends a RETrieve message).

C. Bridged Call Exclusion

This feature allows a station user to restrict other users in the same EKTS group from bridging onto an active call or retrieving a held call. The feature does not provide any restriction of bridging or hold retrieval in an EKTS group at the other end of the call.

While Bridged Call Exclusion is in effect for a particular call, requests from other terminals in the EKTS group from bridging onto or retrieving a call remotely (by sending a RETrieve message to the switch) are rejected with a RETrieve REJect message.

When Bridged Call Exclusion is activated by a user, the associated EKTS members will receive a NOTIFY message with Notification Identification IE coded as "privacy is enabled." On the other hand, if Bridged Call Exclusion is deactivated by a user, the associates will receive a NOTIFY with NI coded as "privacy disabled."

Privacy activation will be allowed while the call is bridged. For Automatic Call Exclusion (ACE), privacy activation/deactivation will be allowed while the call is on hold.

The following ACE/Manual Call Exclusion (MCE) requirements apply:

- For an EKTS group with ACE users, privacy will be automatically reactivated by the switch when the following situations occur:
  - — A user with ACE deactivates privacy and another user bridges onto the call.
  - — A user with ACE deactivates privacy and disconnects from the call (and there is at least one user remaining on the call who has the ability to activate/deactivate privacy, excluding an analog member).
- If an ACE user bridges onto a nonprivate call, privacy will be activated.
- Only the user who deactivates ACE can manually reactivate privacy.
- If an ACE user disconnects from a bridged call and no one remaining on the call has the ability to activate/deactivate privacy, the switch will deactivate privacy.
- Only the user who activates MCE can deactivate privacy.

As a subscription capability of the EKTS service, two options are available for Bridged Call Exclusion: Automatic and Manual.

Note: The switch will not allow mixing of the two types of Bridged Call Exclusion within an EKTS group.

a. ***Automatic Call Exclusion (ACE):*** With this option, Call Exclusion is automatically activated when a user assigned Automatic Call Exclusion goes off hook, answers an incoming call, or retrieves a held call remotely.

b. ***Manual Call Exclusion (MCE):*** Under this option, Bridged Call Exclusion is not activated unless invoked by the user.

E. Intercom Calling

A user may originate a call by pressing the intercom call appearance associated with an intercom group and entering one or two digits. If auto-ICOM is supported, only an intercom call appearance needs to be pressed to establish the call. The intercom call appearance is not associated with a DN.

On the terminating end, the SETUP message to the primary will contain a special alerting pattern (Alerting Pattern 3). The call will terminate on an intercom call appearance.

Intercom calls can be conferenced; however, a call on an intercom call appearance cannot be transferred.

F. Abbreviated and Delayed Ringing

When abbreviated and delayed ringing are assigned to users in an EKTS group, the SETUP message sent to these users will include a signal information element that indicates "normal alerting" to users assigned abbreviated ringing. On the other hand, the SETUP message will include a signal information element with "alerting off" to users assigned delayed ringing.

After a predetermined time, if no user answers the call, an INFORMATION message with a signal information element coded to "alerting off" will be sent to each user assigned abbreviated ringing. Similarly, an INFORMATION message with the signal information element coded to "normal alerting" will be sent to each user assigned delayed alerting.

G. Bridge Onto Conference

This feature allows users having shared call appearances of a directory number to bridge onto a conference call that was established at another terminal with an appearance of the same directory number. The EKTS bridging allows up to six users active on a call when Bridge Onto Conference is available.

This feature will also allow a conference call to be set up at one station, put on hold there, and retrieved at another station that shares the same DN. For example, this feature can be used by a principal who asks a secretary to set up a conference call with two or more other parties and then notify the principal when the call is ready to be picked up. The feature can apply while the principal and secretary have EKTS terminals that share the same DN. The feature can also apply if only the secretary has an EKTS set and the principal has an analog set that shares a DN with the secretary.

5.2.1.21.4 Examples of EKTS Procedures

Figures 5.2.1-31, 5.2.1-32, 5.2.1-33, 5.2.1-34, 5.2.1-35, 5.2.1-36, 5.2.1-37, 5.2.1-38, 5.2.1-39, 5.2.1-40, 5.2.1-41, 5.2.1-42, 5.2.1-43, 5.2.1-44, 5.2.1-45, 5.2.1-46 show examples of EKTS Procedures.

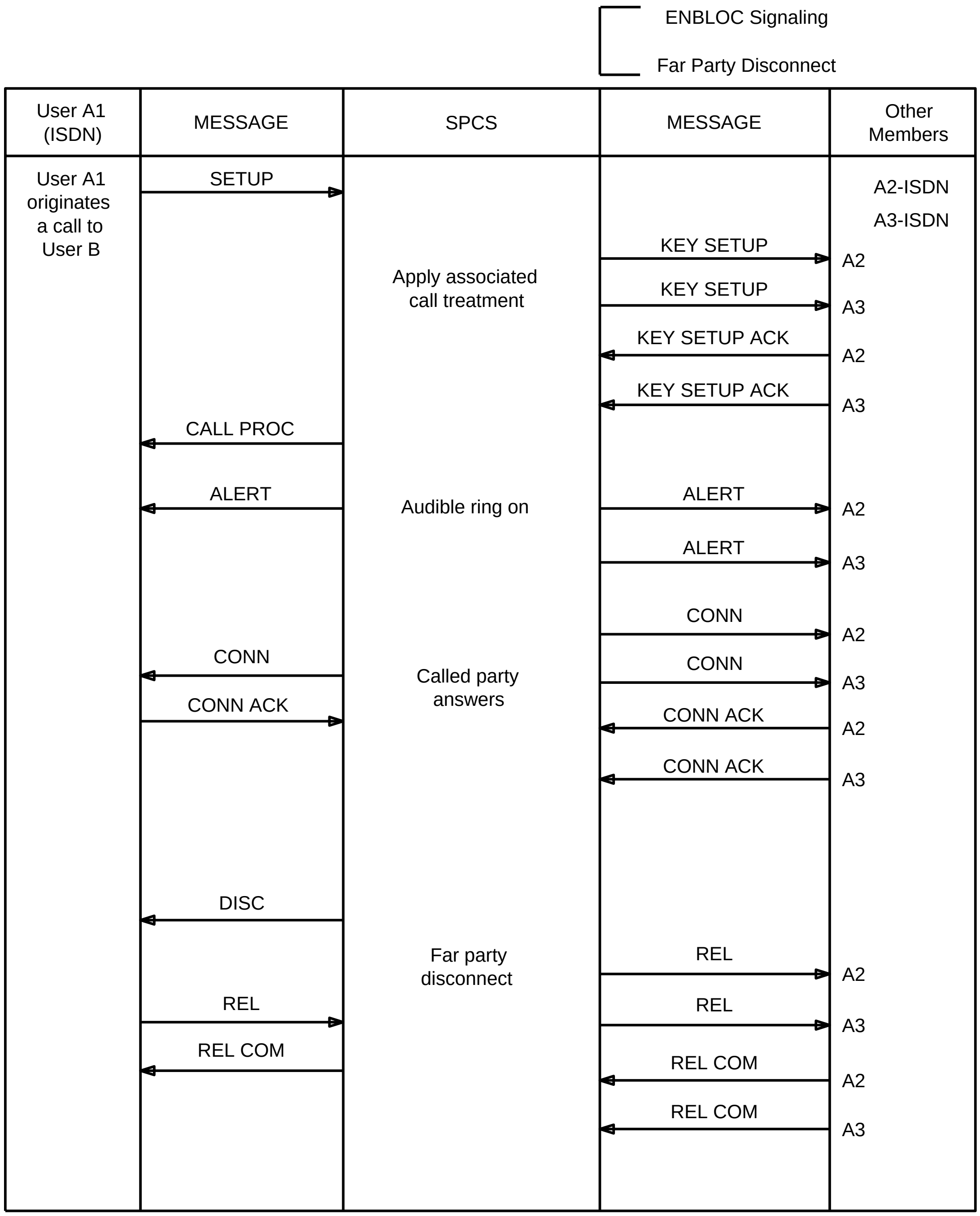


Figure 5.2.1-31 — Outgoing Call Treatment (1 of 4)

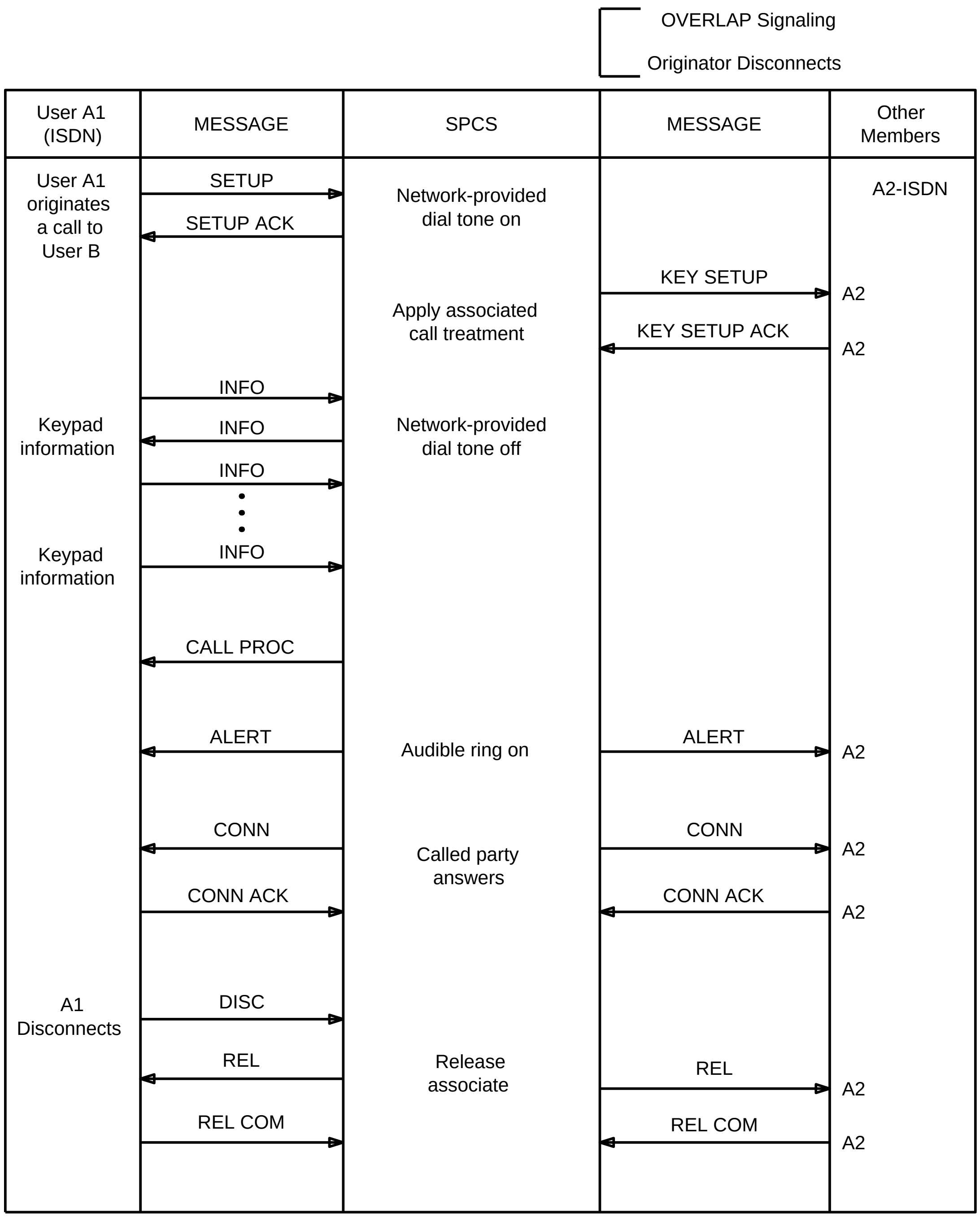


Figure 5.2.1-31 — Outgoing Call Treatment (2 of 4)

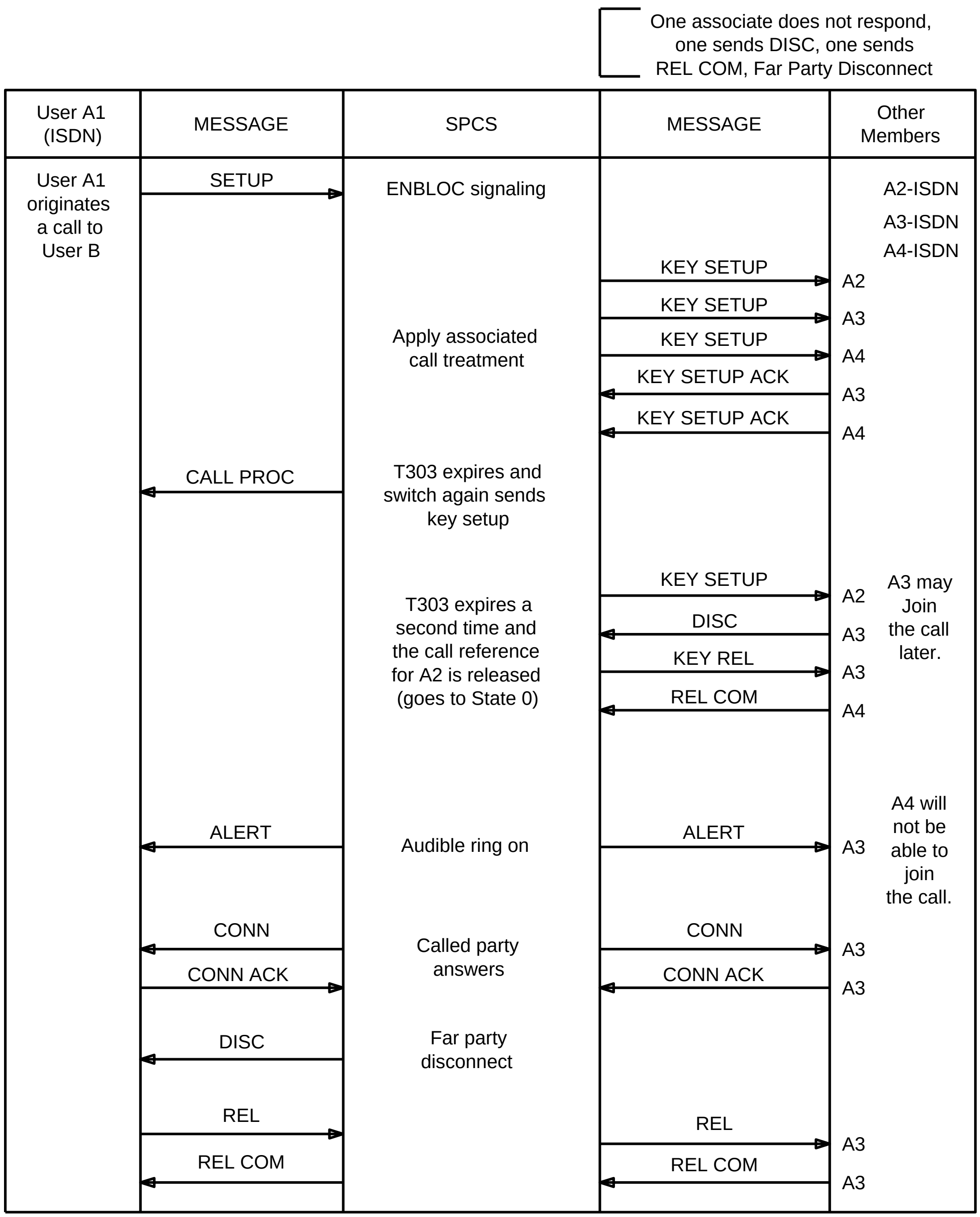


Figure 5.2.1-31 — Outgoing Call Treatment (3 of 4)

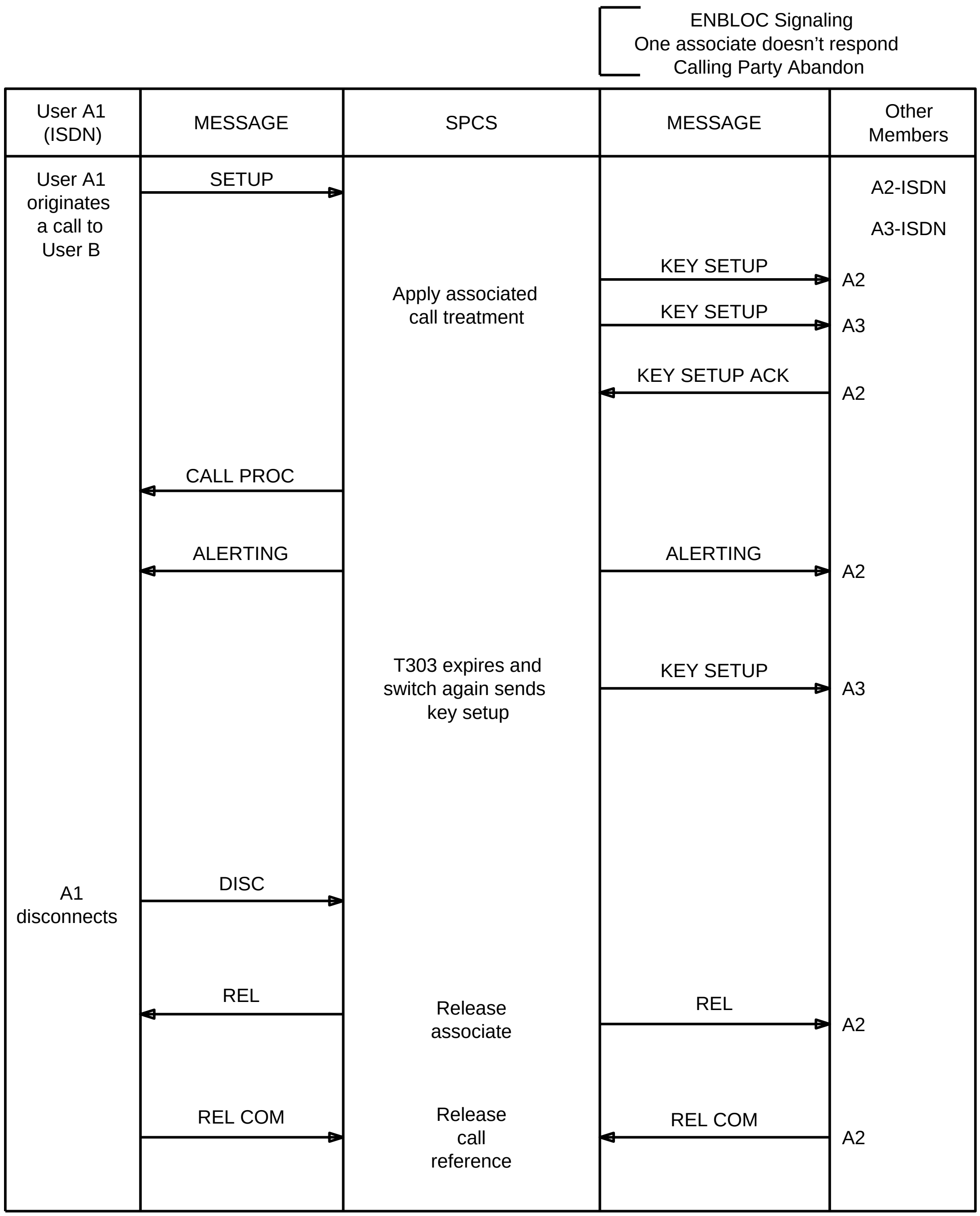


Figure 5.2.1-31 — Outgoing Call Treatment (4 of 4)

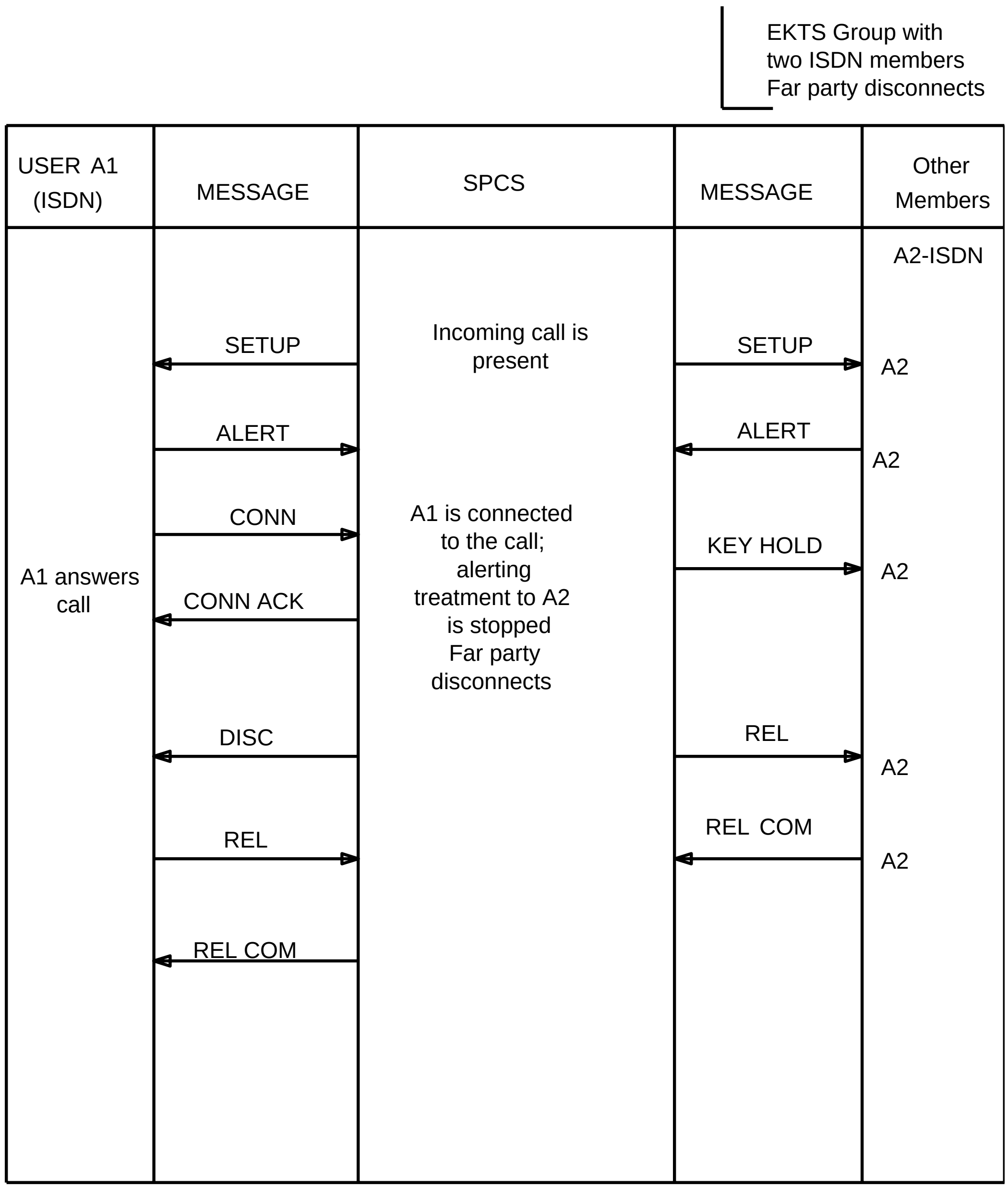


Figure 5.2.1-32 — Incoming Call Treatment (1 of 7)

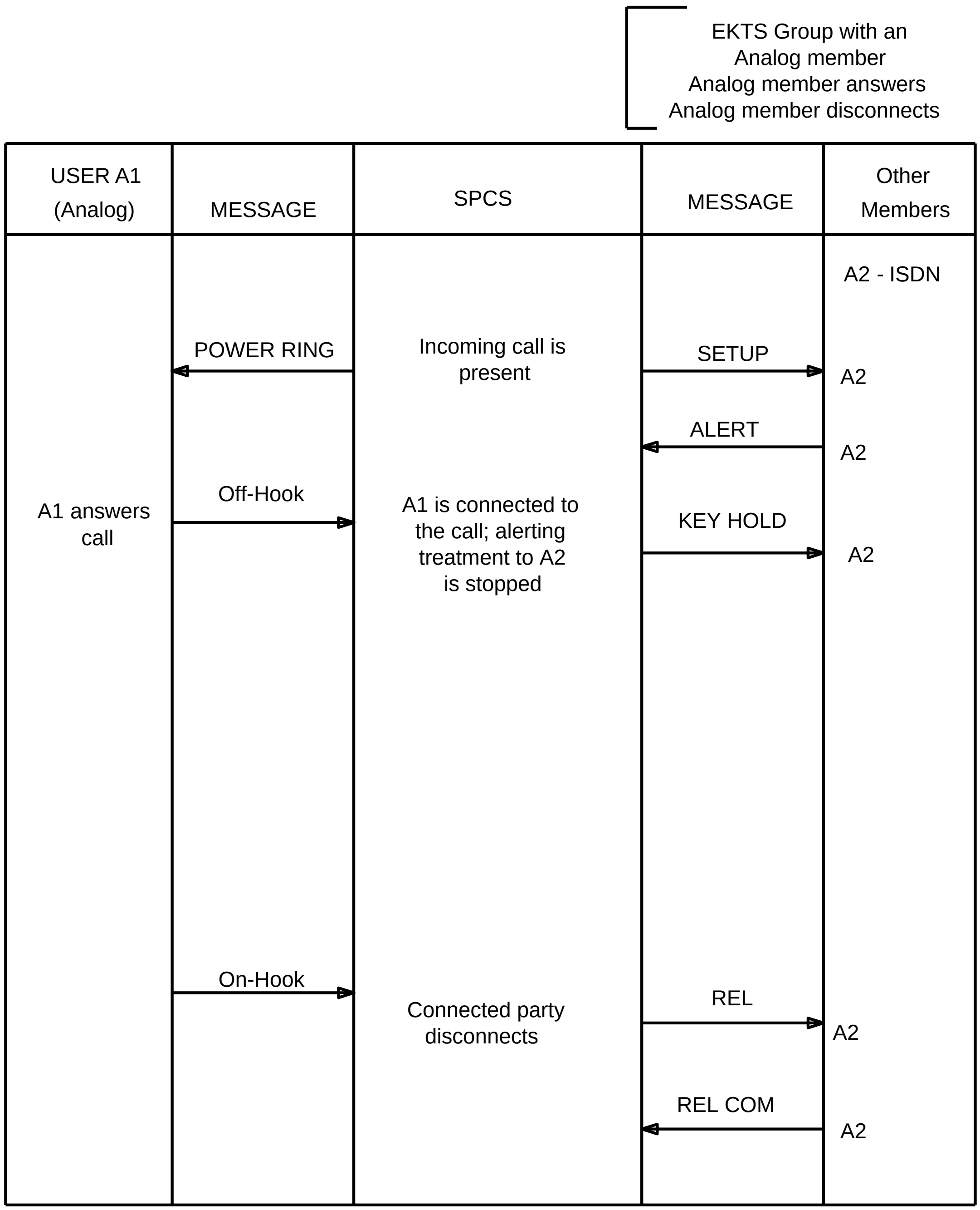


Figure 5.2.1-32 — Incoming Call Treatment (2 of 7)

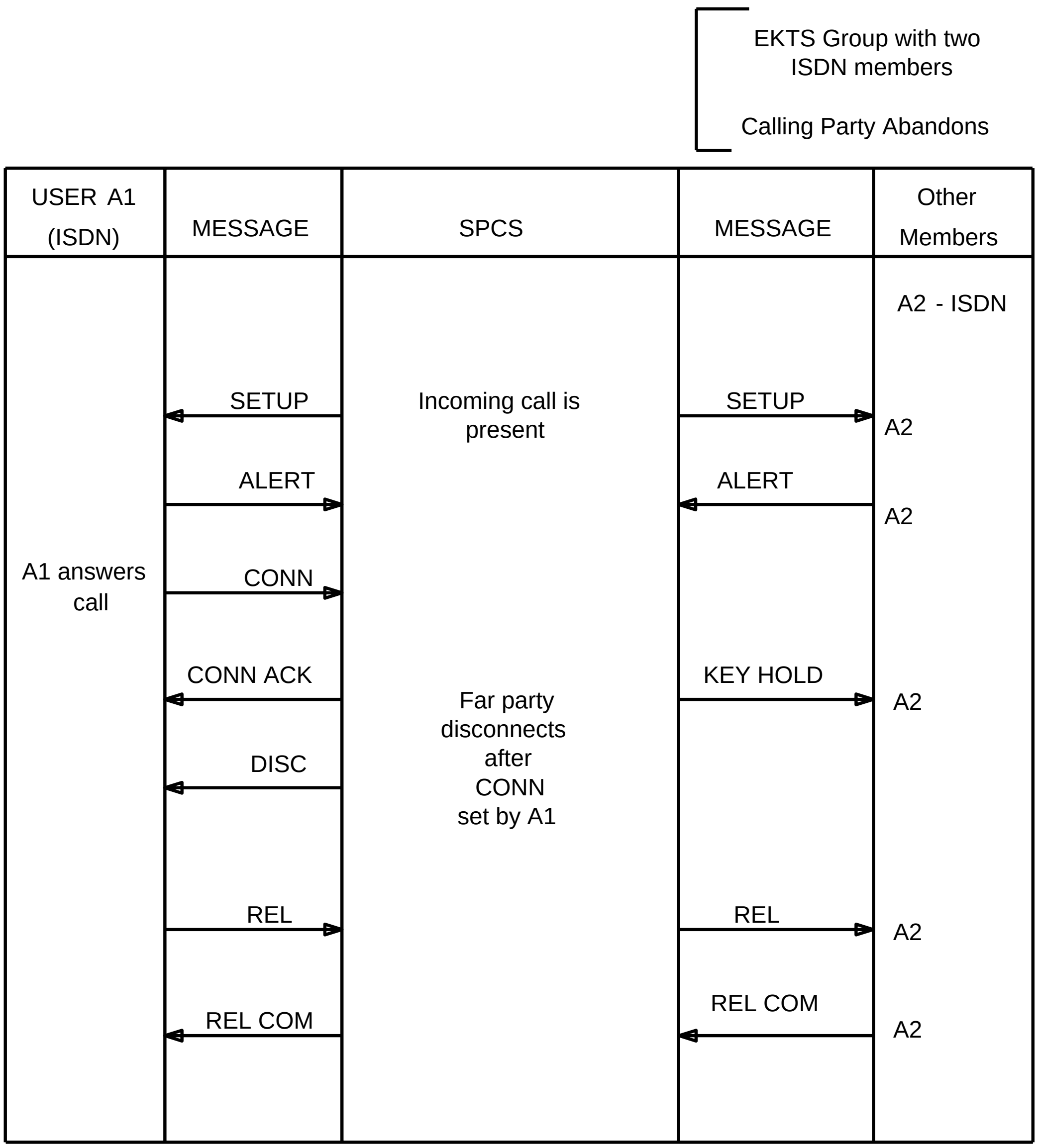


Figure 5.2.1-32 — Incoming Call Treatment (3 of 7)

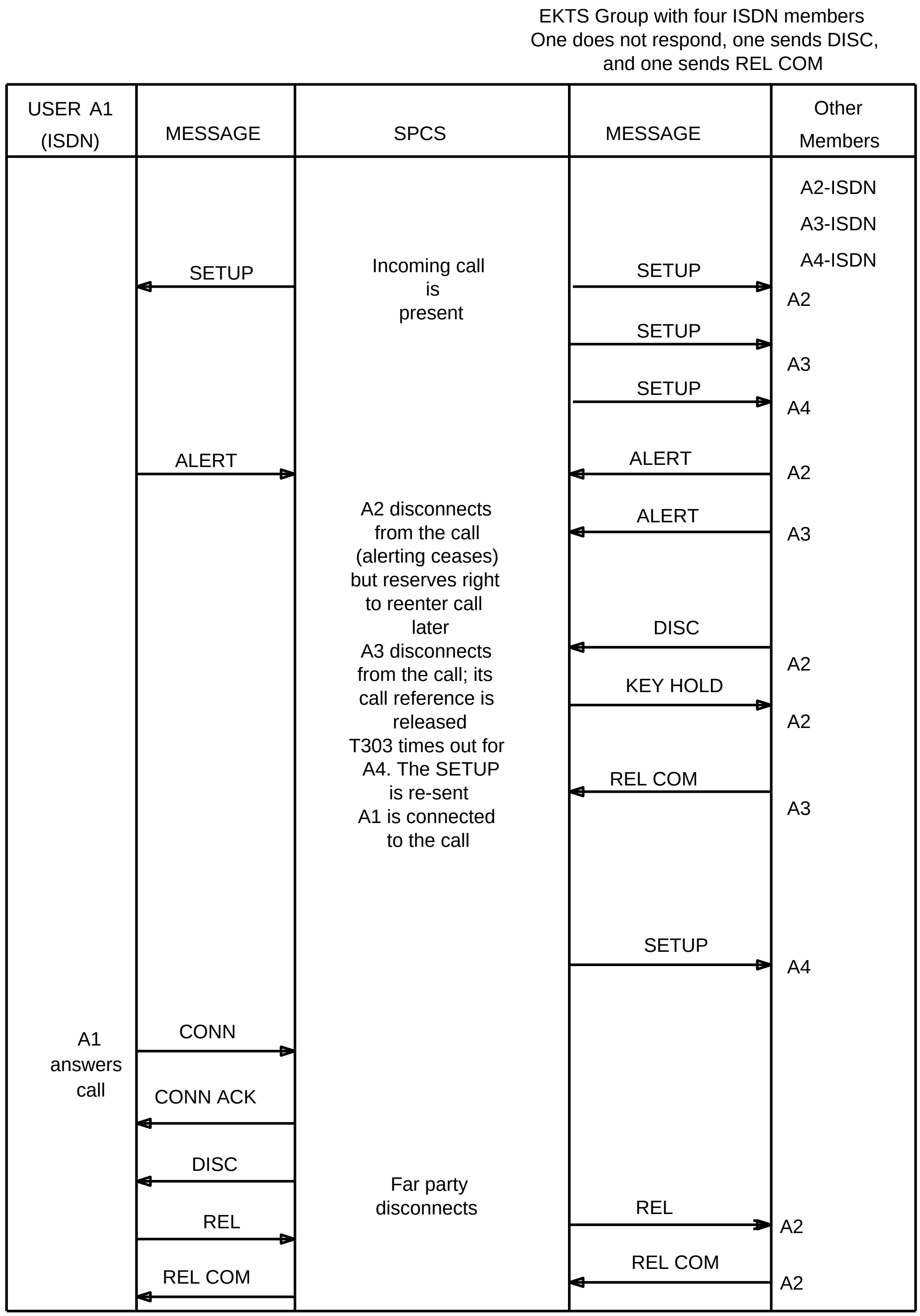


Figure 5.2.1-32 — Incoming Call Treatment (4 of 7)

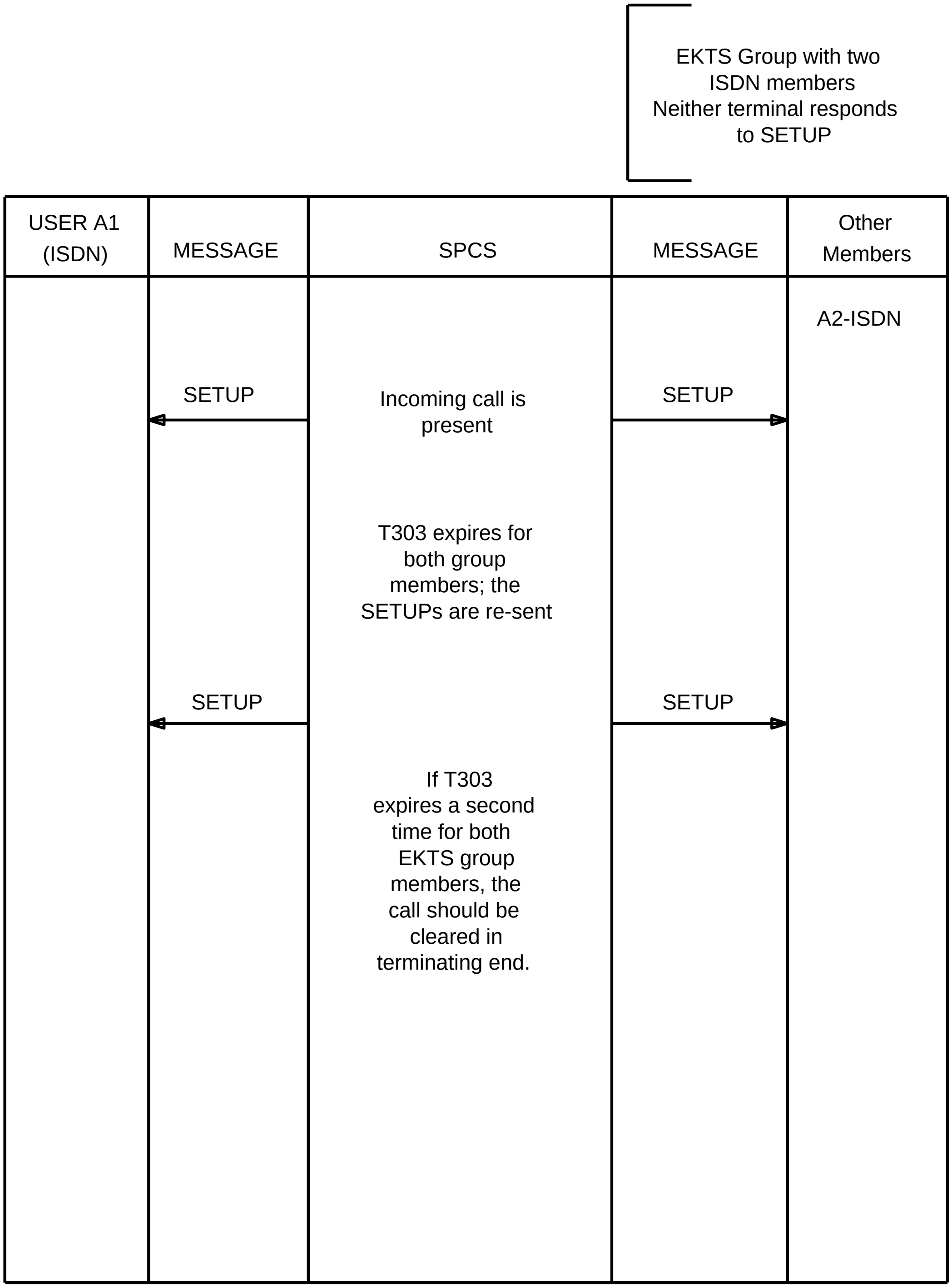


Figure 5.2.1-32 — Incoming Call Treatment (5 of 7)

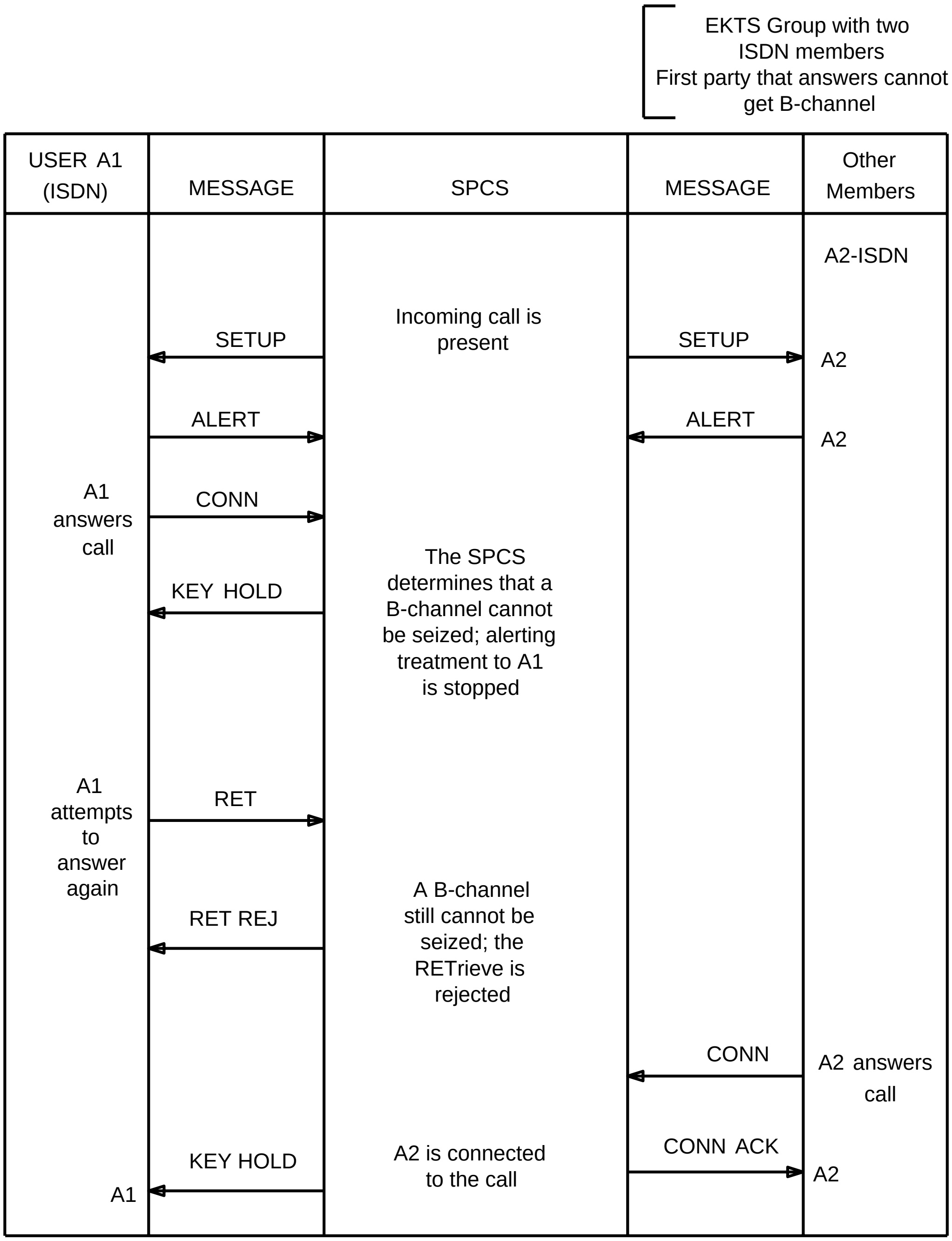


Figure 5.2.1-32 — Incoming Call Treatment (6 of 7)

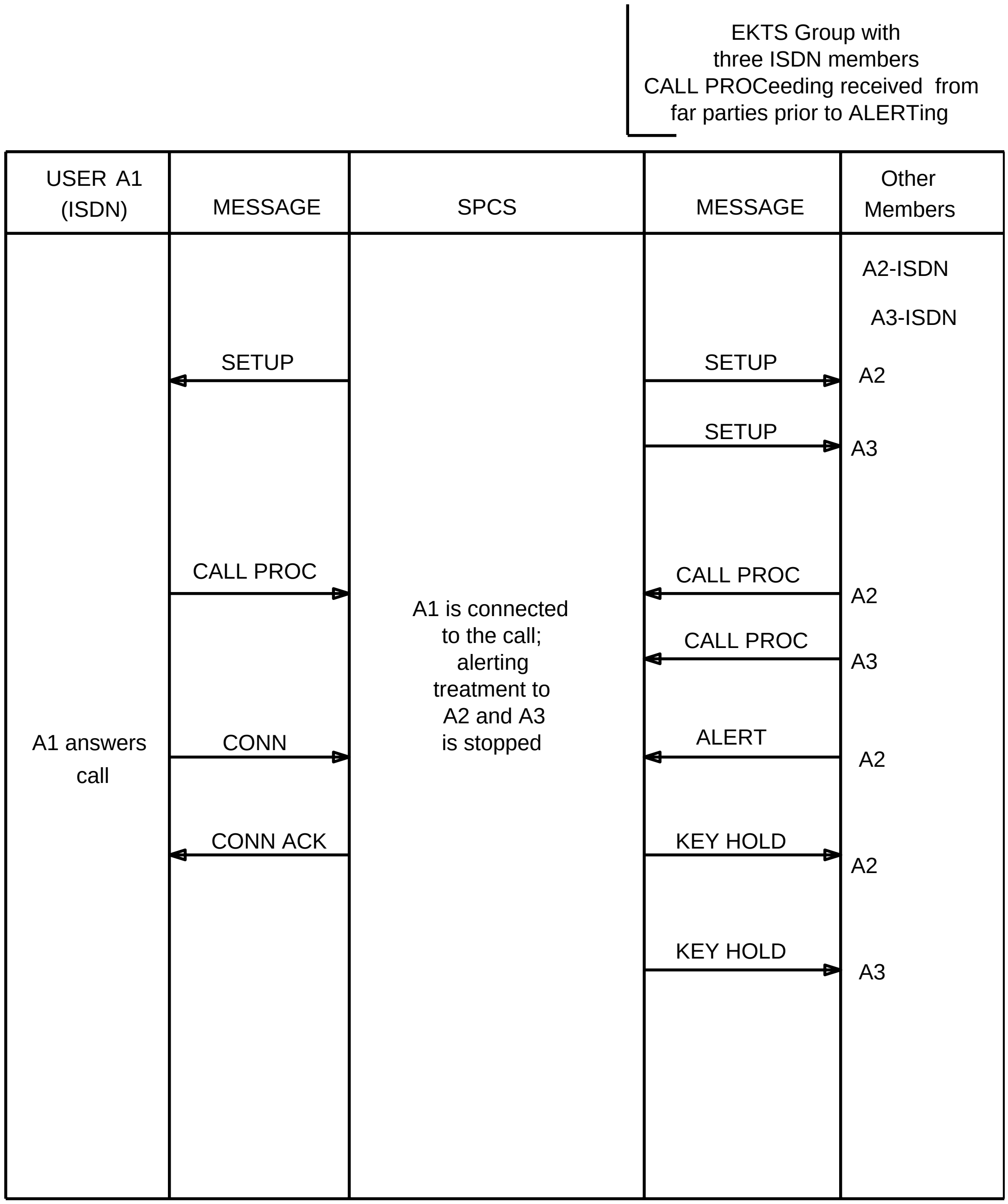


Figure 5.2.1-32 — Incoming Call Treatment (7 of 7)

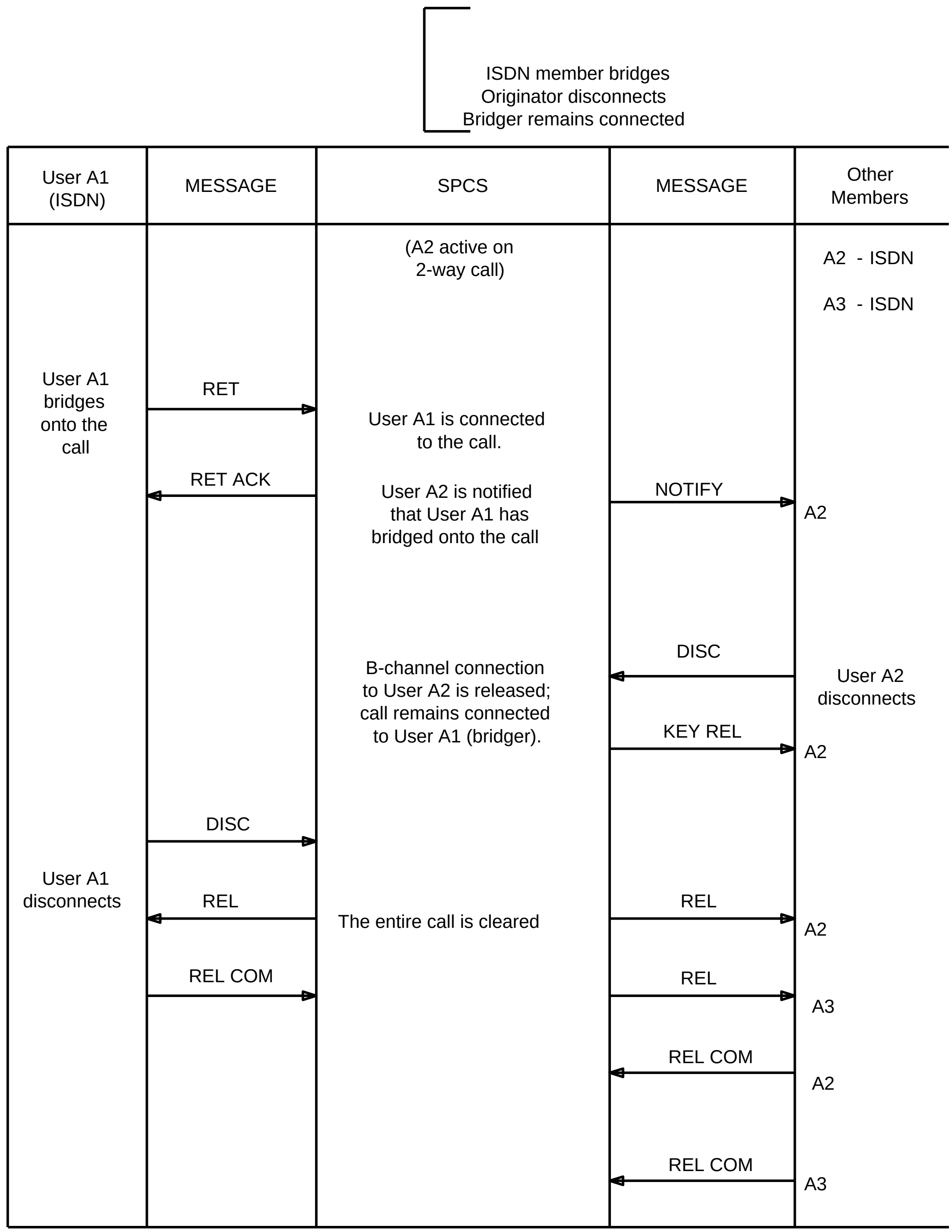


Figure 5.2.1-33 — Bridging (1 of 4)

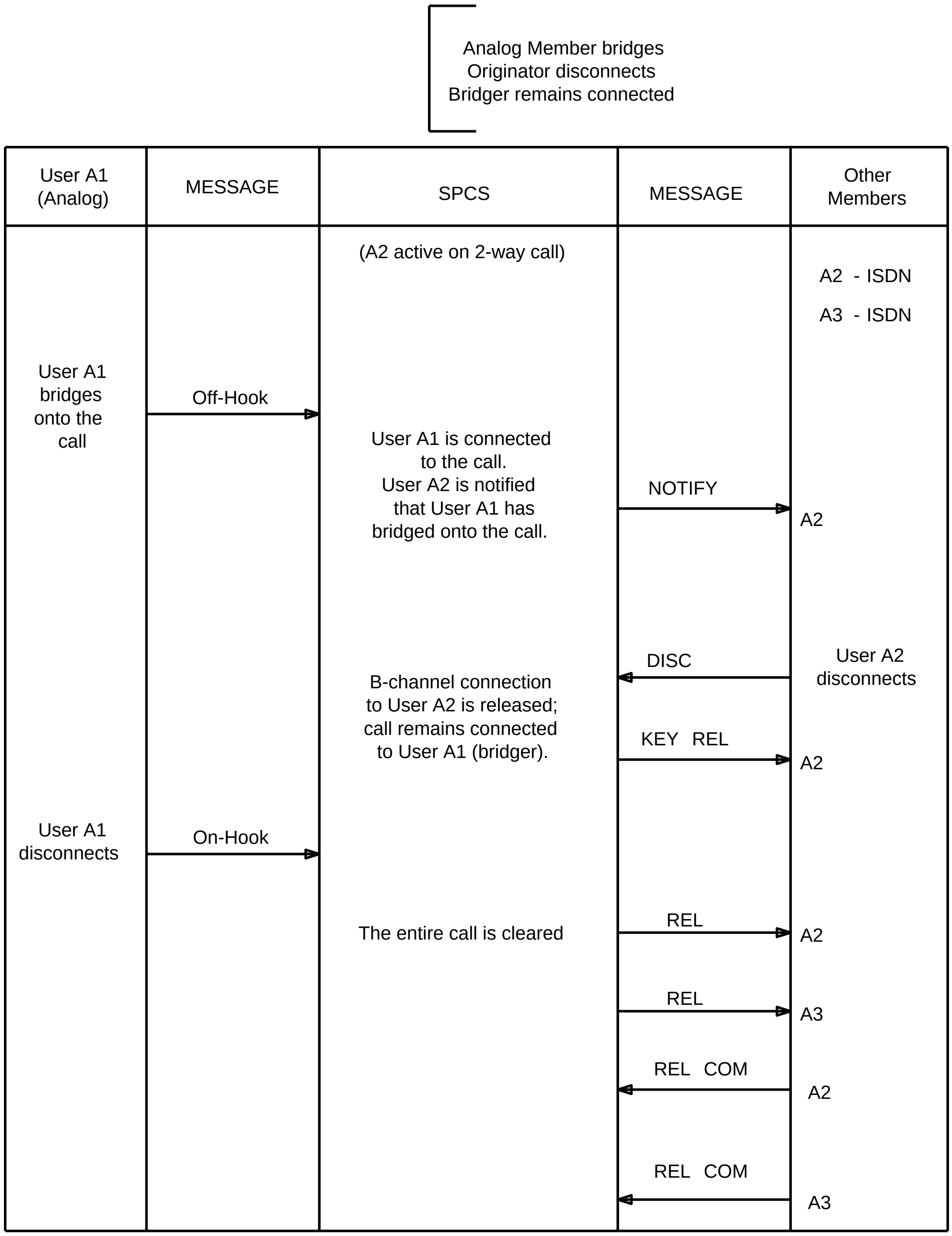


Figure 5.2.1-33 — Bridging (2 of 4)

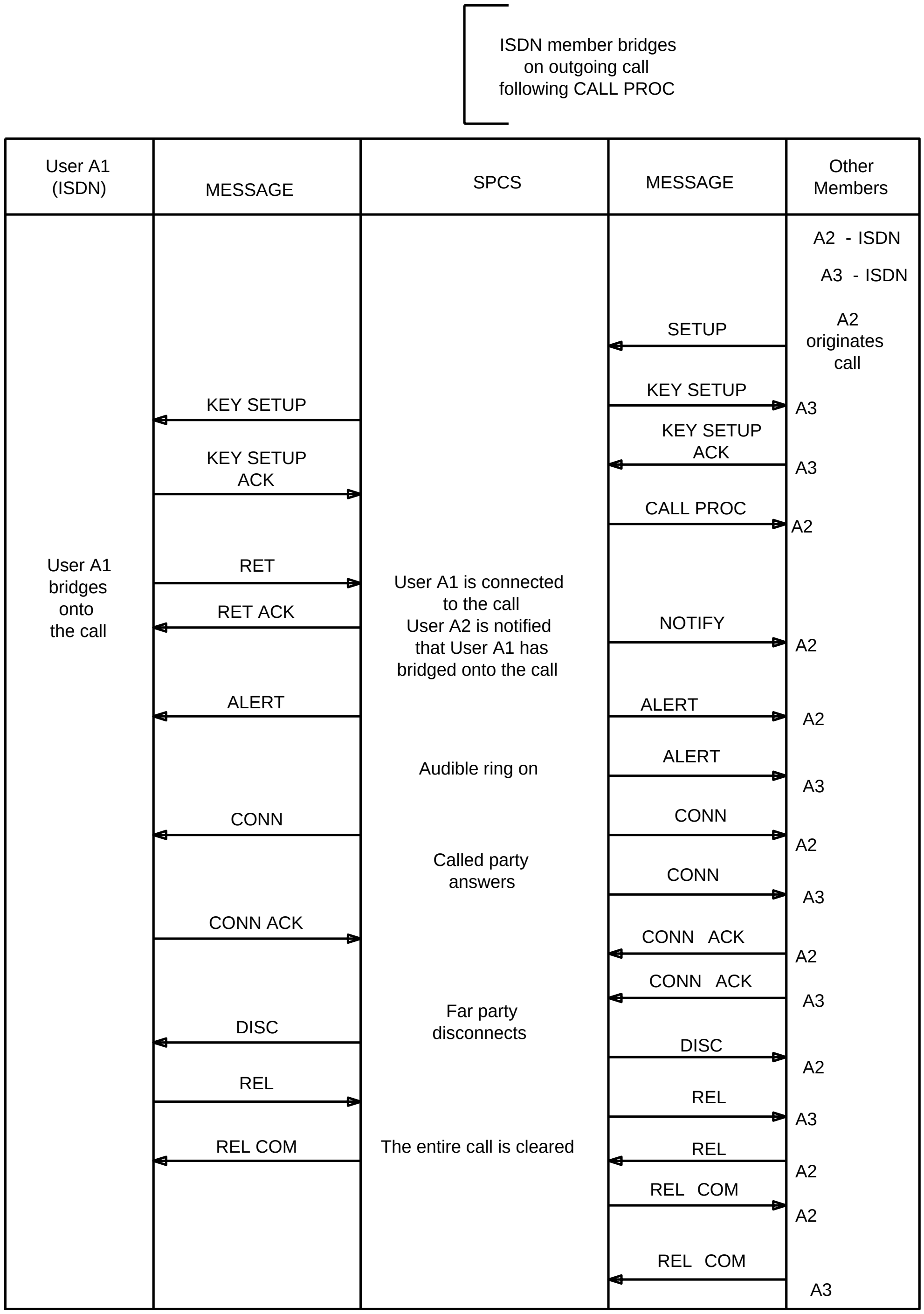


Figure 5.2.1-33 — Bridging (3 of 4)

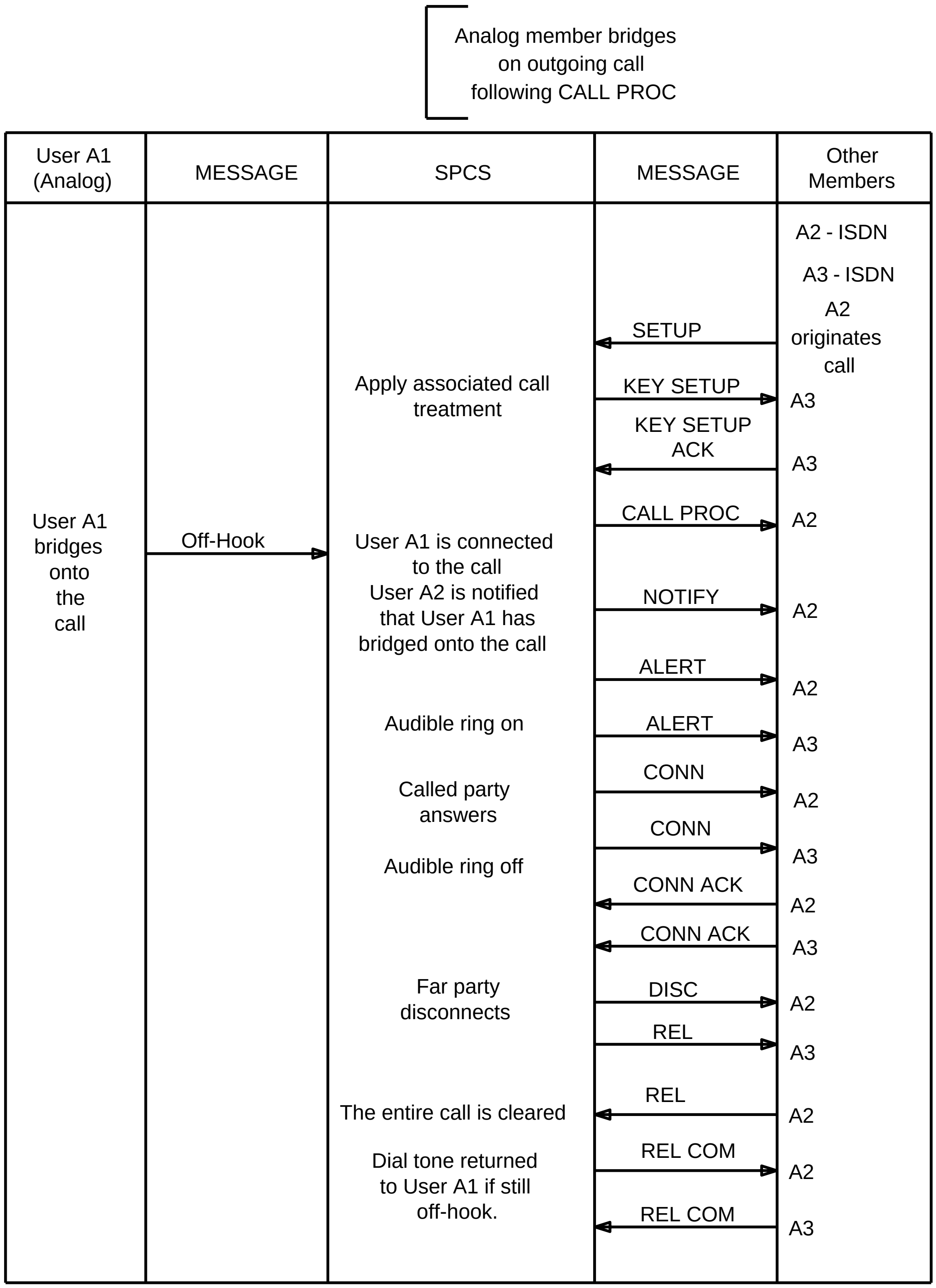


Figure 5.2.1-33 — Bridging (4 of 4)

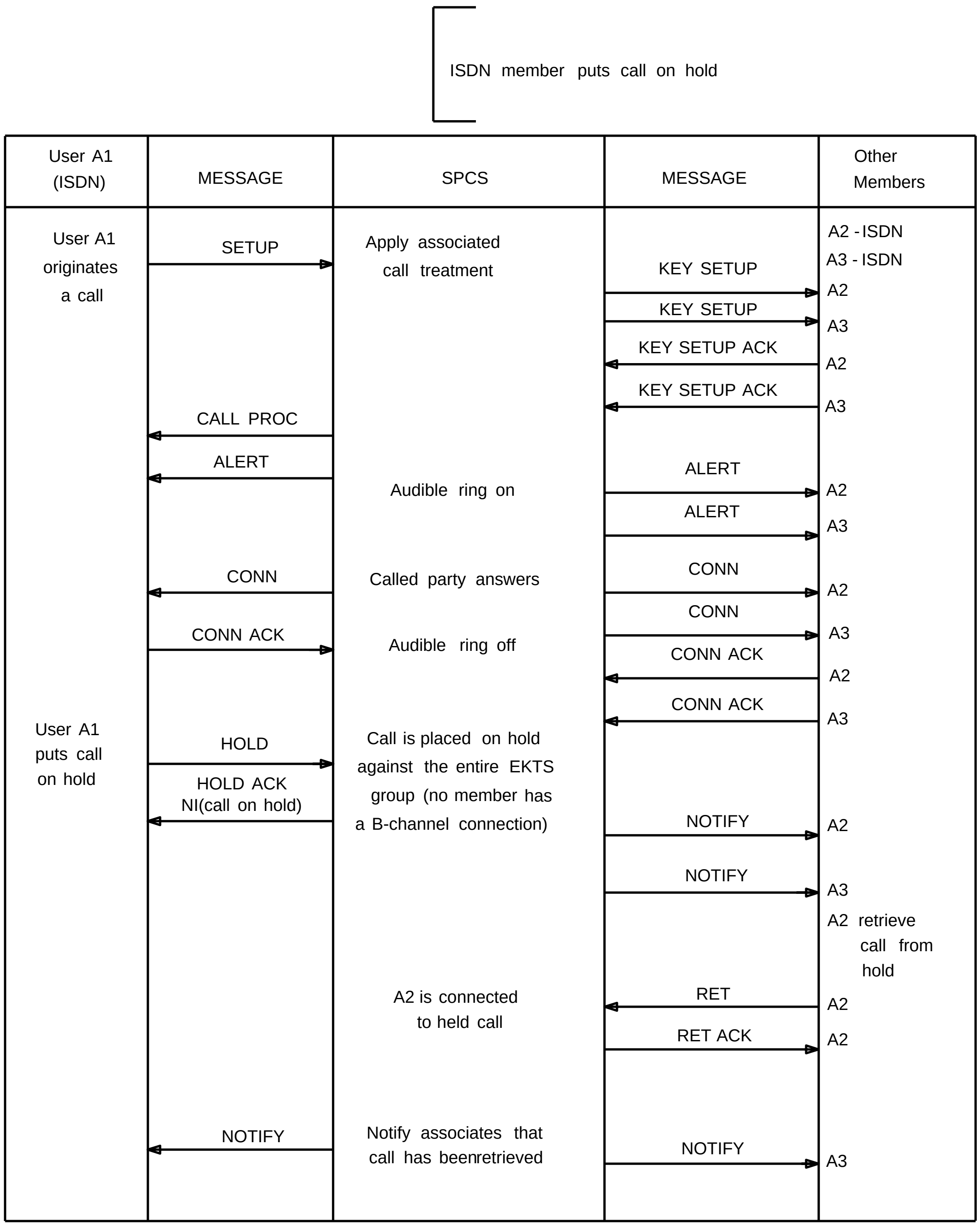


Figure 5.2.1-34 — ISDN Hold (1 of 3)

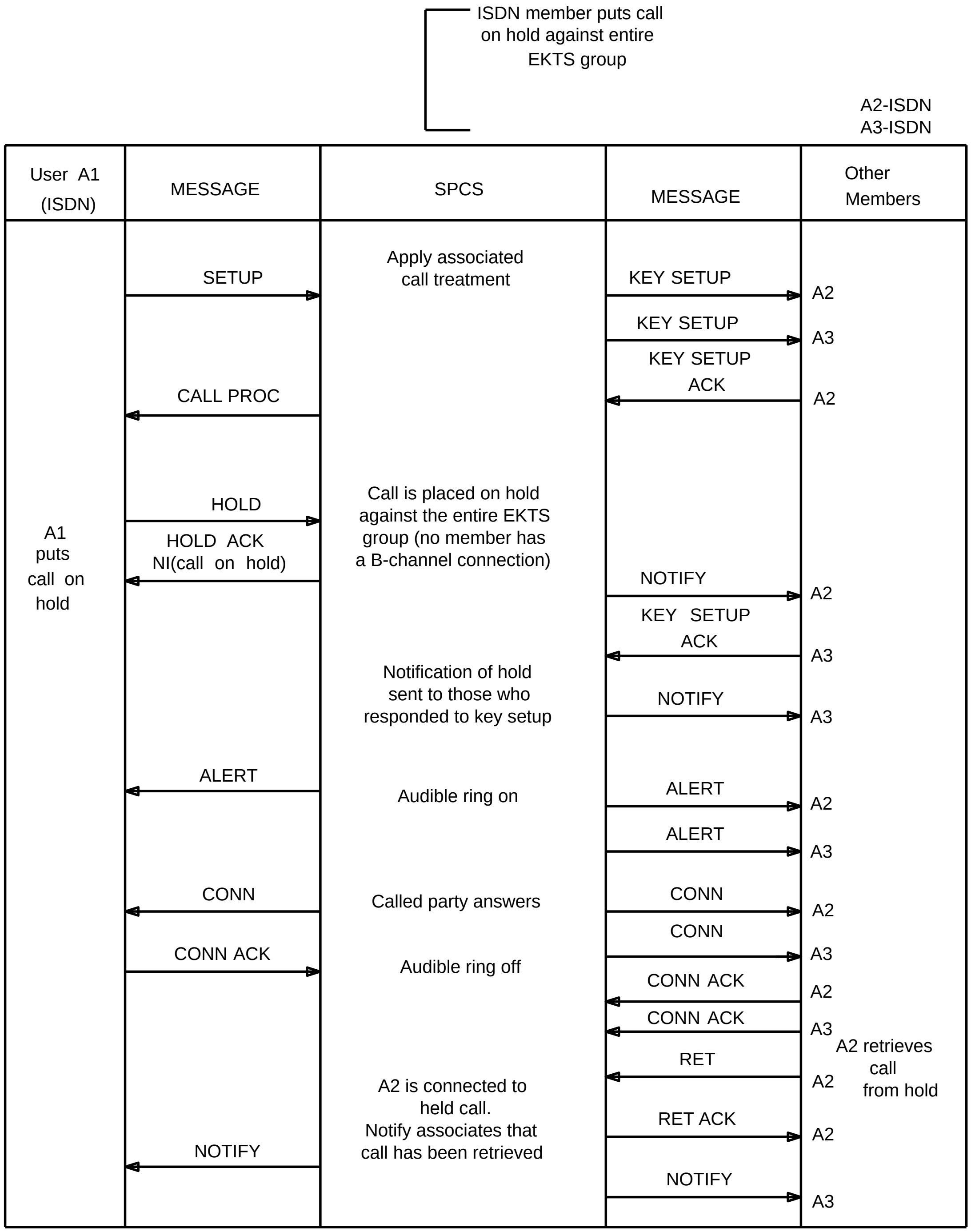


Figure 5.2.1-34 — ISDN Hold (2 of 3)

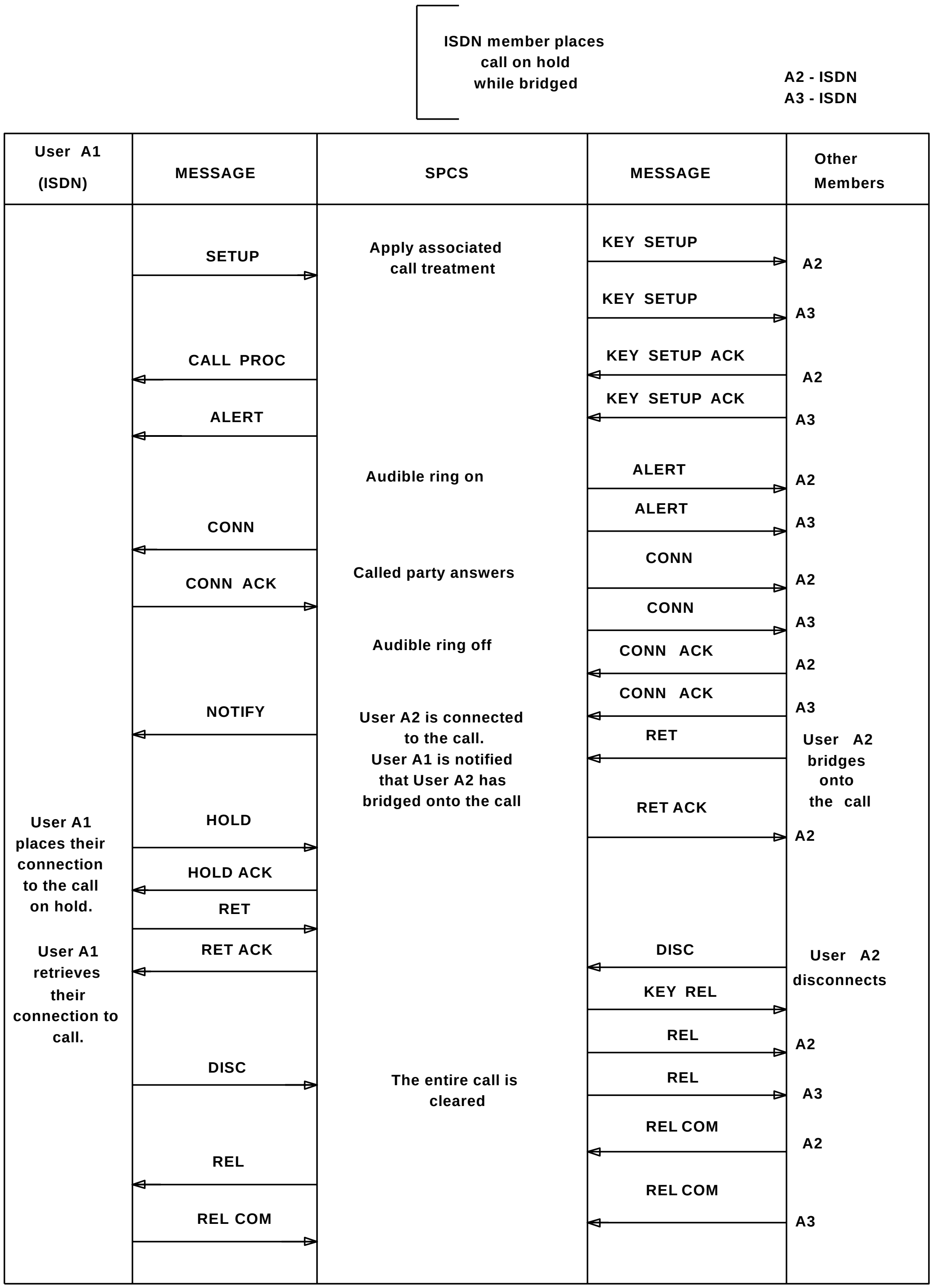


Figure 5.2.1-34 — ISDN Hold (3 of 3)

Outgoing call; enbloc signaling
Failed attempt to bridge on
Privacy release

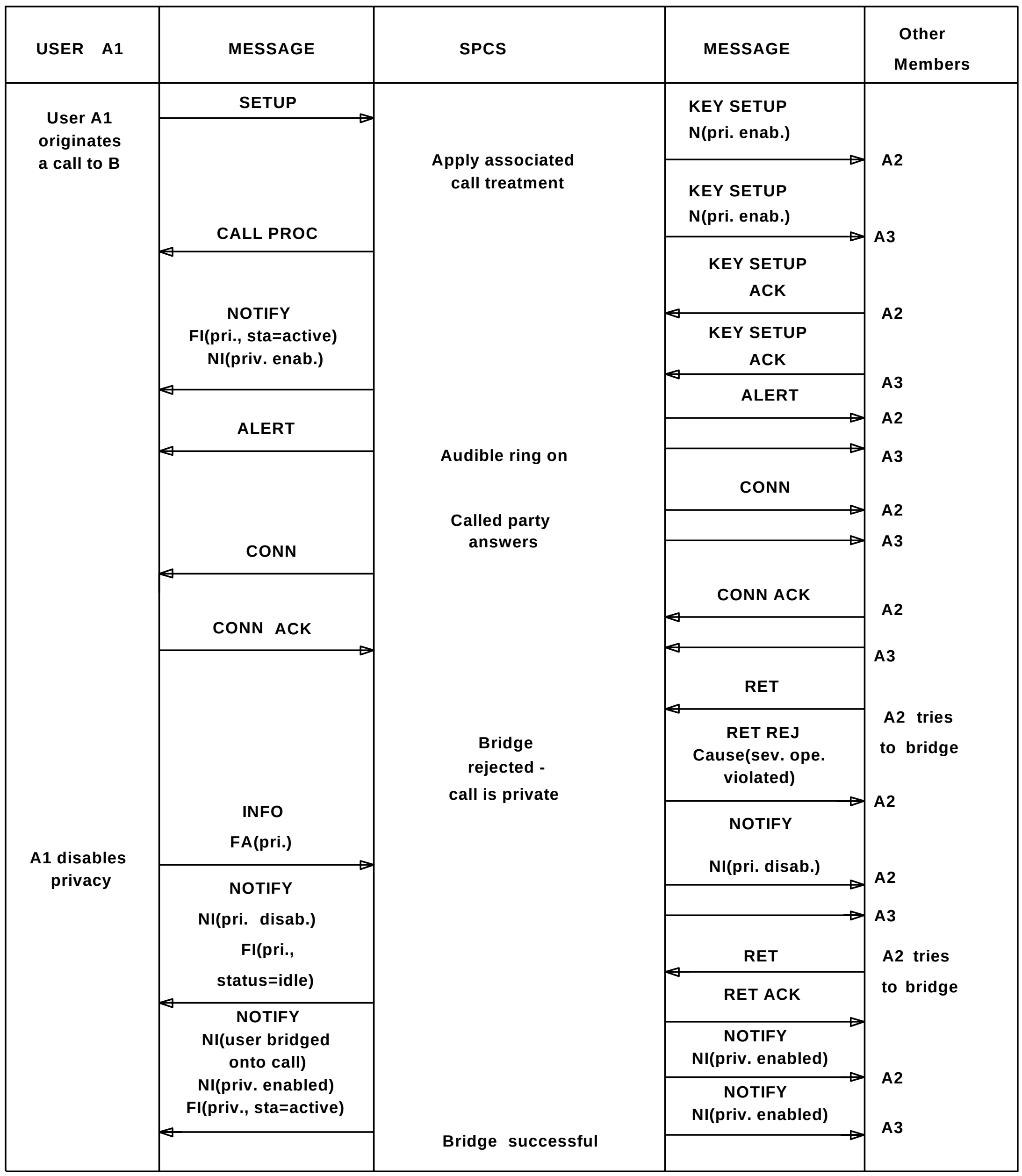


Figure 5.2.1-35 — ISDN Automatic Call Exclusion (A1, A2, A3 - ISDN with ACE) (1 of 2)

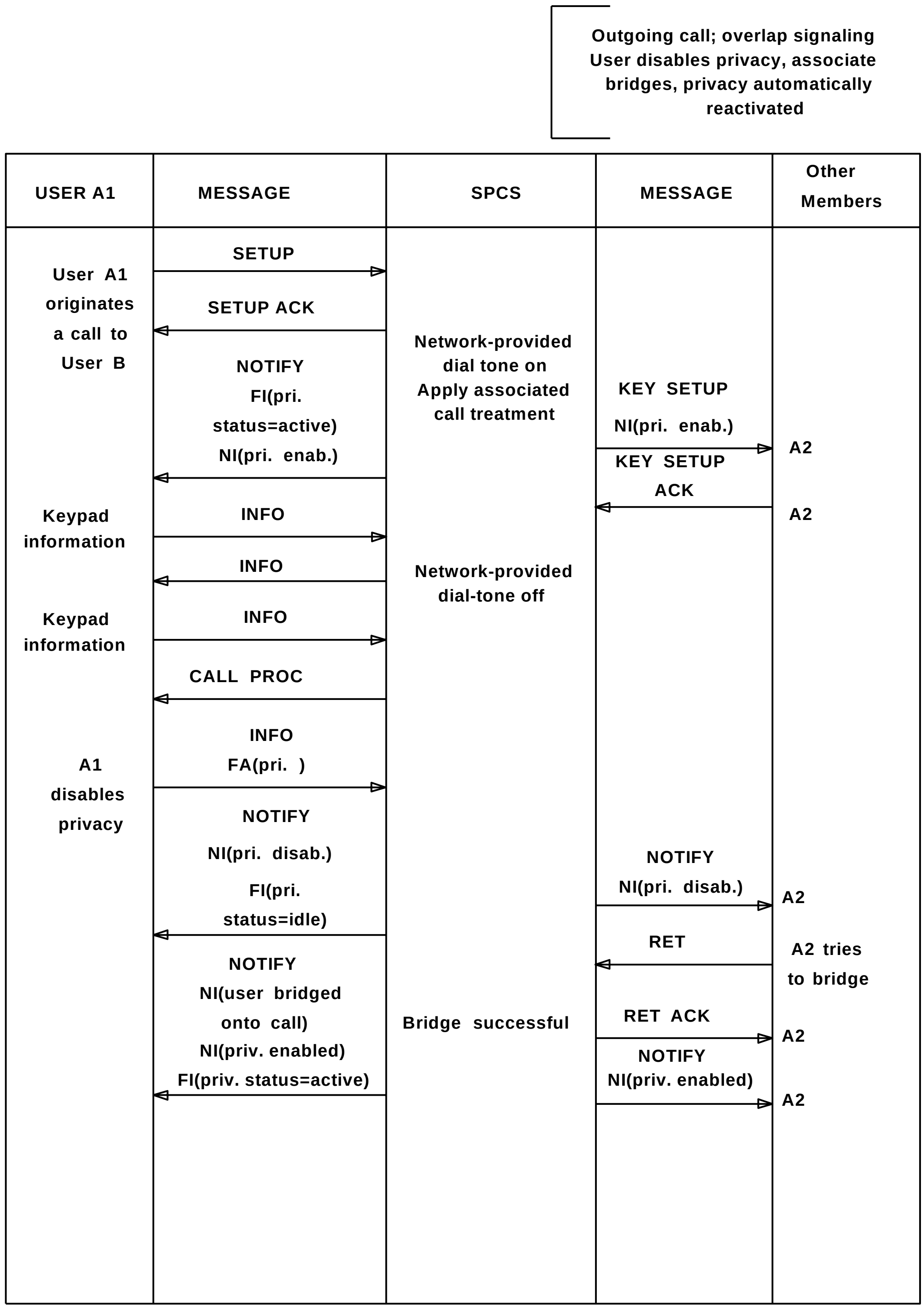


Figure 5.2.1-35 — ISDN Automatic Call Exclusion (A1, A2, A3 - ISDN with ACE) (2 of 2)

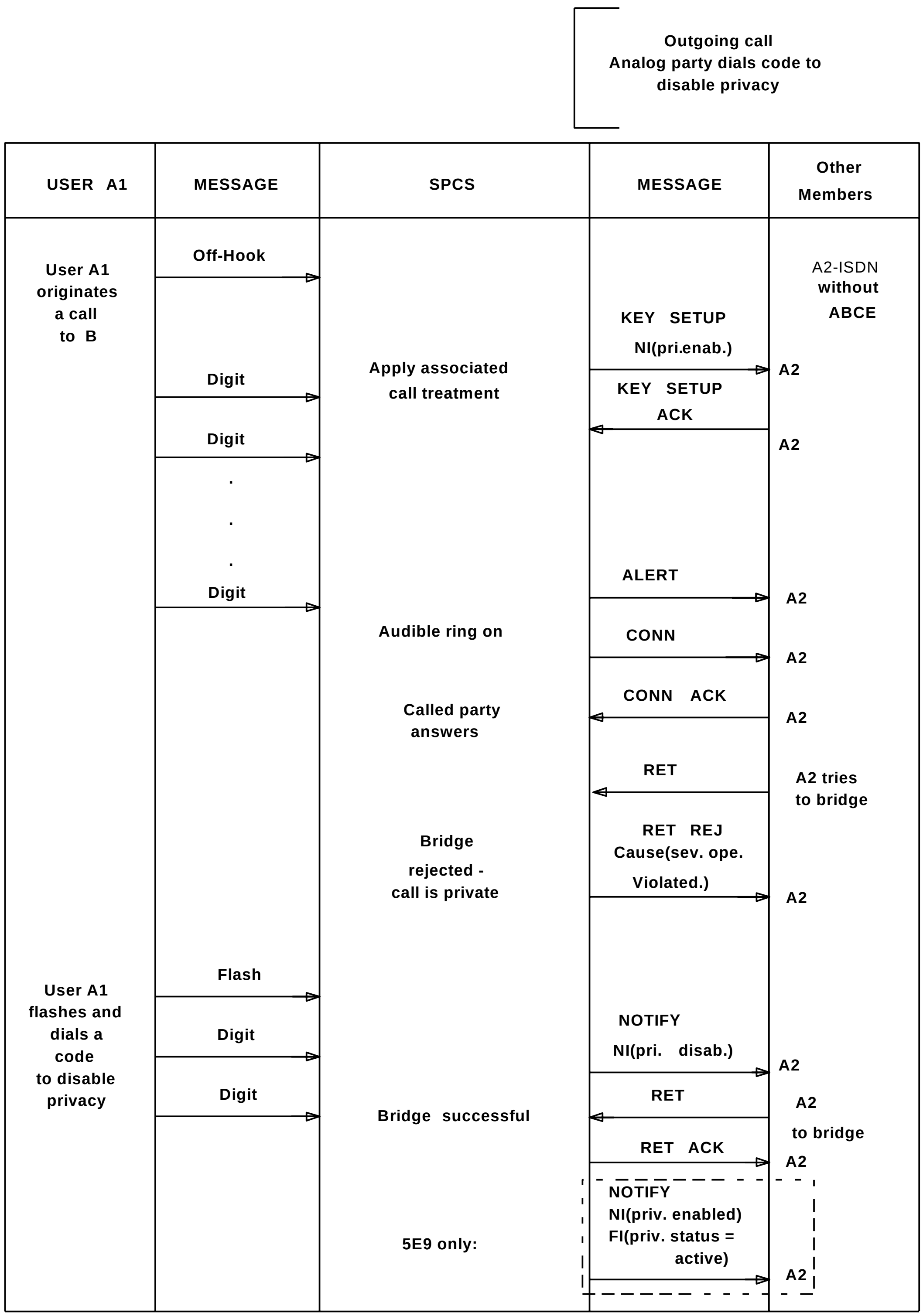


Figure 5.2.1-36 — ISDN Automatic Call Exclusion (A1 - Analog with ACE)

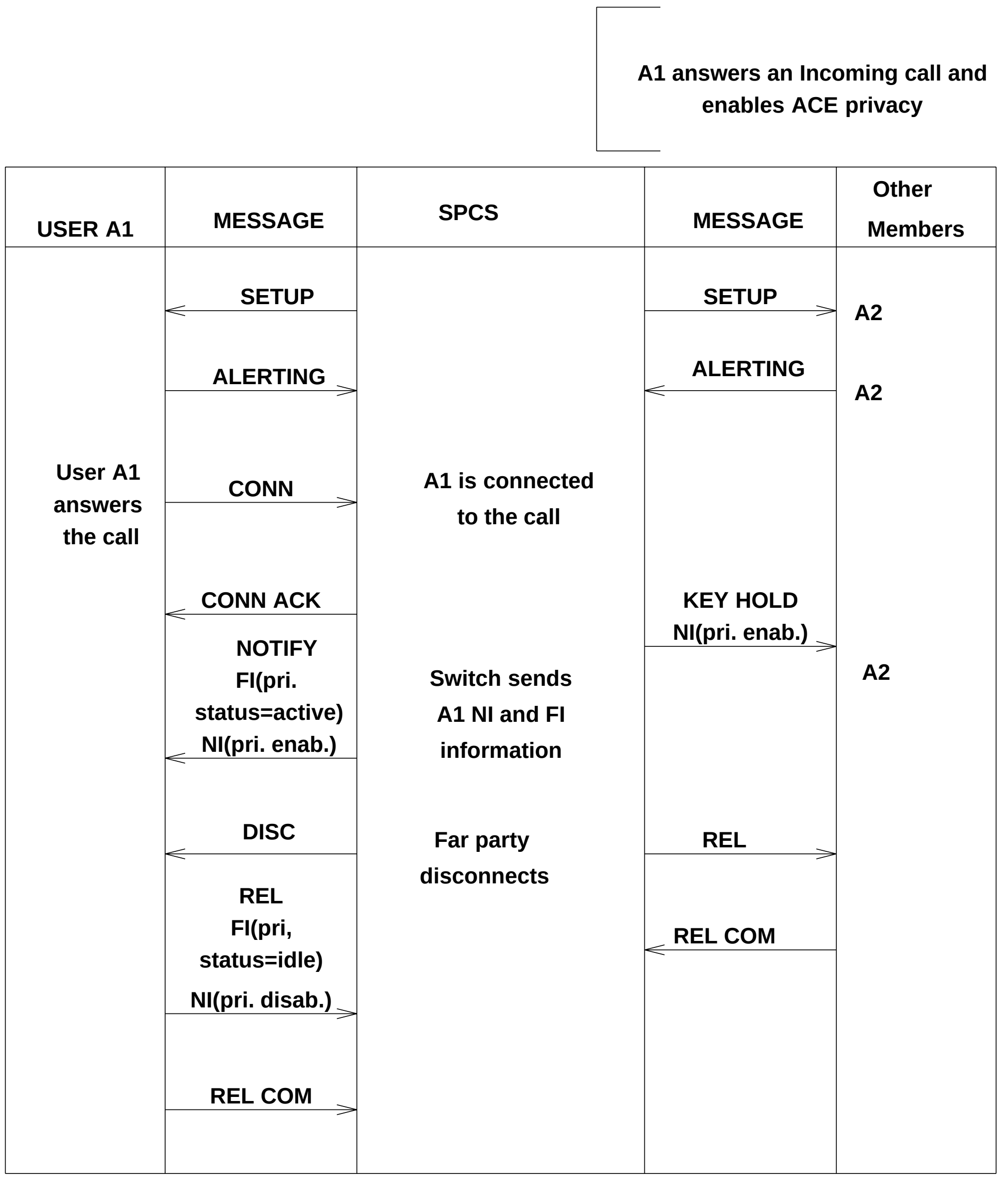


Figure 5.2.1-37 — Automatic Call Exclusion (A1, A2 - ISDN with ACE)

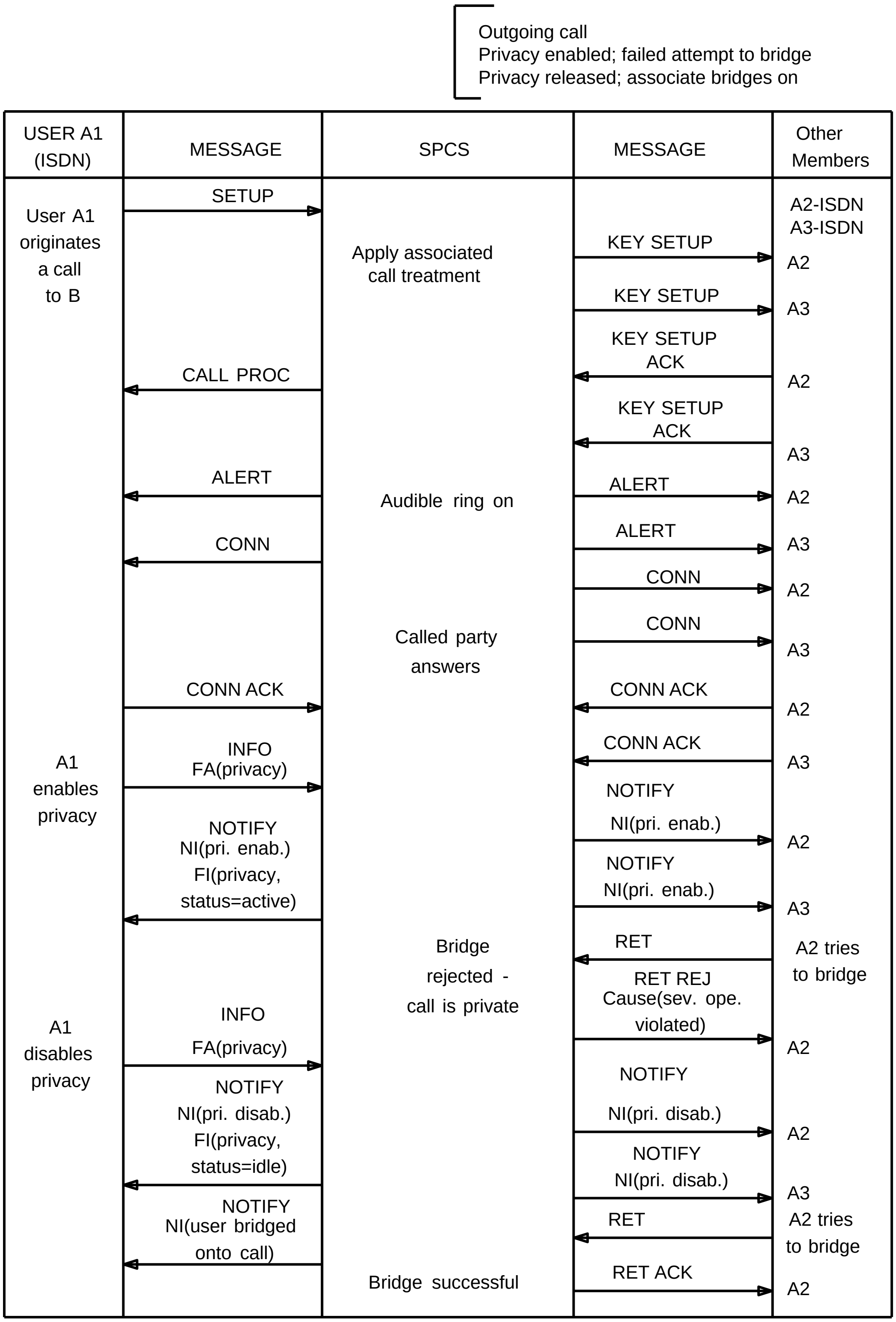


Figure 5.2.1-38 — Manual Call Exclusion (1 of 2)

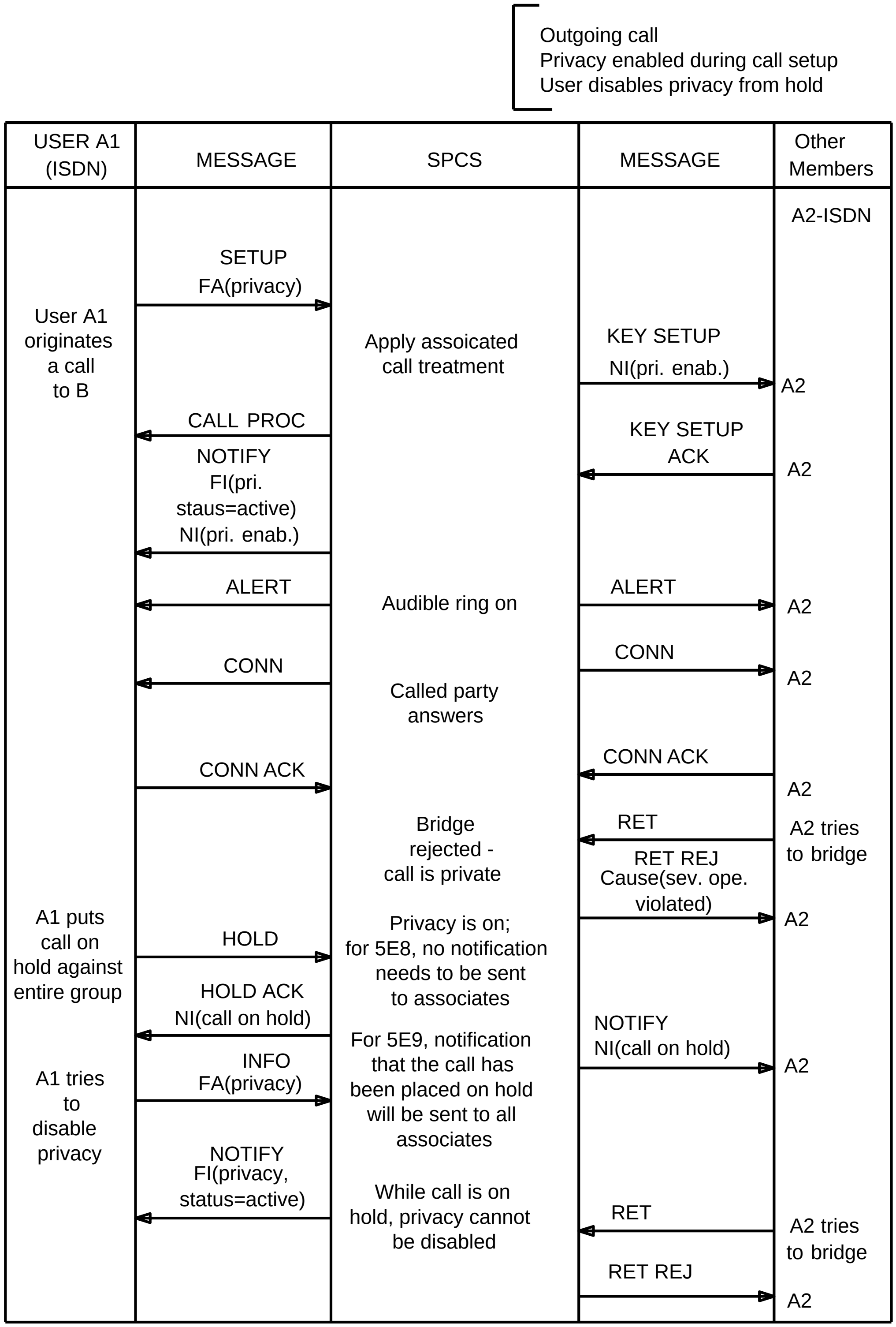


Figure 5.2.1-38 — Manual Call Exclusion (2 of 2)

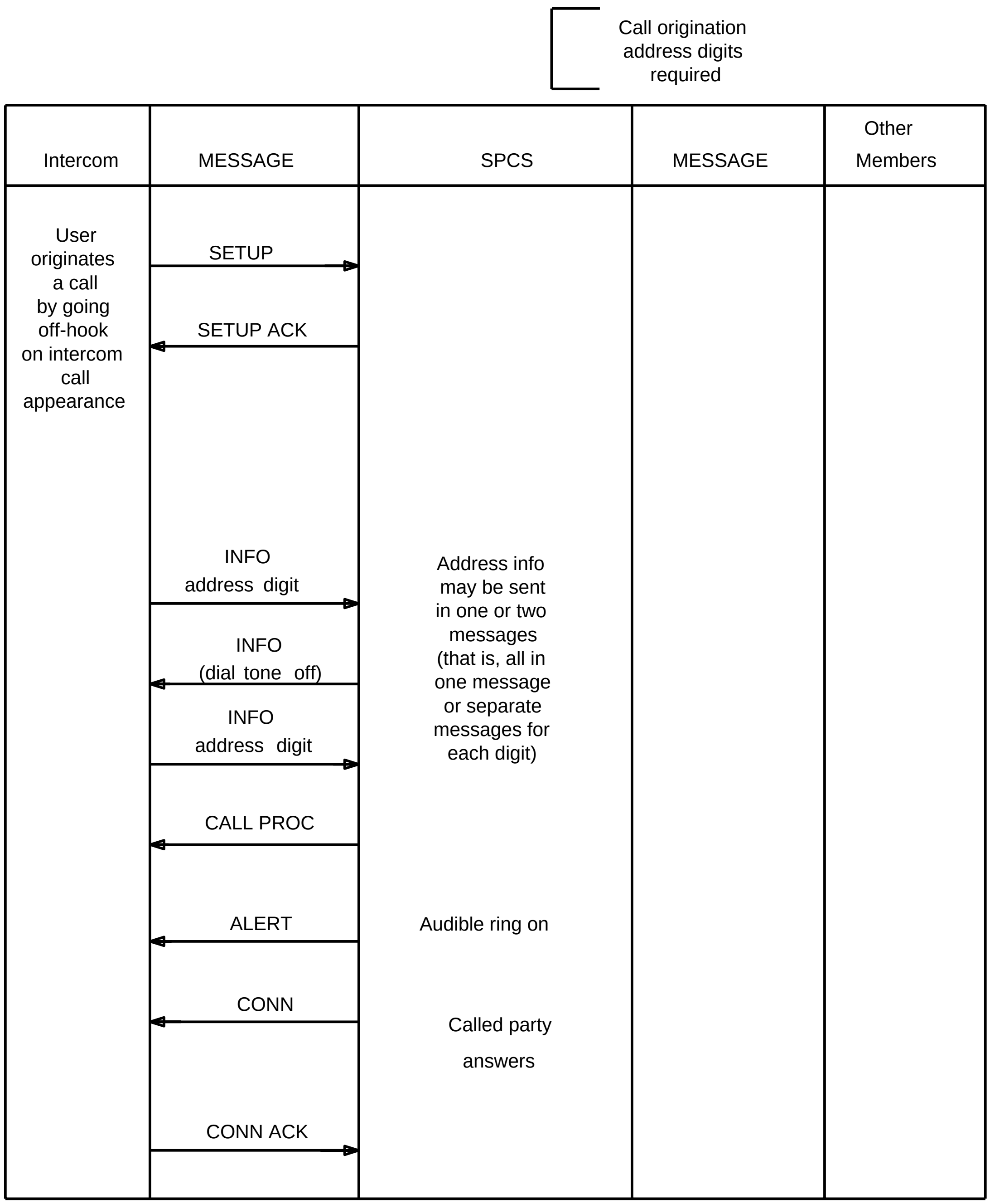


Figure 5.2.1-39 — ISDN Intercom Calling (1 of 2)

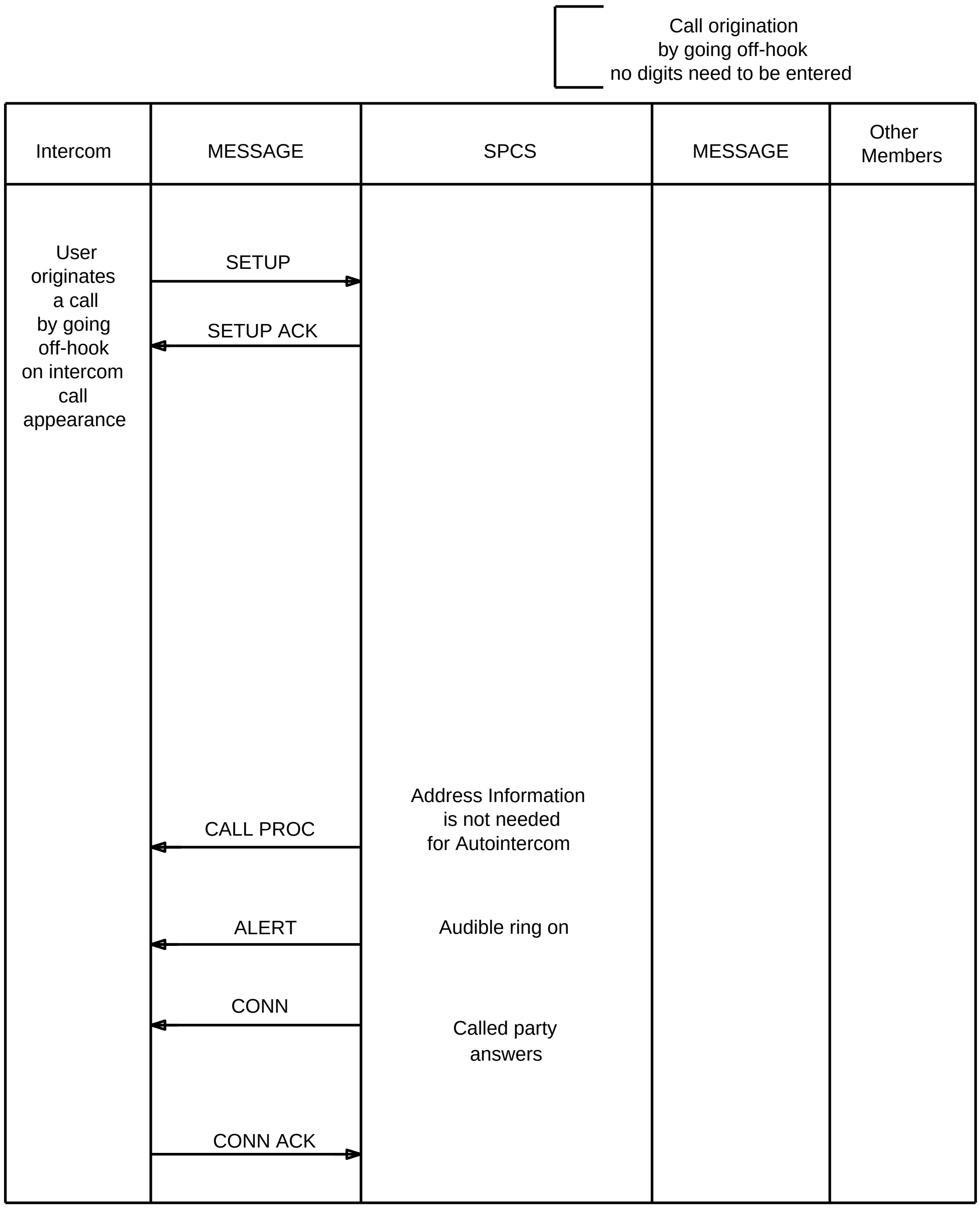


Figure 5.2.1-39 — ISDN Intercom Calling (2 of 2)

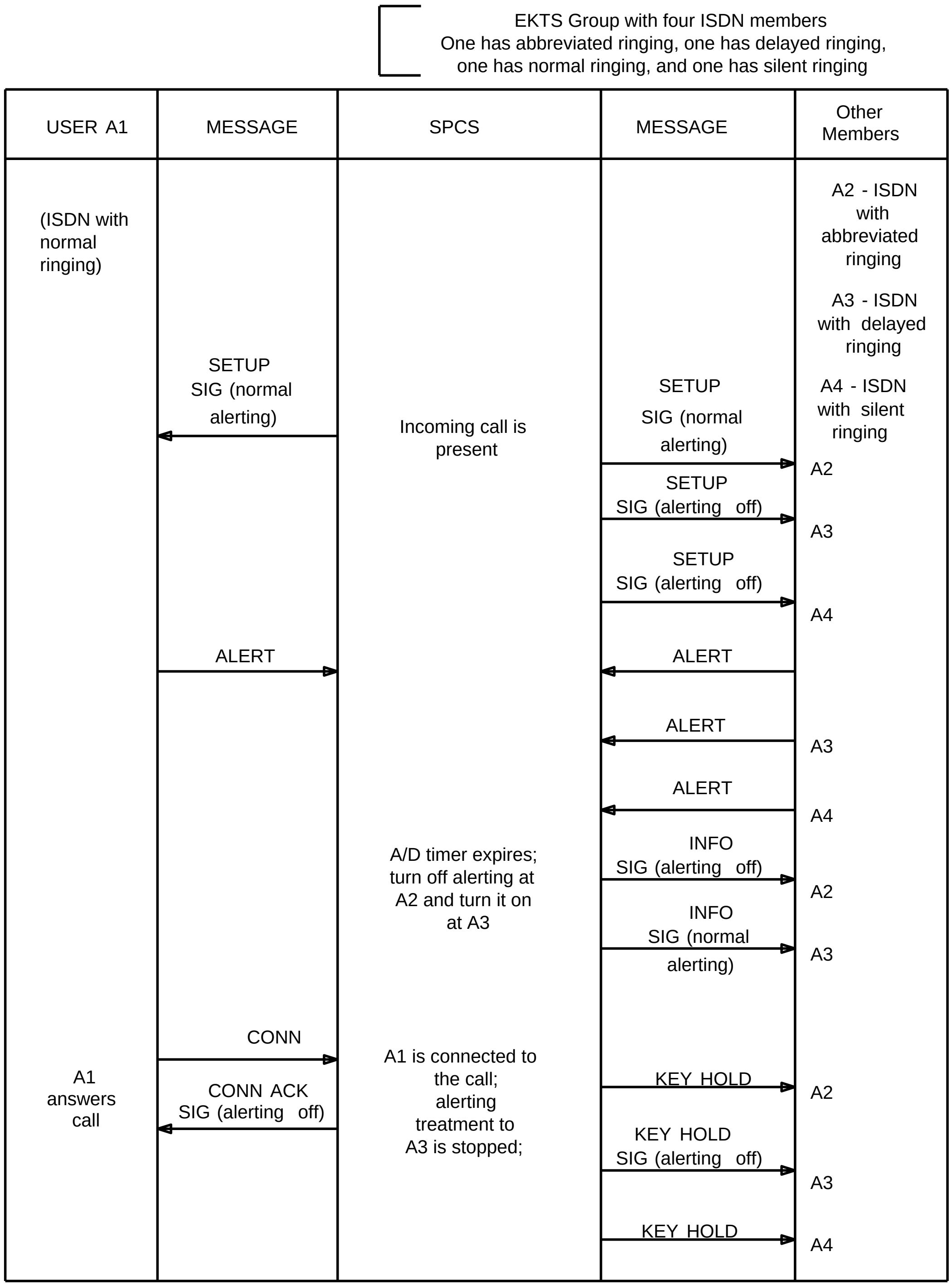


Figure 5.2.1-40 — Abbreviated and Delayed Ringing

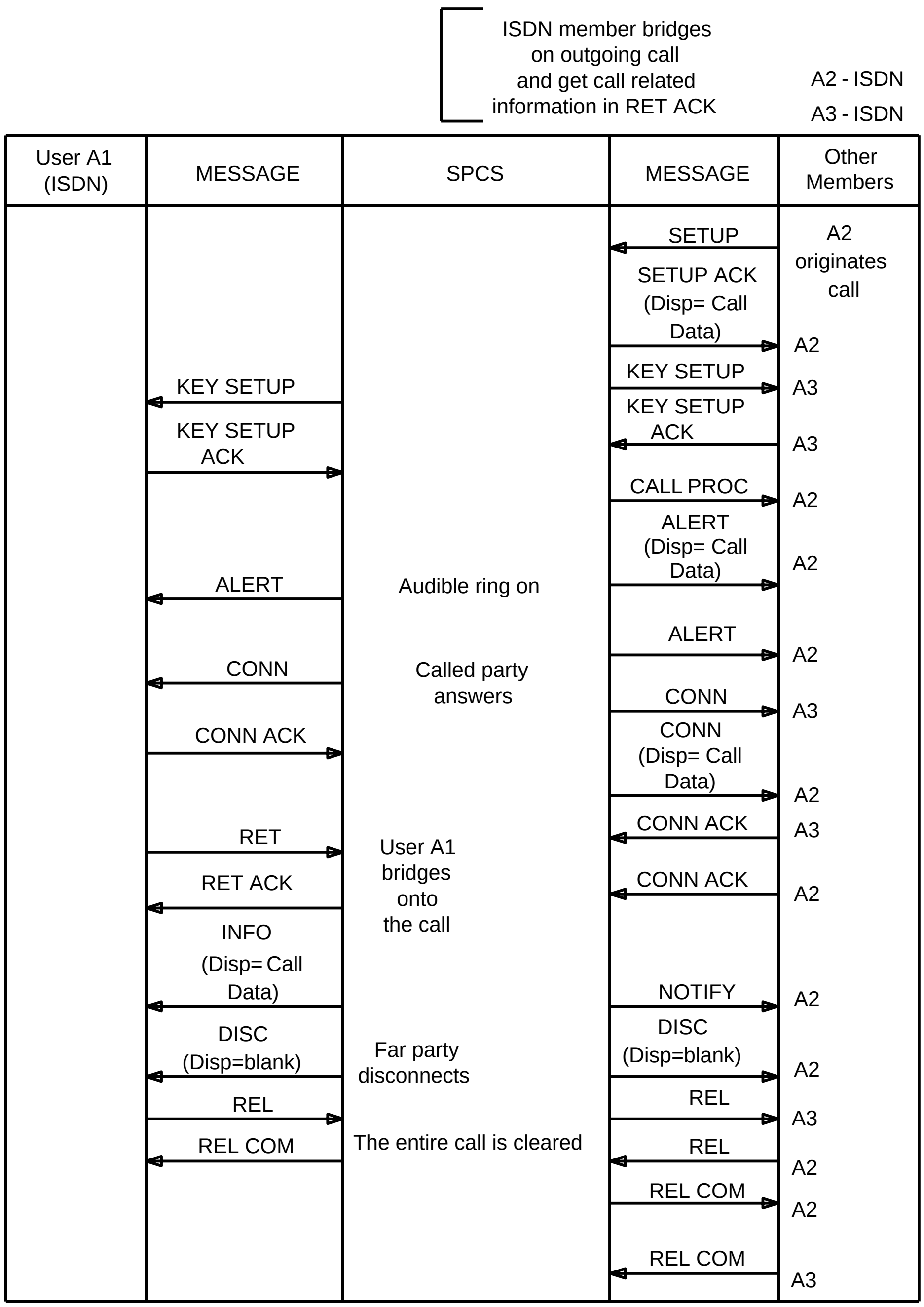


Figure 5.2.1-41 — Display (1 of 2)

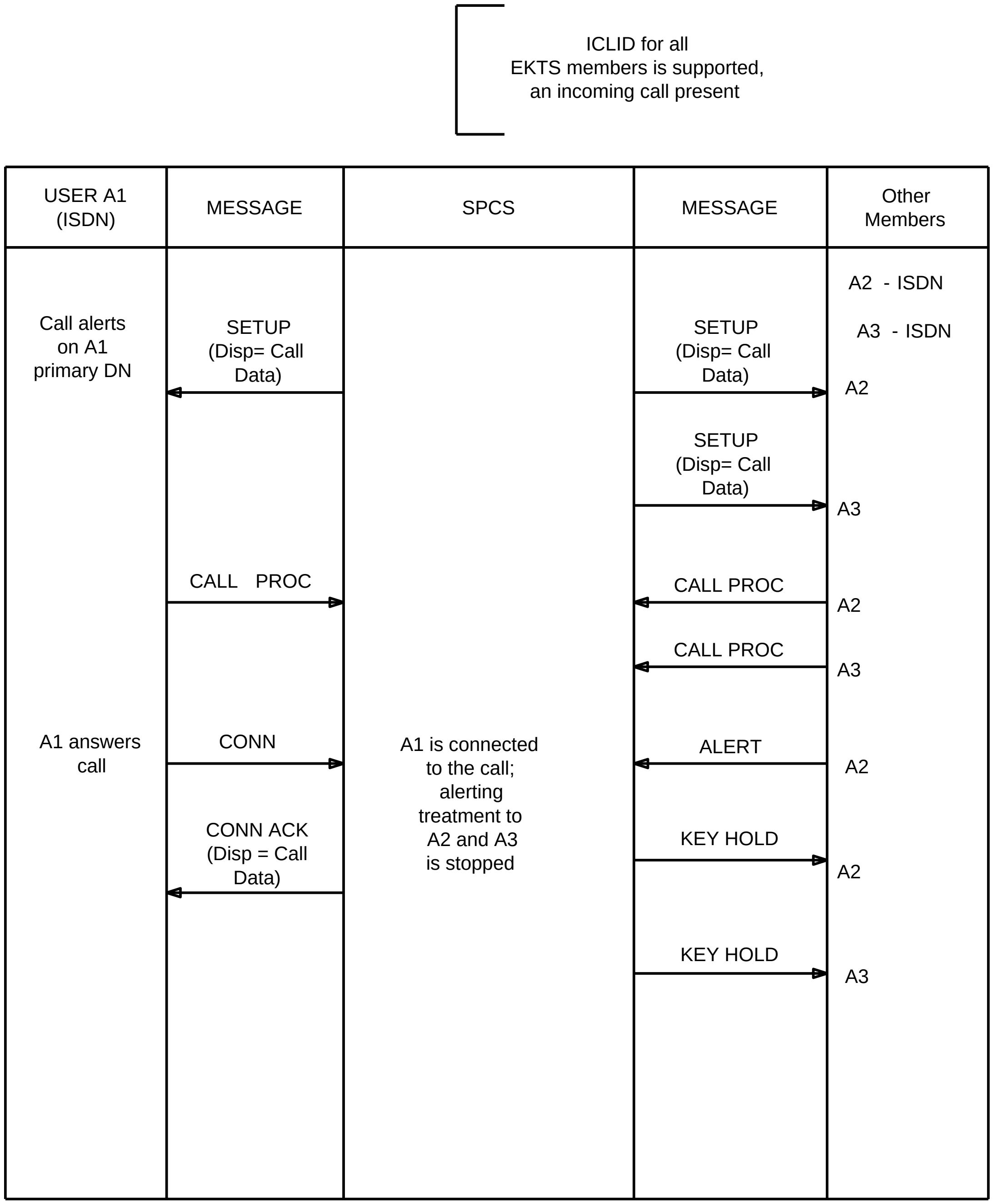


Figure 5.2.1-41 — Display (2 of 2)

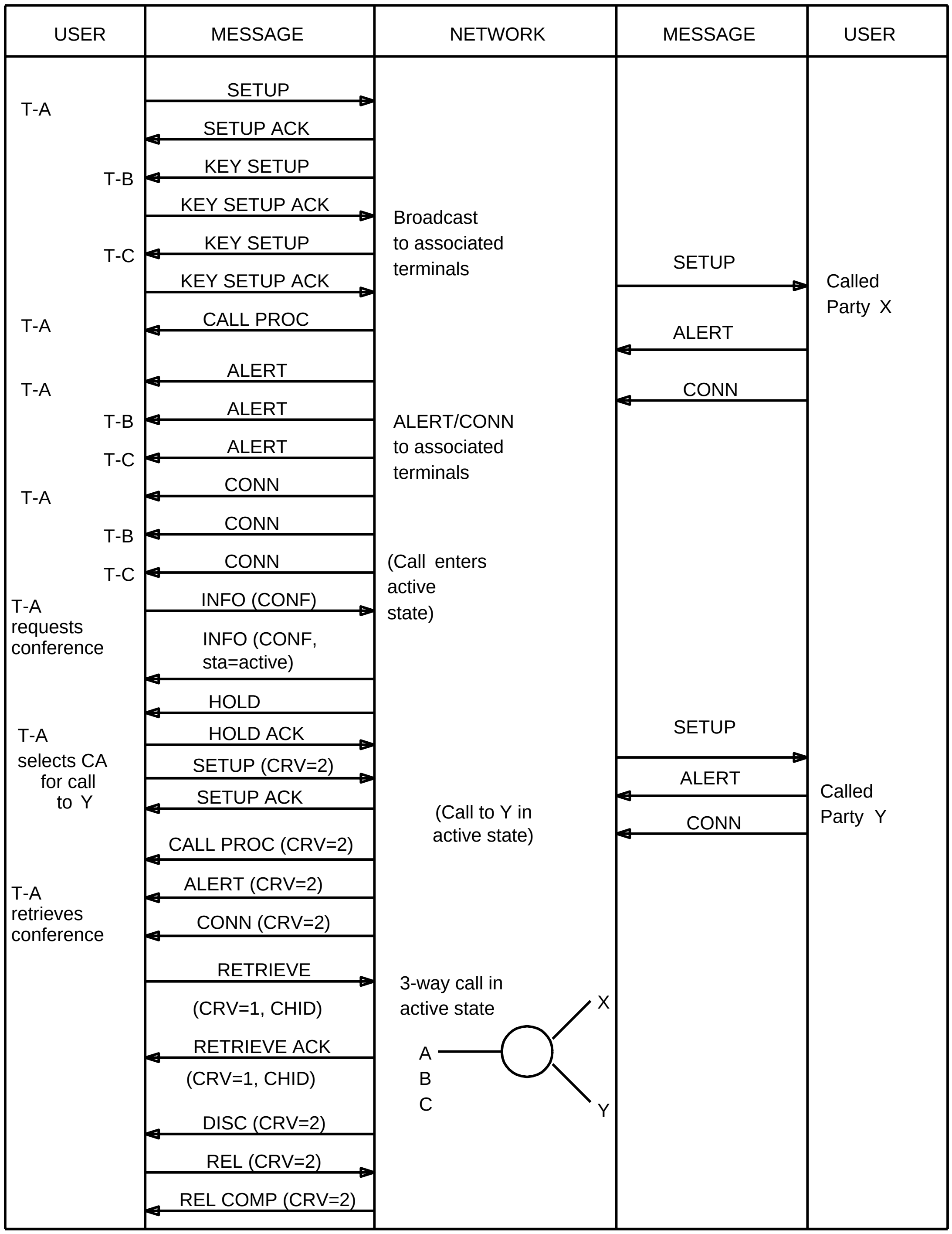


Figure 5.2.1-42 — ISDN Shared DN Member Originates Conference

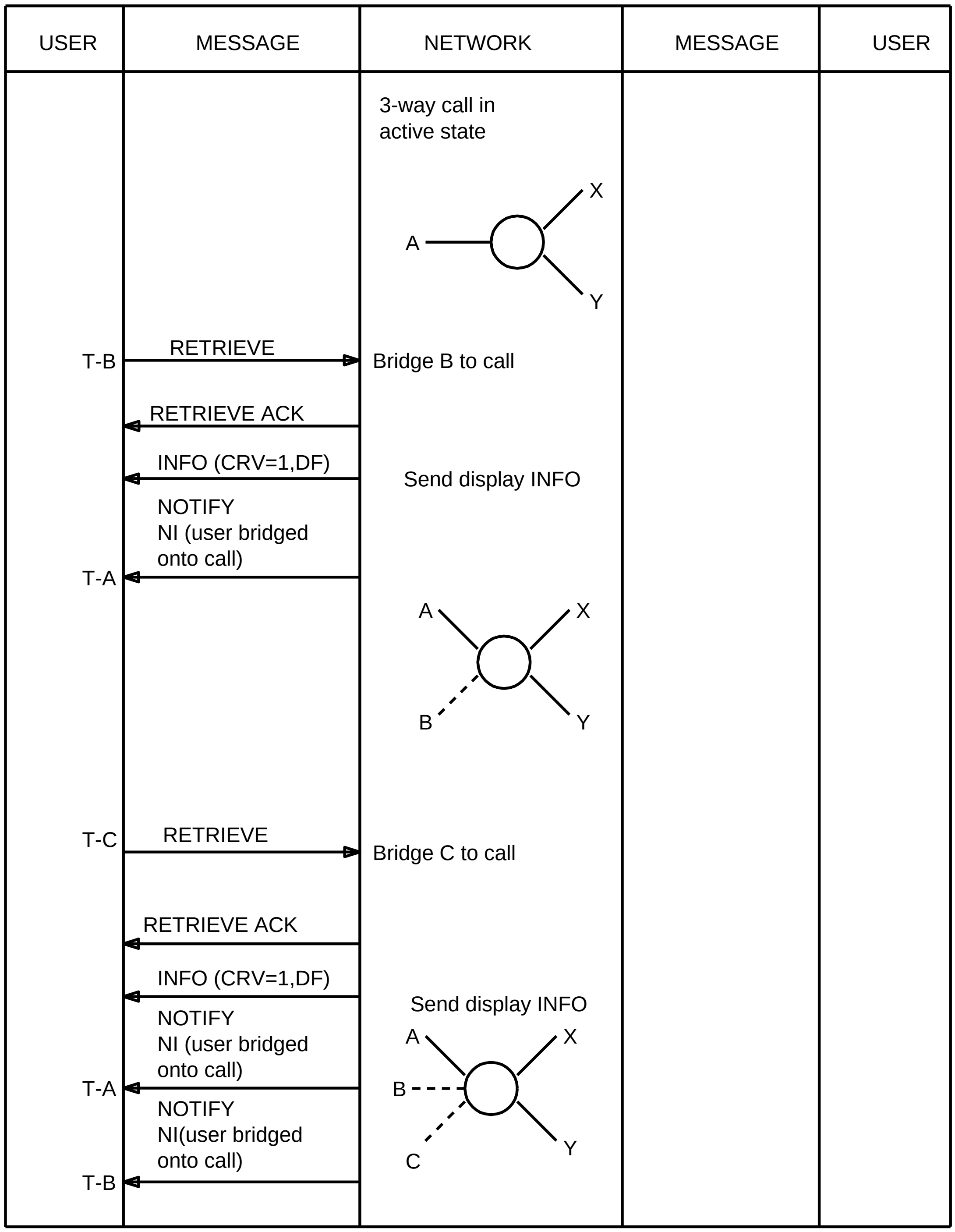


Figure 5.2.1-43 — Shared DN Member Bridge Onto Conference

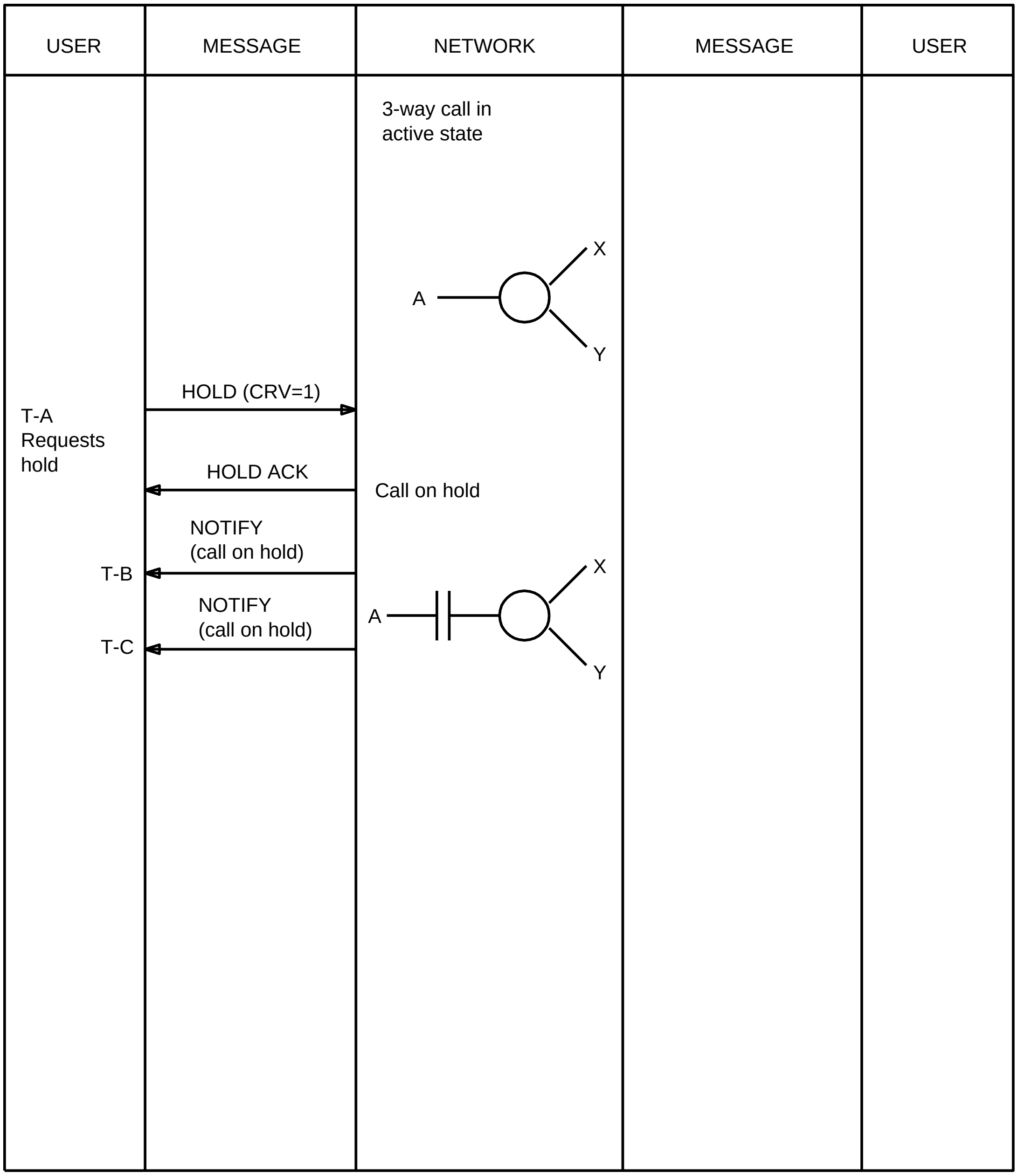


Figure 5.2.1-44 — Conference Put on Hold

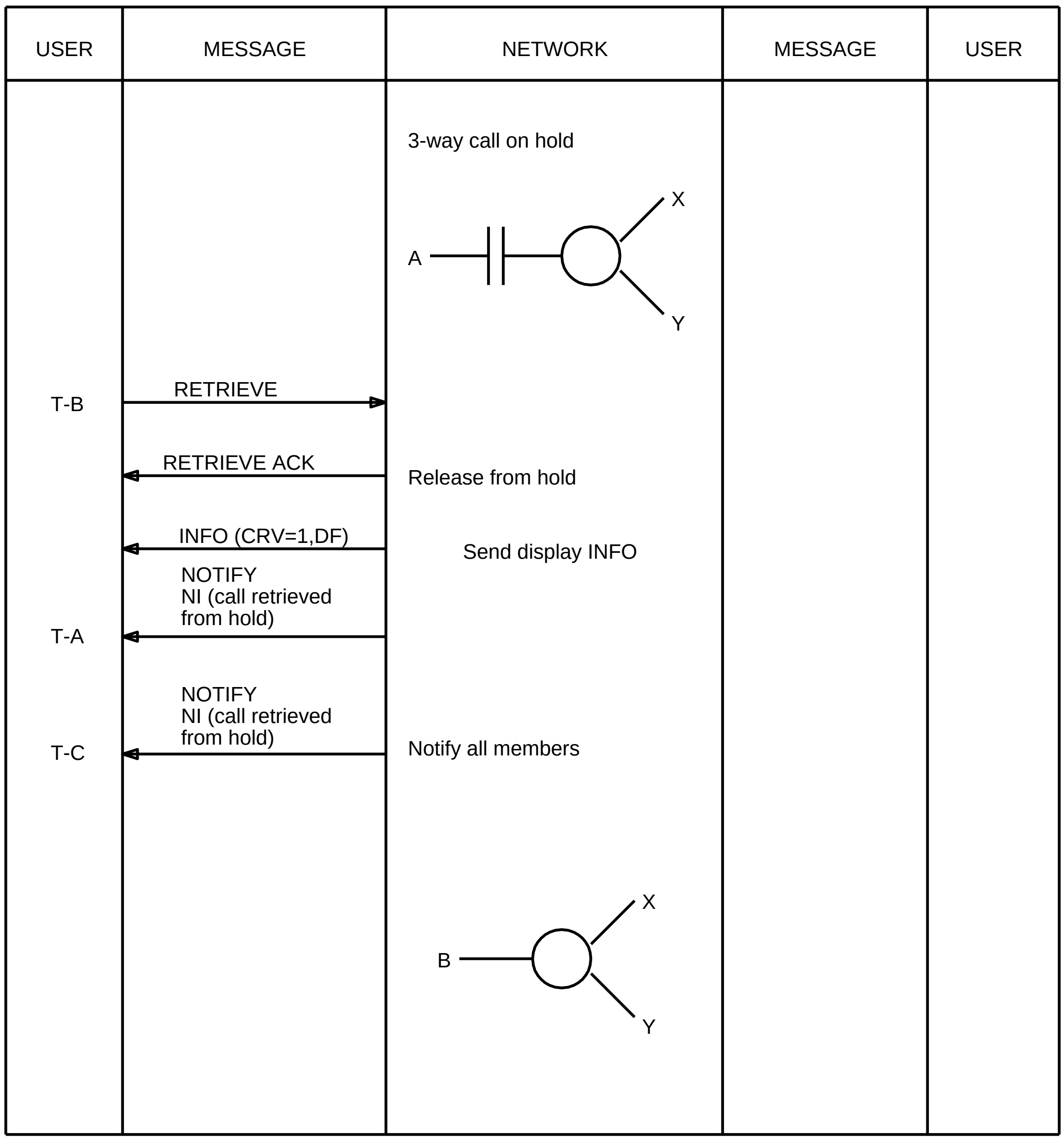


Figure 5.2.1-45 — Shared DN Member Retrieves Held Conference

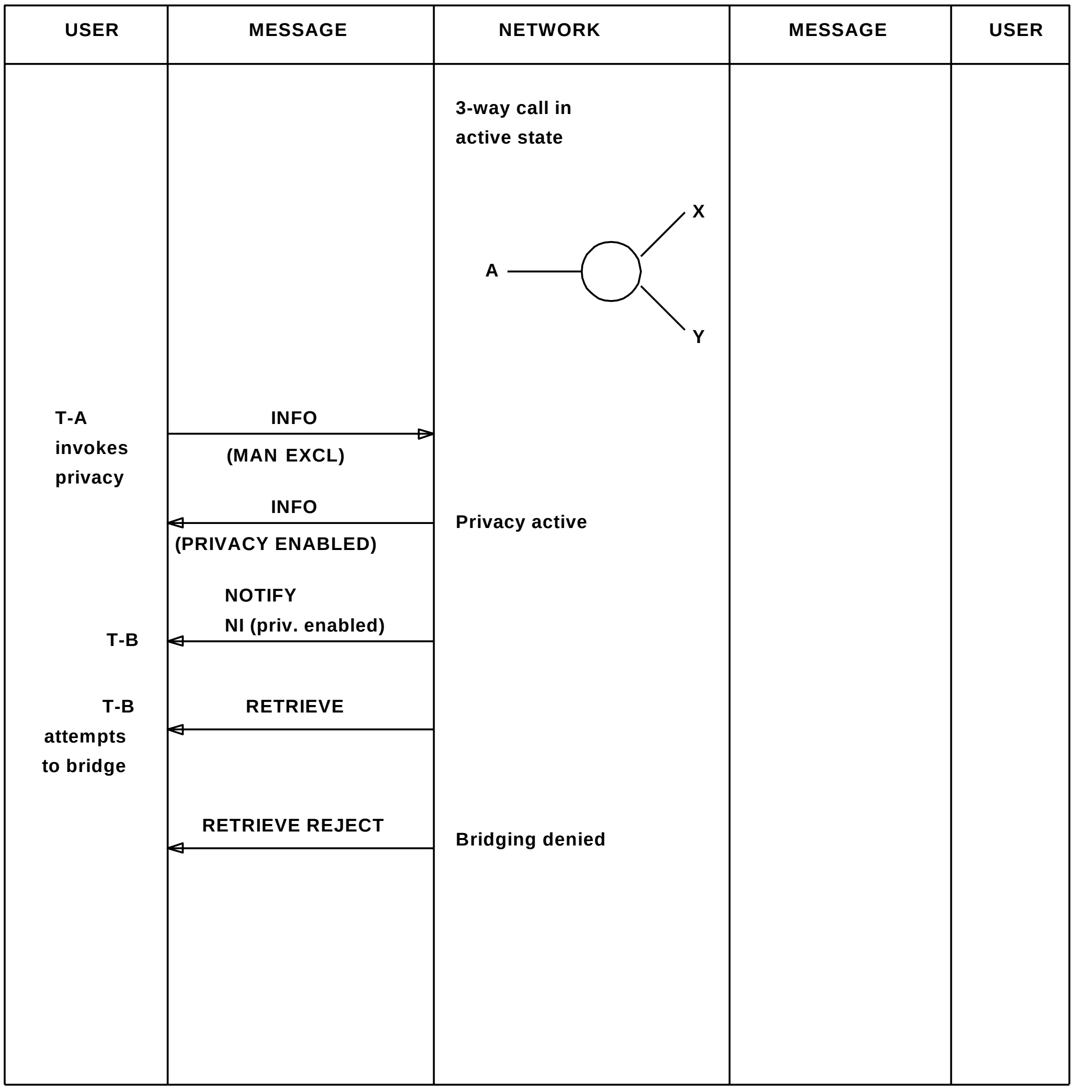


Figure 5.2.1-46 — Manual Bridged Call Exclusion on Conference

5.2.1.22 Emergency (911) Services

The following subfeatures are available:

- ***Basic Emergency Service (911):*** This feature is not assignable to a terminal or directory on a National ISDN - 1 interface, but a terminal on a NI1 interface may call 911.
- ***Enhanced 911 (E911):*** This feature is not a terminal-assignable feature, but a terminal on a NI interface may be used as an E911 termination point.
- ***Emergency Ringback (ER)***.

5.2.1.23 Flexible Calling Feature

All terminals may, with the service order, access the Conference, Drop, and Transfer features as described in the following sections.

5.2.1.23.1 Conference

Conferencing (3-way or 6-way) allows a user to converse simultaneously with multiple parties. To support a conference, a terminal must have two or more Call Appearances or have a busy limit of at least two for an ACO terminal.

5.2.1.23.1.1 Feature Control Procedures

To establish a conference call (3-way or 6-way), the terminal sends the network an INFOrmation message containing the Feature Activation Information Element equal to Conference request and the Call Reference of a call (CR=1 in this context) in State 3, 4, or 10 that is to be part of the conference. This call (CR=1) can be in call State 2 (dial tone portion only), 3, 4, or 10. In addition, the conference request could be included in a SETUP message (with CR=1) with a Feature Activation IE equal to "conference."

After receiving the conference request, the network responds with an INFOrmation message to the terminal with a feature indication IE equal to conference and status equal to active. The network also includes a conference display IE. The network now considers this call (CR=1) to be a conference call. To continue the conference operation, the terminal can initiate a new call to be the added leg call (Figure 5.2.1-47) or retrieve a call from hold to be the added leg call (Figure 5.2.1-48).

If the terminal initiates a new call by sending a SETUP message, then the network starts a timer and sends a HOLD message to the terminal. If the terminal responds with a HOLD ACKnowledge message, the network cancels the timer and places the call on consultation hold. The network then sends a SETUP ACKnowledge message to the terminal that includes an update to the display. The terminal then sends address signaling and the network sets up the new call. (Note that the terminal could have included address signaling in the SETUP message, obviating the need for the user to dial digits.)

If the terminal sends a HOLD REJect message in response to the network's HOLD message, the network will not change the terminal from the situation that existed before the switch sent the HOLD message. If the terminal sends a HOLD ACKnowledge message in response to the network's HOLD message *after* the timer has expired, the network will clear the call (CR=1).

After having established another call with the Call Reference (CR=2), the terminal may send the network a RETrieve message with the Call Reference (CR=1) of the soft-held or consultation held call to establish a conference. After the network has received the RETrieve message, and the current conditions allow the network to merge the two calls, the network sends a RETrieve ACKnowledge message to the terminal indicating the success of establishing a conference and initiates call clearing for the Call Reference of the added leg call (CR=2). The RETrieve ACKnowledge message will contain the Call Reference (CR=1) and provide updated display information.

If the terminal continues the conference operation (from the point at which the network received the conference request) by retrieving a call from hold (CR=2) to be the added leg call (Figure 5.2.1-48), then the terminal sends a RETrieve message to the network with the Call Reference of the held added leg call. After the network receives the message, and conditions allow the network to merge the two calls, the network initiates call clearing for the Call Reference of the held added leg call (CR=2) and sends a RETrieve ACKnowledge message to the terminal indicating the success of establishing the conference. This RETrieve ACKnowledge message contains the Call Reference (CR=2) and provides updated display information.

For conference features that allow more than three parties on the call, the previous procedures can be repeated to add additional parties up to the subscribed limit. To add additional parties to a three-way call, the switch does not require a second INFO message requesting conference. The conference call can be placed either on hold by the terminal sending a HOLD message or on consultation hold by the terminal sending a SETUP message for a new call. The merge procedures apply as described previously.

Beginning with the 5E11 software release, both B-channels can be configured for circuit-switched voice (CSV, speech, or 3.1-kHz audio), allowing two simultaneous voice calls to be active from a single TEI (terminal). The Flexible Calling Conference feature is impacted by this new capability. When the terminal sends a RETrieve message to retrieve a held conference or held call, the B-channel selection field in the channel identifier information element is encoded with the B-channel onto which the conference or call should be retrieved. The response from the switch depends on the B-channel selection and the sequence of calls made on the two B-channels.

- For retrieve attempts made with the B-channel selection field encoded as *any*, *unspecified*, or *none*:
  - When there is no active conference call and there is an active CSV call on one or both B-channels, held conference calls will be merged with the most recently established active CSV call.
  - When there is an active conference call on one B-channel and the other B-channel is free, held CSV calls will be merged with the active conference call.
  - When there is an active conference call on one of the B-channels and an an active CSV call on the other B-channel, the retrieval attempt will be rejected.
- For retrieve attempts made with the B-channel selection field encoded as *preferred*:
  - When one B-channel has an active conference call and the other B-channel has an active CSV call, retrieval of held CSV calls will be rejected.
  - When one B-channel is active with a CSV call or conference call and the other B-channel is free, held CSV calls or held conference calls will be retrieved/merged onto the requested B-channel.
  - When both B-channels have active CSV calls, held conference calls will be merged with the most recently established CSV call.
- For retrieve attempts made with the B-channel selection field encoded as *exclusive*:
  - When the requested B-channel has an active conference call, held CSV calls will be merged with the active conference call.
  - When the requested B-channel has an active CSV call, held conferences will be merged with the active CSV call and retrieval of held CSV calls will be rejected.
  - When the requested B-channel is free, held conference calls or held CSV calls will be retrieved onto the requested B-channel.

Examples of the conference procedures are given in Figures 5.2.1-47 and 5.2.1-48.

User	Message	Network
Active conference call with Call Reference (CR=1) User requests conference (Presses conference button)	INFO (CR=1, FA=Fld Conf) →	
	← INFO (CR=1, FI=Conf, Status=Active, Display)	
	SETUP (CR=2) →	
User selects another call appearance (CR=2) and places first call on hold by originating a second call.	← HOLD (CR=1)	Start timer FC-T1
	HOLD ACK (CR=1) →	
	← SETUP ACK (CR=2, Display)	Network places call on consultation hold and cancels timer FC-T1
User enters digits in multiple INFO messages.	INFO (CR=2) → . . .	
	← CALL PROC (CR=2)	
	← CONN (CR=2)	
While this call (CR=2) is active, user retrieves the conf. call by pressing the call appearance for CR=1.	RETRIEVE (CR=1) →	
	← RETRIEVE ACK (CR=1, Display)	Network merges CR=2 with CR=1
	← REL (CR=2)	
Controller (user) and conferees are merged on CR=1.	REL COM (CR=2) →	Switch clears CR-=2

Figure 5.2.1-47 — Conferencing a New Call Using Consultation Hold

User	Message	Network
Active conference call with Call Reference (CR=1)		
User requests conference (Presses conference button)	INFO (CR=1, FA=fld Conf) →	
	← INFO (CR=1, FI=Conf, Status=Active, Display)	
User retrieves held nonconference call	RETRIEVE (CR=2) →	
	← RETRIEVE ACK (CR=2, DISPLAY)	Network merges CR=2 with CR=1
	← REL (CR=2)	Switch clears CR=2
	REL COM (CR=2) →	

Figure 5.2.1-48 — Adding a Held Call to a Conference

5.2.1.23.2 Drop

DROP allows a user to drop (disconnect) the last party added to a call, as described in the following paragraphs.

5.2.1.23.2.1 Feature Control Procedures

The feature control procedures are as follows:

a. ***DROP During a Conference Call***: The following procedures apply when the terminal is a "controller" of a conference call. A conference call is a call involving more than two terminals. A controller is a terminal that the network allows to add parties to and drop parties from the call. Normally, a controller is a creator of a conference.

   To drop the last party added to a conference call, the terminal sends the network an INFOrmation message with the Drop request and the Call Reference of the conference call. If the last added call of the conference can be dropped, the network will respond with an INFOrmation message that contains display information. The removed terminal will receive disconnect procedures from the network. If the remaining conference call has only two conferees, the INFOrmation message will also contain status information.

   If the last added party of the conference call with three or more parties has already been removed, the network will then ignore the Drop request (Figures 5.2.1-49 and 5.2.1-50).

b. ***DROP During a Normal 2-Party Call***: If a terminal sends the network an INFOrmation message with the Drop request and the Call Reference of the call on B-channel, the network will initiate the call clearing procedures on both directions by sending a DISConnect message to both terminals. The terminal will follow standard disconnect procedures by sending the network a RELease message. The network responds by sending the terminal a RELease COMplete message (Figure 5.2.1-51).

User	Message	Network
User requests drop of call (Press Drop button)	INFO (CR=1, FA=FId Drop) --------------------------->	
	INFO [CR=1, Display (FI=Fid Conf)] <---------------------------	Network drops the last added call
	OR No Response <------------------------->	Network does not drop call

Figure 5.2.1-49 — Drop During 6-Way Conference Call

User	Message	Network
User requests drop of call (Press Drop button)	INFO (CR=1, FA=FId Drop) --------------------------->	
	INFO (CR=1, FI=FId Conf Display) <---------------------------	Network drops the last added call

Figure 5.2.1-50 — Drop During 3-Way Conference

User	Message	Network
User requests drop of call	INFO (CR=1, FA=Drop) ---------------------------->	
	DISC (CR=1) <----------------------------	Network tears down call
	REL (CR=1) ---------------------------->	
	REL COMP (CR=1) <----------------------------	

Figure 5.2.1-51 — Drop During a 2-Party Call

5.2.1.23.3 Transfer

Transfer allows a user to transfer a call to another terminal. In general whether a user is permitted to transfer calls to specific destinations depends on restrictions associated with the user's Service Profile. However, due to B-channel resource limitations at the interface, a user cannot transfer a call when the three parties involved in the transfer function are on a single interface. Other restrictions may be that the number of Call Appearances has to be greater than or equal to two for a terminal or the busy limit has to be greater than or equal to two for an ACO terminal.

5.2.1.23.3.1 Feature Control Procedures

To initiate the transfer of a call, the terminal sends the network an INFOrmation message with the Transfer request and the Call Reference of the active call to be transferred (CR=1 in this context). The network will start the timer and respond to the terminal with a HOLD message. The terminal can respond with a HOLD ACKnowledge or a HOLD REJect message in the normal condition.

If a HOLD ACKnowledge is returned, the network will put the call on soft-hold, cancel the timer, and note that the held call is to participate in a transfer. The network will send to the terminal an INFOrmation message to update the terminal status and display. The terminal is now free to engage in other activities.

If the terminal sends a HOLD REJect message in response to the network's HOLD message, the network will not change the terminal from the situation that existed before the switch sent the HOLD message. If the terminal sends a HOLD ACKnowledge message in response to the network's HOLD message after the timer has expired, the network will clear the call to be put on soft-hold (CR=1).

After establishing another call, the terminal may send the network a second INFOrmation message with the Transfer request and the Call Reference for a call that is to be the transferred to party (CR=2). After receiving this second Transfer request, if the conditions allow the transfer to occur, the network will respond with an INFOrmation to update the terminal status and display. The network will join those two calls together and initiate the call clearing procedure to the controller for both the transferred party and transferred to party CRs.

If the network determines that the transfer is not allowed, the network sends an INFOrmation message to the terminal with an appropriate cause value. Transfer status is set to idle, and no transfer will occur.

The terminal may send the network a RETrieve message with the Call Reference (CR=1) of the soft-held call to retrieve the soft-held call. When the network has received the RETrieve message, it will reconnect the call and send a RETrieve ACKnowledge message to the terminal to indicate the success of retrieving a call. After a call has been retrieved, no record of the Transfer attempt will exist, and any Transferring must be started new.

It is anticipated that these procedures will be employed as follows: a user engaged in an active call will decide to transfer the call to another party. The user will cause the terminal to send an INFOrmation message with the Transfer request to the network. Once the user receives an INFOrmation from the network after responding to the HOLD ACKnowledge message, the user can originate another call. The second INFOrmation message with the Transfer request can be sent at this time to the network. This second Transfer request will cause the two calls to be joined together, and remove the transfer originator from the call.

An example of this transfer procedure is given in Figure 5.2.1-52. Figure 5.2.1-53 provides an example of transferring an existing held call to an active call. Figure 5.2.1-54 provides an example of transferring (floating) a conference call, that is, the controller dropping off of the conference, but having the far parties remain in conversation with each other. Figure 5.2.1-55 provides the signaling flow for the explicit transfer of a conference call.

User	Message	Network
Active call with Call Reference (CR=1)		
User requests transfer (Presses Transfer) button)	INFO (CR=1, FA=Transfer) →	Network starts FC-T1 timer
	← HOLD (CR=1, FI=Transfer, status=Prompt, Display)	Network places call on hold and cancels FC-T1 timer
	HOLD ACK (CR=1) →	
User selects CA and dials transfer destination	SETUP (CR=2) →	
	← SETUP ACK (CR=2, Display)	
	. . .	
	← CONN (CR=2)	
User transfers call (presses Transfer Button)	INFO (CR=2, FA=Transfer →	Network joins CR=1 with CR=2
	← DISC (CR=1)	Network initiates call clearing for CR=1
	REL (CR=1) →	
	← REL COM (CR=1)	
	← DISC (CR=2, FI=Transfer, status=Idle, Display)	Network initiates call clearing for CR=2
	REL (CR=2) →	
	← REL COM (CR=2)	

Figure 5.2.1-52 — Transfer of an Active Call

User	Message	Network
Active call with CR=1		
User requests transfer (Press Transfer button)	INFO (CR=1,FA=FId Tran) ---------------------------->	
	HOLD (CR=1) (FI=T ransfer,Status=Prompt,Disp=FC-13) <----------------------------	Network places call on hold and starts timer FC-T1
	HOLD ACK (CR=1) ---------------------------->	Cancel FC-T1
	RETRIEVE (CR=2) ---------------------------->	
User retrieves a held call with CR=2	RETRIEVE ACK (CR=2) <----------------------------	
User transfers Call (PressTransfer button)	INFO (CR=2, FA=F.Id. Transfer) ---------------------------->	Network joins CR=1 with CR=2
	REL (CR=1) <----------------------------	Network initiates call clearing for CR=1
	REL COMP (CR=1) ---------------------------->	
	DISC (CR=2, FI=transfer, Status=idle, Disp=FC-15) <----------------------------	Network initiates call clearing for CR=2
	REL (CR=2) ---------------------------->	
	REL COMP (CR=2) <----------------------------	

Figure 5.2.1-53 — Transfer a Held Call

User	Message	Network
Active Conference call with CR =1		
User requests transfer (Press Transfer button)	**INFO (CR =1,FA=FId Tran)** **---------------------------->**	
	DISC (CR =1, **FI=conference, Status=idle, Disp=FC-10)** **<----------------------------**	**Network initiates call clearing for CR =1, conference call at the controller and joins the far parties**
	REL (CR =1) **---------------------------->**	
	REL COMP (CR =1) **<----------------------------**	

Figure 5.2.1-54 — Transfer a Conference Call

User	Message	Network
Active conference call with Call Reference (CR=1)		
User requests transfer (Presses Transfer button)	INFO (CR=1, FA=FId Transfer) →	
	← DISC (CR=1)	Network initiates call clearing for CR=1 and maintains the connection for the far parties
	REL (CR=1) →	
	← REL COM (CR=1)	

Figure 5.2.1-55 — Explicit Transfer of an Active Conference Call

5.2.1.24 Free Terminating Line Service

This feature is available to a National ISDN interface, but it has no applicable dial access or feature button procedures. It is accessed through normal Basic Call originations.

5.2.1.25 Individual Calling Line Identification (ICLID)

5.2.1.25.1 Supported ICLID Subfeatures

The following ICLID subfeatures are supported for Circuit Switched Voice calls on subscribed National ISDN BRI lines:

- Calling Number Delivery (CND)
- Directory Number Privacy

These sub-features are applicable simultaneously to both CSV and CSD calls. That is, if ICLID CND is active for circuit-switched voice calls, it is also active for circuit-switched data calls to the subscribed DN. Directory number privacy may be invoked by a subscribed terminal or in a generally available environment for either a CSV or a CSD call. The ICLID feature is described in "Individual Calling Line Identification (ICLID) Displays," Section 5.2.2.4.

5.2.1.25.2 Feature Control Procedures

The ICLID CND sub-feature may be activated or deactivated through dial code, feature buttons, recent change, or the Time of Day feature. Feature control procedures for dial code and feature button activation of Directory Number Privacy and ICLID CND display activation/deactivation (that is, I-DF) follow the stimulus signaling procedures described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. Single feature button operation is supported for I-DF activation/deactivation.

5.2.1.26 Individualized Dialing Plan (Basic Business Group Dialing Plan)

5.2.1.26.1 Feature Definition

Custom Dialing features include those features that allow for abbreviated dialing schemes. Only Speed Calling and Customer-Changeable Speed Calling require special consideration.

All Custom Dialing features require no additional terminal impact beyond the basic call procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2. Specifically, address information may be sent en-bloc or in the overlap sending mode using the Keypad information element. Address information may also be sent in en-bloc mode using CdPN information element.

- Intercom Dialing
- Critical Interdigit Timing for Dialing Plan
- Customer Access Treatment Code Restriction
- Alternate Code Treatment
- Single-Digit Dialing
- Group Feature Access Code Definitions
- Individual Group Numbering Plan
- Overriding Dialing Plan
- Wild Card Features.

5.2.1.26.2 Supplementary Dialing Features and Functional Addressing

For terminals that support Functional Addressing, the keypad equivalent digit information may be carried in the Called Party information element.

If the user signals a public CdPN (International, National, Local or Unknown) the switch should interpret the address digits as it would interpret keypad dialed address digits from a DN that does not have supplementary routing or dialing features. If the calling DN is a member of an IDP, the switch assumes that the user has dialed the "POTS ACCESS" code (which can be 9 or *9, or even a null code). See "Functional Addressing," Section 5.1.1.2.1.2.4, for details on routing when private dialing plans are used.

5.2.1.27 Inspect Feature

The Inspect feature is used to display call data about held, alerting, and active calls; the DN or intercom group information associated with an idle call appearance; and feature names associated with feature buttons. To use the Inspect feature:

1. The terminal sends a feature invocation request known by the network to mean inspect, using scenarios A:1 (using a new call reference), B:1 (using an existing call reference), and C:1 (using a null call reference) in "Feature Invocation Scenarios," Section 5.1.2. The network sends an INFOrmation message with either an existing or the null CR IE, a Feature Indication (FI) IE, and a Display Control IE that indicates inspect to the terminal. From that point (until the inspect timer expires), the network shall interpret the next CA or feature button depression as a request to inspect that call appearance or feature button; that is, the CA buttons cannot be used to originate calls, to answer calls, or so forth; and the feature buttons cannot be used to activate a feature, to deactivate a feature, or so forth. An incoming call can be offered, however, to the terminal, and the associated display information sent to the terminal (although a terminal with a limited display may choose not to display it).

2. ***Feature Button Inspect.*** The terminal sends either of the following:

   — an INFOrmation message that contains an existing Call Reference Value (CRV) or the null CRV and the Feature Activator value associated with the feature button. The network sends an INFOrmation message that contains the existing or the null CRV and the display text associated with the feature button.

   — a SETUP message that contains a non-null CRV and the Feature Activator value associated with the feature button. The network sends a REL COM message containing the non-null CRV and the display text associated with the feature button.

3. ***Idle Call Appearance Inspect.*** The terminal sends a SETUP message that contains a non-null CRV and the DN or CA ID. The network sends a REL COM message containing the non-null CRV and the display text to display the DN associated with the CA or the default DN.

4. ***Non-Idle Call Appearance Inspect.*** The terminal sends a SETUP message that contains a non-null CRV and the DN or CA ID. The network sends a REL COM message containing the non-null CRV and the display text to display the DN associated with the active, held, or alerting call.

5.2.1.28 International Direct Distance Dialing (IDDD)

This feature is available to a National ISDN interface, but it has no applicable dial access or feature button procedures. It is accessed through normal Basic Call originations.

5.2.1.29 ISDN Calling Number Identification Services (I-CNIS)

5.2.1.29.1 Feature Definition

The ISDN Calling Number Identification Services (I-CNIS) feature is an enhancement to the Custom ISDN Calling Party Number (CPN)/Billing Number (BN) Delivery feature. I-CNIS can be viewed as being composed of both originating sub-features and terminating sub-features. The originating sub-features include Number Screening, Number Privacy (also called Directory Number Privacy), and Calling Party Number (CPN)/Calling Party Subaddress (CgPS) Transfer. The Terminating sub-features are Calling Party Number Delivery (CND), including delivery of CgPS, and Redirecting Number Delivery (RND).

- **Number Screening:** A calling party on a standard ISDN line may include a Calling Party Number (CPN) in the CPN IE of the user to network direction SETUP message. If the ISDN line subscribes to Number Screening the switch will validate the User Provided Calling Party Number (UPN). If the UPN fails screening or the ISDN line does not subscribe to Number Screening, the UPN is discarded by the switch and the Primary DN for the originating CPE is used as the CPN for the call [this is referred to as the Network Provided Number (NPN)]. For a basic EKTS call, the UPN will be screened against a list of DNs valid for the calling CPE. For a CACH EKTS call, the UPN is not used by the switch, rather the CPN is derived from the Call Appearance IE. For non-EKTS calls, the UPN must match the Primary DN for the originating CPE in order to pass screening.
- **CgPS Transfer:** I-CNIS checks (no screening is performed; only verification of protocol for CgPS IE) and transports the CgPS provided by the calling party to the terminating end. The switch will discard a CgPS received in the CgPS IE of a user to network direction SETUP message if a valid User Provided Calling Party Number (UPN) is not also present in the SETUP message.
- **Calling Number Delivery (CND):** If the called standard ISDN DN is subscribed to either the "CPN Only" or the "CPN Preferred" option of the CPN/BND feature, then Calling Party Number information and Calling Party Subaddress may be delivered to the called party. CPN is delivered to the terminating ISDN CPE in the CPN IE of a network to user direction SETUP message. If however the CPN was marked "presentation restricted" by the Directory Number Privacy feature, then no address digits are included in the CPN IE. Instead, the CPN IE will be sent with the Presentation Indicator field set to "presentation restricted." If no CPN is available at the terminating end of the call, then a CPN IE is sent with the PI set to "Number not Available due to Interworking." CgPS is delivered to the terminating ISDN CPE when the called ISDN DN is subscribed to CPN/BND and a CPN marked "presentation allowed" is also delivered to the terminating ISDN CPE. The CgPS is delivered in the CgPS IE of the user to network direction SETUP message.

  Note: I-CNIS does **not** provide display, or delivery of information in the Display Text IE. The LASS ICLID feature provides display of calling party information, refer to "Individual Calling Line Identification (ICLID) Displays," Section 5.2.2.4, for more information on the ICLID feature.
- **Redirecting Number Delivery (RND):** If the called ISDN DN is subscribed to the RND feature, then Redirecting Number (forwarding number) information may be delivered to the called party. One or two instances of RN information is delivered to the terminating ISDN CPE in the RN IE(s) of a network to user direction

SETUP message. When a call has been forwarded only once, a single instance of RN information—the Original Called Number (OCN)—will be delivered. When a call has been forwarded more than once for up to two instances, first and last forwarding numbers will be delivered. If however an RN was marked "presentation restricted" by the Directory Number Privacy feature, then no address digits are included in the RN IE. Instead, the RN IE will be sent with the Presentation Indicator field set to "presentation restricted." If no RN is available at the terminating end of the call and redirection did occur, then a RN IE is sent with the PI set to "Number not Available due to Interworking."

- **Directory Number Privacy:** The DN Privacy sub-feature allows an ISDN originator to set the CPN Presentation Indicator to "presentation restricted" in order prevent their number from being delivered to the called party. There are two types of DN Privacy: "All Call Privacy (ACP)" and "Per-Call Privacy."

  All Call Privacy may be subscribed to on a per-line (per-ISDN terminal), per-Screening Index[2] or per-office basis.

  Any call originating from any DN on a line/terminal with an ACP value of "private" assigned will have the DN presentation status marked "presentation restricted" (private). An originating party may turn off ACP for a single call by invoking (through dial code, feature button, or explicit indication in Octet 3a of the CPN IE) a Per-Call Privacy feature to change the presentation status to "presentation allowed." Per-Call Privacy may be subscribed to on a per-line (per-ISDN terminal) basis, or may be made generally available to some or all users on a per-office basis. Per-Call Privacy is invoked by the originating caller through explicit indication of a presentation indicator value in Octet 3A of a User Provided CPN IE in the SETUP message or through dial code or feature button procedures as described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. There are three Per-Call Privacy actions available through dial code to set the calling party number presentation status, these are: Name Number Display Allowed (NNDA), Name Number Private (NNP), and Per-Call Privacy Toggle (PCP). The latter, PCP Toggle, sets the presentation status to the opposite of the invoking terminals ACP value. Only PCP Toggle supports feature button invocation procedures.

5.2.1.29.1.1 Feature Control Procedures

The I-CNIS feature may be activated or deactivated through dial codes, feature buttons, recent change, or the time of day feature. Feature control procedures for dial codes and feature buttons are described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. Single feature button operation is supported for I-CNIS activation/deactivation.

5.2.1.30 ISDN PRI Access from CENTREX

This feature is controlled by Central Office personnel. It has no protocol interaction.

2. Per-Screening Index is provided through the Calling Party Number Presentation Capability (CPNPC) Special Feature.

5.2.1.31 LASS Automatic Callback (AC)

5.2.1.31.1 Feature Definition

The Automatic Callback (AC) feature allows the terminal to place a call to the Directory Number (DN) that last called the user. Additionally, this feature will allow the network to "camp-on" to the relevant DN assuming it is found busy.

5.2.1.31.2 Feature Control Procedures

5.2.1.31.2.1 Activation

Feature invocation procedures for AC follow the procedures described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. Paired feature button operation will be supported for this feature, one button to activate AC and another to deactivate AC. There is only one lamp or indication for both feature buttons. A user may activate AC with a feature button and deactivate with an access code.

Up to 30 activations of AC are possible due to the paired button operation.

Invocation procedures for one-level AC activation follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, 3, and 7). If the line is idle at the time of the attempt to activate AC, normal ISDN call procedures shall continue (the call will be completed). For two-level AC activation (where the user is prompted through announcements to enter in-band information over the B-channel), the differences from the one-level AC procedures are illustrated in Figure 5.2.1-56.

5.2.1.31.2.2 Deactivation

Deactivation follows the procedures described "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, 3, and 7), B (Item 1) and C (Item 1). When deactivation is successful, the Feature Indication information element sent by the switch will contain the Feature Identifier used for activation and the Feature Status will be set to "idle."

5.2.1.31.2.3 Notification of Monitored Party Idle

When an AC feature request is successful and the called party is not busy, the terminal will receive a NOTIFY message with the following information:

- Call Reference Value = "Null"
- Bearer Capability = BC monitored (speech or 3.1-KHz audio)
- Notification Indicator = "Monitored user Idle"
- Signal = Alerting on - Pattern 2 (based upon the value of RNGBK TYPE whose default value will be set to distinctive ringing pattern C that maps to Pattern 2)
- Feature Indication = (Feature Identifier="AC activation"; Feature Status=Prompt)
- Calling Party Number = Monitored party number in the digits field and "national number in the ISDN numbering plan" in the Call Type field
- Called Party Number = Subscribing Party Number in the digits field and "local number in ISDN numbering plan" in the call type field
- Display IE indicating the monitored user is idle.

After sending the NOTIFY message, the switch sets a timer and waits for the AC subscriber to respond with a SETUP message.

5.2.1.31.2.4 Callback Execution

While the timer is still running, if the switch receives a SETUP message, this message will be checked to distinguish whether it is in response to the NOTIFY message. It will be taken as the response if the bearer capability information matches that of the activation currently being notified, and it contains no address information or feature activation information. The user may use any idle call appearance of any DN on the terminal. If the SETUP message is not a response, then it will be treated as a new origination.

After receiving the SETUP message in response to the ringback notification, the switch will send Signal="Alerting off" in an INFO message. The same INFO message may include a blank Display IE to clear the display.

5.2.1.31.2.5 Deactivation Upon Far End Being Busy Past Timer Expiry

When the AC subscriber activates the service, the switch starts a timer to limit the amount of time that the service can remain active. If this timer expires, a NOTIFY message with Null CRV will be sent point to point to the AC subscriber. The information within the message shall be coded as follows:

- Call Reference Value = "Null"
- Bearer Capability = BC monitored (speech or 3.1-KHz audio)
- Notification Indicator = "Monitoring Discontinued"
- Feature Indication = [Feature Identifier="AC activation"; Feature Status=idle or active (since multiple activations are allowed, the feature indicator may still remain in an "active" state when one of the activations expires)].

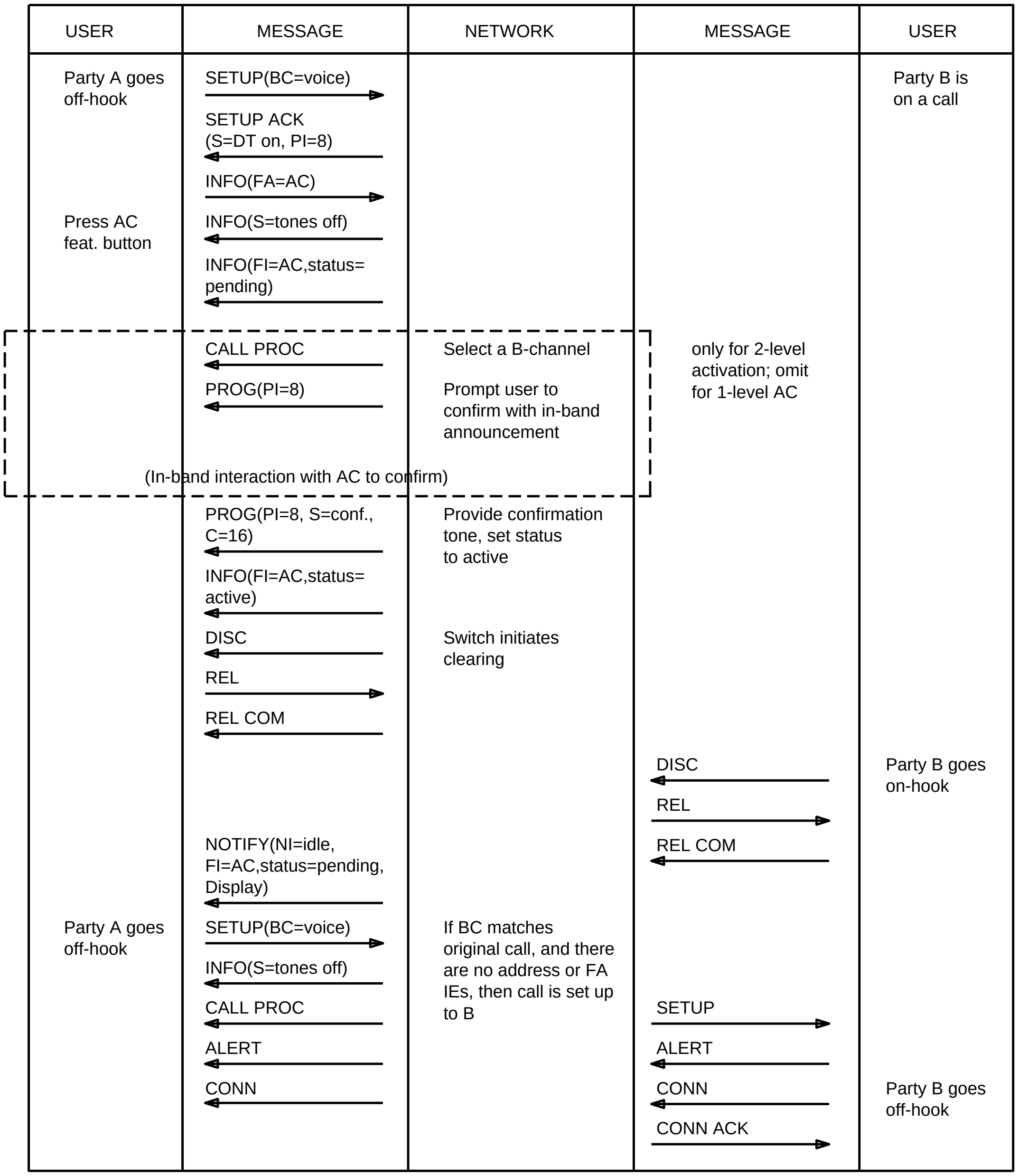


Figure 5.2.1-56 — LASS-AC Protocol for Standard Interface (1-level and 2-level Activation)

5.2.1.32 LASS Automatic Recall (AR)

5.2.1.32.1 Feature Definition

The Automatic Recall (AR) feature allows the terminal to place a call to the Directory Number (DN) that was last called by the user. Additionally, this feature will allow the network to "camp-on" to the relevant DN assuming it is found busy.

5.2.1.32.2 Feature Control Procedures

5.2.1.32.2.1 Activation

Feature invocation procedures for AR follow the procedures described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. Note that paired feature button operation will be supported for this feature, one button to activate AR and another to deactivate AR. There will be only one lamp or indication for both feature buttons. A user may activate AR with a feature button and deactivate with an access code. Also note that the same pair of buttons will be used for AR for data.

Multiple (up to 30) activations of AR are possible due to the paired button operation.

Invocation procedures for AR while the terminal is receiving a busy signal (that is, after receiving CALL PROCeeding) are shown in Figure 5.2.1-57.

Invocation procedures for AR, when the customer disconnects the busy call and then requests AR, follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, 3, and 7). If the line will become idle between the time of the original call and the time of the attempt to activate AR, normal ISDN call procedures shall continue.

5.2.1.32.2.2 Deactivation

Deactivation follows the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, 3, and 7), B (Item 1), and C (Item 1). Note that when deactivation is successful, the Feature Indication information element sent by the switch will contain the Feature Identifier used for activation and the Feature Status will be set to "idle."

5.2.1.32.2.3 Notification of Monitored Party Idle

When an AR feature request is successful and the called party is not busy, the terminal will receive a NOTIFY message with the following information:

- Call Reference Value = "Null"
- Bearer Capability = BC monitored (speech, 3.1-KHz audio, CSD; 64 kbps clear or 64 kbps rate adapted from 56 kbps)
- Notification Indicator = "Monitored user Idle"
- Signal = Alerting on - Pattern 2 (based upon the value of RNGBK TYPE whose default value will be set to distinctive ringing pattern C that maps to Pattern 2)
- Feature Indication = (Feature Identifier="AR activation"; Feature Status=Prompt)
- Calling Party Number = Monitored party number in the digits field and "national number in the ISDN numbering plan" in the Call Type field
- Called Party Number = Subscribing Party Number in the digits field and "local number in ISDN numbering plan" in the call type field
- Display IE indicating the monitored user is idle.

After sending the NOTIFY message, the switch sets a timer and waits for the AR subscriber to respond with a SETUP message.

5.2.1.32.2.4 Callback Execution

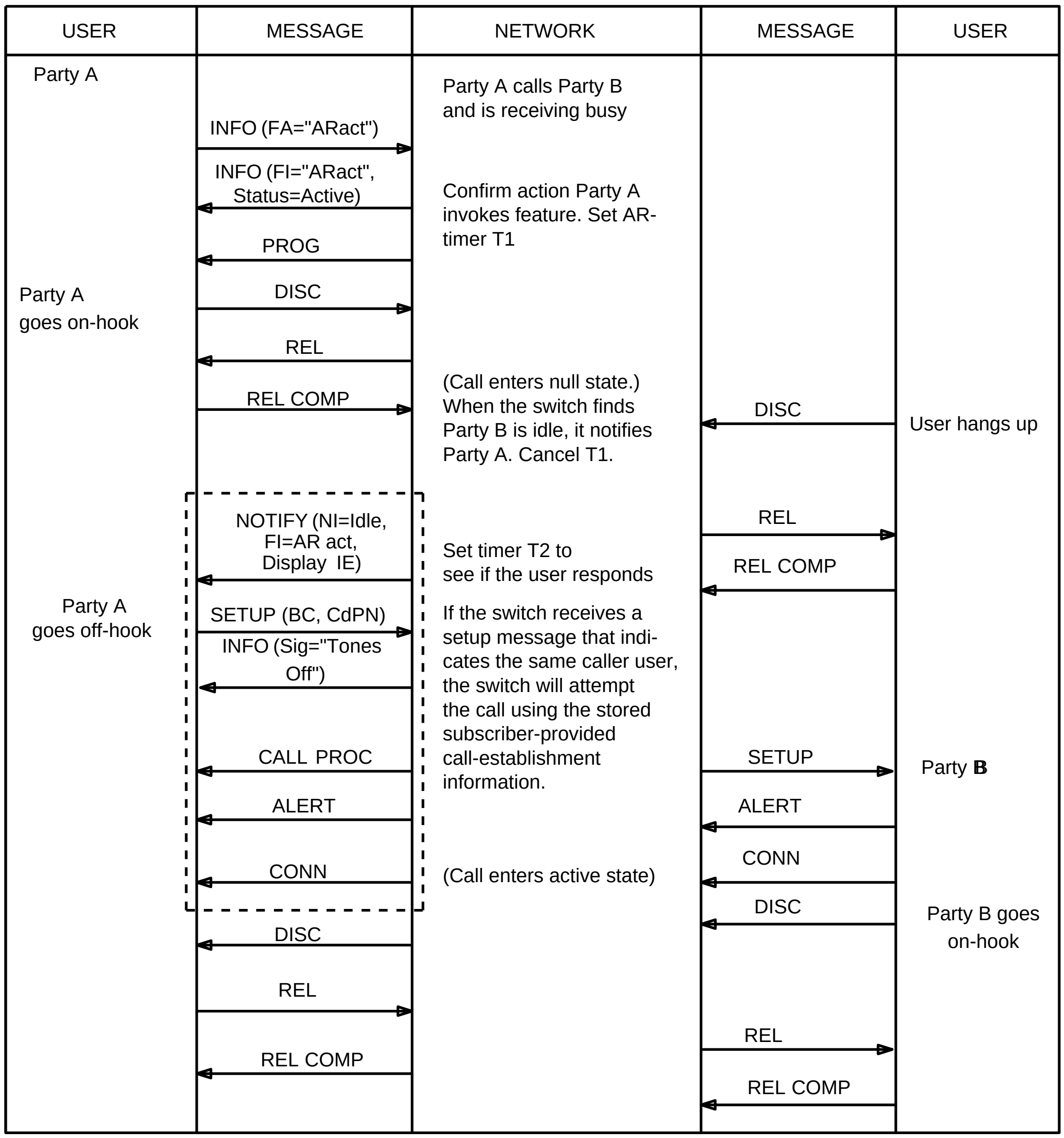
While the timer is still running, if the switch receives a SETUP message, this message will be checked to distinguish whether this is in response to the NOTIFY message. It will be taken as the response if the bearer capability information matches that of the activation currently being notified, and address information is absent (address information may include Keypad, CdPN, TNS, or OSA). If the SETUP message is not a response, then it will be treated as a new origination.

After receiving the SETUP message in response to the ringback notification, the switch will send Signal="Alerting off" in an INFO message. The same INFO message may include a blank Display IE to clear the display.

5.2.1.32.2.5 Deactivation Upon Far End Being Busy Past Timer Expiry

A NOTIFY message with Null CRV will be sent point to point to the AR subscriber if the Timer T1 expires for a particular application. The information within the message shall be coded as follows:

- Call Reference Value = "Null"
- Bearer Capability = BC monitored (speech, 3.1-KHz audio, CSD; 64 kbps clear or 64 kbps rate adapted from 56 kbps)
- Notification Indicator = "Monitoring Discontinued"
- Feature Indication = [Feature Identifier="AR activation"; status=idle or active (since multiple activations are allowed, the feature indicator may still remain in an "active" state when one of the activations expires)].



Note: Dotted box shows the message flows modified for the ringback procedure

Figure 5.2.1-57 — LASS-AR Protocol for Standard Interface (Activated While Receiving Busy Treatment)

5.2.1.33 LASS Bulk Calling Line Identification (BCLID)

The LASS Bulk Calling Line Identification (BCLID) feature allows incoming call-related information for calls to National ISDN BRI lines that are part of a Multiline Hunt Group, Terminal Group, or for individual lines to be delivered to centralized customer premise equipment (CPE) through a dedicated data channel from an Attached Processor (AP). As call related information is not delivered to the subscribed ISDN BRI line/terminal, there is no interaction with the stimulus signaling procedures.

5.2.1.34 LASS Customer Originated Trace (COT) Modular Feature

Procedures for accessing Customer Originated Trace follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1.

5.2.1.35 LASS Selective Call Acceptance (SCA)/Computer Access Restriction (CAR)

The LASS Selective Call Acceptance (SCA) and Computer Access Restriction (CAR) features provide essentially the same functionality. Both features allow a user to accept incoming calls from only those DNs on the SCA or CAR screening list. Calls from numbers not on the screening list may either be forwarded to another number or given a rejection announcement. CAR is available on only a subscription basis, and may not be accessed as a generally available feature. Only one of the two features (SCA or CAR) may be assigned to a National ISDN DN at a time. SCA and CAR apply to only Circuit Switched Voice (CSV) calls.

Procedures for accessing SCA and CAR [such as Screen List Editing (SLE)] follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1. Once an SLE session is invoked for SCA or CAR, procedures for either activating/deactivating the feature or editing the screening list use in-band signaling, and do not use ISDN D-channel signaling.

5.2.1.36 LASS Selective Call Forwarding (SCF)

The LASS (SCF) feature allows a National ISDN user to forward incoming calls from only calling DNs on the SCF screening list. Calls from numbers not on the screening list are offered to the user. SCF is available on either a subscription or generally available basis, is provisioned on a per-DN basis, and applies to only Circuit Switched Voice (CSV) calls.

Procedures for accessing SCF [such as Screen List Editing (SLE)] follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1. Once an SLE session is invoked for SCF, procedures for activating/deactivating the feature or for editing the screening list use in-band signaling, and do not use ISDN D-channel signaling.

5.2.1.37 LASS Selective Call Rejection (SCR)

The LASS (SCR) feature allows a National ISDN user to block incoming calls from DNs on the SCR screening list. Calls from numbers not on the screening list are offered to the user. SCR is available on either a subscription or generally available basis, is provisioned on a per-DN basis, and applies to only Circuit Switched Voice (CSV) calls.

Procedures for accessing SCR [such as Screen List Editing (SLE)] follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1. Once an SLE session is invoked for SCR, procedures for activating/deactivating the feature or for editing the screening list use in-band signaling, and do not use ISDN D-channel signaling.

5.2.1.38 LASS Selective Distinctive Alert (SDA)

The LASS (SDA) feature allows a National ISDN user to receive a special alerting pattern for incoming calls from DNs on the SDA screening list. Calls from numbers not on the screening list are offered to the user with normal alerting. SDA is available on either a subscription or a generally-available basis, is provisioned on a per-DN basis, and applies to only Circuit Switched Voice (CSV) calls.

Procedures for accessing SDA [such as Screen List Editing (SLE)] follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1. Once an SLE session is invoked for SDA, procedures for activating/deactivating the feature or for editing the screening list use in-band signaling, and do not use ISDN D-channel signaling.

5.2.1.39 Message Detail Recording (MDR)

5.2.1.39.1 Feature Definition

This feature produces individual AMA records per outgoing call on private facilities selected by the user. The per-call records are then provided to the customer so that the customer may perform such functions as cost accounting or engineering.

This feature requires interaction with an applications processor.

5.2.1.39.2 Feature Activation and Deactivation

5.2.1.39.2.1 Supported Feature Activations and Deactivations

The following are feature activations and deactivations:

- ***Regular Activation/Deactivation:*** Activation and deactivation on-demand accomplished through dialed access code.

  Feature Control and Group Control are provided by this subfeature.

- ***Per Call Activation/Deactivation:*** Deactivation/activation accomplished through dialed access code by user before entering called address. The activation status automatically returns to its previous state after call ends.

  Customer Control is provided by this subfeature.

- ***Always Active:*** Dialed access codes are not allowed to change activation status.

  Terminals in an MDR group can be split across standard, custom, and analog interfaces.

5.2.1.39.2.2 Feature Control Procedures

Procedures for the retrieval of the AMA record made for outgoing private facilities calls will be contained in document 235-900-303, **5ESS** *Switch ISDN Applications Processor Interface Specification*.

5.2.1.40 Message Service System

5.2.1.40.1 Overview

Message Service System (MSS) minimizes the number of unanswered calls to subscribing customers by using Call Forwarding options to route calls to message service attendants on a custom interface. The message service attendant answering an incoming call receives a display containing information related to the call. The incoming call information may be sent to the message service attendant on the custom interface directly or indirectly, through an Applications Processor (AP), from the network. This attendant will be on a custom interface. Each MSS user has a message waiting indicator (MWI) that, when active, indicates that messages are waiting to be retrieved. The MWI may take the form of a special inband tone (NITs and FITs) or a visual indicator (FITs only) at the user terminal. The following feature is associated with MSS:

- ***MSS Attendants:*** Allows message service attendants on a custom interface to activate an MSS user MWI on a standard interface.

5.2.1.40.2 Message Waiting Indicator Control by MSS Attendants

Invocation procedures for MWI activation/deactivation by message service attendants require that the message service attendants have two distinct Button Numbers for the MWI Control by MSS Attendants feature, a Button Number for activation, and another Button Number for deactivation.

Invocation procedures for MWI activation/deactivation by message service attendants may also require that the requesting message service attendant specify address information to identify the user for whom MWI is to be activated or deactivated.

- ***Activation:*** Activation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, B (Item 1).

  When a request is successful, if the designated user has subscribed to a Button Number for the MWI feature, the network sends an INFOrmation message with the null Call Reference containing a Feature Indication information element to each user terminal. The Feature Indication information element indicates that the feature is activated.

- ***Deactivation***: Deactivation procedures are same as the activation procedures.

  When a request is successful, if the designated user has subscribed to a feature identifier for the MWI feature, the network sends an INFOrmation message with a null Call Reference containing a Feature Indication information element to user terminal. The Feature Indication information element indicates that the feature is deactivated.

5.2.1.40.3 Message Waiting Indicator Deactivation by MSS Users

Deactivation procedures follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, 3, and 7) and C (Item 1).

When a request is successful, if the user has subscribed to a feature identifier for the MWI Deactivation by MSS Users feature, the network sends an INFOrmation message with a null Call Reference containing a Feature Indication information element to user terminal. The Feature Indication information element indicates that the feature is deactivated. The MWI Deactivation by MSS Users feature and the MWI feature must have the same Button Number assignment.

5.2.1.41 Multiline Hunt Service

5.2.1.41.1 Supported Multiline Hunt Service

Hunting groups provide a software-defined search, within the group, for an idle terminal to which a call can complete.

The following types of hunt algorithm are supported:

- Linear hunting
- Circular hunting (including queuing)
- Uniform hunting (including queuing)
- Stop hunt
- Make busy (group, member, random)
- Nonhunt
- Queuing monitor.

A MLHG terminal must be able to recognize the Endpoint Identifier (EID) information element that will be included during call offering procedures. In other words, a MLHG member terminal must be an initializing terminal.

5.2.1.41.2 Feature Control Procedures

Normal hunting terminations follow those procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2. Activation and deactivation for the Make Busy, Group Make Busy, and Stop Hunt features follow the procedures described in "Feature Invocation Scenarios," Section 5.1.2, A (Items 1, 2, and 3) and C (Item 1).

5.2.1.42 Networking Features

The following subfeatures are available:

- Carrier Interconnection
- Selective Carrier Denial (SCD) (Analog only)
- Intraswitch/Interswitch Calling Party Number (CPN)/Billing Number (BN) Optioning to Terminating User
- Interswitch Voice Messaging.

5.2.1.43 Private Facility Access (PFA)

The PFA requests will be accepted by the switch for the following:

- Access code with no address information handled by the serving switch (cut-through operation)
- Access code with address information handled by the serving switch (senderized operation).

Following PFA features shall operate for a terminal on a Bellcore standard interface:

- Toll-free NPA Services (also known as INWATS)
- Toll-free NPA Service Simulated Facilities Group (SFG)
- OUTWATS
- OUTWATS with Simulated Facility Group
- ANI Over Private Facilities
- ANI6/ANI7 on an SFG or Trunk Group
- Foreign Exchange (FX) Line/Trunk
- Tie Trunk Access
- Tandem Tie Trunk Dialing
- Simulated Facility Groups (SFGs) for In and Out Calls
- Common Control Switching Arrangement (CCSA) Access
- Enhanced Private Switched Communications Service (EPSCS) Access
- Electronic Tandem Switching (ETS) Access (also known as Access to ETS Trunks)
- Trunk Group Busy Lamps
- Recorded Telephone Dictation

- Selective Control of Facilities
- Radio Paging Access
- Message Detail Recording (MDR) Via Revenue Accounting Office (RAO)
- WATS Administrative Data
- Individual Billing Number for WATS
- Intercom Calling Restriction.

The PFA activation procedures using Access Codes shall follow the procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1, for Stimulus Signaling (see also "Stimulus Signaling Protocols Capability," Section 5.1.1.2).

Information Request Procedures will be used for senderized information when address needs to be collected after the access code for PFA has been received.

5.2.1.44 Queuing Modular Feature

The following subfeatures are available:

- Queuing for Lines
- Queuing for Lines with Call Waiting Lamps
- Queuing for Lines with Delay Announcements
- Ringback Queuing for Trunks: The NI-1 protocols are similar to the notification for ringback used for Automatic Recall feature (Figure 5.2.1-25)
- Ringback Queuing for Trunks with Priority Queue
- Off-Hook Queuing for Outgoing Trunks
- Off-Hook Queuing for Outgoing Trunks with Priority Queue
- Off-Hook Queuing for Outgoing Trunks with Priority Queue and Delay Announcements
- Ringback Queuing for SFGs
- Ringback Queuing for SFGs with Priority Queue
- Off-Hook Queuing for SFGs
- Off-Hook Queuing for SFGs with Priority Queue
- Off-Hook Queuing for SFGs with Priority Queue and Delay Announcements
- Queuing for Uniform Call Distribution Data Hunt Groups.

5.2.1.45 Speed Calling/Customer Changeable Speed Calling

5.2.1.45.1 Supported Speed Calling

Speed Calling permits the user to dial selected numbers using fewer digits than normally required. This includes the following:

- 1-Digit Speed Calling
- 2-Digit Speed Calling
- Customer-Changeable 1-Digit Speed Calling

- Customer-Changeable 2-Digit Speed Calling.

Information Request Procedures specified in "Information Request Procedures," Section 5.1.1.2.1.2.5, will be used for programming a customer-changeable speed calling list. The procedure will be used for collecting the digits for the Speed Call Digit followed by the DN.

Single or multiple Information request may be used to collect the Speed Call Digit and the DN. Silence shall continue to be applied on the B-channel after collecting the Speed Call Digit while waiting for the DN to be entered by the user.

Shared Speed Call list can be assigned to terminals on analog, custom, or NI-1 interfaces.

5.2.1.45.2 Feature Control Procedures

The procedures for invoking this feature follow those described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2.

5.2.1.46 Telephone Status Monitor and Select

5.2.1.46.1 Feature Description

This feature provides the following types of service to subscribers:

1. Telephone Status Monitor, also known as Busy Lamp Field or Busy Lamp Indicator
2. Select, also known as Direct Station Selection (DSS)
3. Audible alert at monitoring station.

The Telephone Status Monitor and Select feature enables a Custom ISDN terminal (Type A, B, C, or D), Custom ISDN Attendant terminal, or National ISDN terminal to monitor the Ringing, Busy, or Idle status of call appearances (CAs) on another Custom BRI, National BRI, or analog line.

Whereas the ISDN Shared Call Appearance (SCA) status lamp capability provides status information based on a DN, this feature provides status information through a feature lamp and provides DSS through an associated feature button for each voice CA on the terminal being monitored. The *5ESS* switch monitors the status of each CA associated with the monitored terminal, and sends to the monitoring terminal(s) a status message to turn on, turn off, flash, or wink the monitoring station lamps to indicate call status.

The primary application of the Telephone Status Monitor and Select feature is to make call coverage more efficient and accurate where an attendant (typically a secretary or one of several secretaries) needs status information to determine a manager’s availability to take calls. To display status information without this feature, the attendant’s set must have multiple SCAs with each manager’s phone. This feature not only frees up the SCA resources otherwise used for status, but also speeds call handling by the attendant, who:

- Answers incoming calls (through Call Pickup, for example)
- Uses the Transfer feature together with the Select capability of the Telephone Status Monitor (TSM) feature button to transfer the monitored call as early as possible.

Note: Although this feature indicates the status of the monitored terminal, it does not reflect whether the user can accept a call.

At a shared secondary DN or secondary only DN, the TSM feature button lamp associated with the terminal's primary DN does not show Ringing status. A secondary only DN, however, can be provisioned with a separate TSM feature button lamp that shows Ringing and Idle status. In addition, a call associated with a secondary DN shows Ringing, or Ringing With Busy status, at the TSM feature button lamp associated with the telephone where this DN is primary.

5.2.1.46.1.1 Telephone Status Monitor

The Telephone Status Monitor portion of this feature allows an ISDN user to monitor the status (as opposed to the individual call appearances) of other telephones by using a single TSM feature button for each telephone being monitored. Regardless of how many ISDN CAs or DNs are assigned to a monitored telephone, the single TSM indicator on the monitoring telephone responds as shown in Table 5.2.1-4 to any status indications from a CA on the monitored telephone.

Table 5.2.1-4 — Telephone Status Monitor and Select Feature Lamp Indications

STATUS AT MONITORED TERMINAL	FEATURE STATUS IN FILE FOR NATIONAL CPE	TYPICAL LAMP REPRESENTATION
Idle	Idle	Lamp Off
Ringing	Pending	Lamp Flashing
Busy	Active	Lamp On
Ringing With Busy	Prompt	Lamp Winks

5.2.1.46.1.2 Select

The Direct Station Selection portion of this feature allows an ISDN user to press the TSM feature button associated with the monitored telephone to place a call directly to the primary DN of the monitored telephone. Multiple telephones may be monitored by a single telephone, but each requires a separate TSM indicator on the monitoring telephone.

Pressing the TSM feature button at the monitoring terminal automatically places a call to the station being monitored.

5.2.1.46.1.3 Audible Alert Option

This feature optionally includes a ping ring service to provide an audible alert to the monitoring terminal when a call is Incoming on one or more of the monitored lines (when the monitored terminal's status has changed from Idle to Ringing, or from Busy to Ringing With Busy).

5.2.1.46.2 Feature Control Procedures

5.2.1.46.2.1 Telephone Status Monitor

The *5ESS* switch updates the status of the monitored telephones by sending to the monitoring terminal an INFOrmation message with a null call reference (CR) and a feature indication IE that identifies the number of the TSM feature button associated with the monitored terminal. Table 5.2.1-4 shows the conditions the switch monitors and the feature status the switch sends in the feature indication IE for terminals on National BRIs.

The switch monitors each voice CA or CR of any DN on a monitored ISDN terminal for changes in terminal status based on the following conditions:

- If a CSV call (including a held call) is in State 2, 3, 4, 10, 11, 12, or 19 on any CA or CR on any DN at the monitored terminal, then a Busy status is presented to the monitoring terminal.
- If an Incoming CSV call is in State 7, 8, or 9 on the monitored terminal's primary DN (excluding a ring-back call due to AC/AR, Call Park, or ACBC ring-back; and excluding an ISDN Key System Intercom call), then a Ringing status is presented to the monitoring terminal.
- If a CSV call (including a held call) is in State 2, 3, 4, 10, 11, 12, or 19 on any CA at the monitored terminal and another call is alerting (in State 7, 8, or 9) on the monitored terminal's primary DN, then a Ringing With Busy status is presented to the monitoring terminal. On a National ISDN Basic Call terminal, Ringing With Busy indicates that an additional alerting call is being offered to the terminal while the CR of a call in a busy state is already associated with the terminal; this suggests that the alerting call be picked up at the monitoring station (by Call Pickup, for example).
- When the monitored terminal is in State 0, 1, or 6, an Idle status is presented to the monitoring terminal.

A secondary DN or secondary only DN does not show a Ringing or Ringing With Busy status at the TSM feature button lamp associated with the monitored terminal. At the monitoring terminal, if the Select TSM feature button is pressed after Directed Call Pickup is invoked, the call pickup attempt fails because the Select function is associated with the primary DN at the monitored terminal.

A separate TSM feature button can be configured for a secondary only DN, however, to show Ringing and Idle status, so that Directed Call Pickup and the Select function for a secondary only DN TSM feature button can be used to pick up an alerting call at a secondary only DN. At the terminal where the secondary only DN is provisioned, Busy status for a call on this secondary only DN is indicated at the TSM feature button associated with the primary DN.

For a secondary DN (but not a secondary only DN), if the monitoring terminal has another TSM feature button and lamp associated with the terminal where this DN is primary, then the call can be answered by using Directed Call Pickup and pressing this additional Select TSM feature button.

5.2.1.46.2.1.1 Direct Station Selection (DSS)

The *5ESS* switch automatically sets up a call to the primary DN of the monitored terminal (or to a secondary only DN), as if the primary DN (or secondary only DN) digits were dialed, if the switch receives from a monitoring terminal an INFOrmation message composed as follows:

- Feature Activation IE equal to the TSM feature button number associated with a monitored terminal or a secondary only DN
- CRV equal to an existing call in State 2.

If the switch receives a SETUP message, for a new call, whose Feature Activation IE is equal to the TSM feature button number associated with a monitored terminal (or secondary only DN), then the switch automatically sets up a call to the primary DN (or secondary only DN) of the monitored terminal, as if the primary DN digits were included in the Keypad IE of the SETUP message.

In this Select service, the call setup, routing, error conditions, and error handling are as if the switch were receiving a Speed Calling feature request. For example, if digits are included in the Keypad IE, the switch ignores them and routes the call as directed by the Feature Activation IE.

5.2.1.46.2.2 Audible Alerting Option

If the monitoring terminal subscribes to the TSM audible alerting option, and an Incoming call is alerting (the call is in State 7, 8, or 9) on the monitored terminal, the switch sends to the monitoring terminal an INFOrmation message with a null CR and a signal IE equal to Alerting Pattern 4. The INFOrmation message sent may be the same one sent to update the FI status, or it may be a separate INFOrmation message. The switch sends this INFOrmation message when the terminal status changes from Idle to Ringing, or from Busy to Ringing With Busy.

If the monitoring terminal does not subscribe to the TSM audible alerting option, then the switch provides only the feature status information.

5.2.1.47 Terminal Group Features (Basic Business Group)

Terminal Group features provide additional services associated with a specific group of terminals. The following Terminal Group features have no additional terminal impact beyond the basic call procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2:

- Business Group Line
- Semirestricted Lines
- Fully Restricted Lines
- Incoming Call Restrictions
- Outgoing Call Restrictions
- Special Intercept Announcements
- Centrex Complex
- Main Satellite Service.

Activating or deactivating the TGSR feature by Access Codes will follow the specification in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. After activation of the feature, user will receive a confirmation tone followed by silence. The user may disconnect at this time. Otherwise, the switch will time out and disconnect the B-channel. No IR procedures are applicable to this service. No call should be established.

Terminals in a TGSR group can be spread across analog interface, custom interface, and NI-1 interface.

5.2.1.48 Time of Day Modular Feature

The following subfeatures are available:

- Time of Day Control of ARS
- Time of Day Deluxe

- Time of Day Control of Account Code
- Time of Day Control Authorization Code
- Time of Day for Line Private
- Time of Day for Trunk Private.

Procedures for activating or deactivating Time of Day, or for indicating the actions to be performed according to the user-specified schedule, follow the protocols and procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1, for feature code access (feature buttons cannot be used to activate or deactivate this feature).

5.2.1.49 Toll Restriction

This feature is controlled by Central Office personnel. It has no protocol interaction.

5.2.2 DISPLAY INTERFACE CAPABILITY

5.2.2.1 Overview

The purpose of this section is to act as a central requirements location for ISDN supplementary voice services that provide display data.

All display information is sent through Codeset 5. Display information is sent only in the direction from switch to user. The Display Text IE may be included in any Q.931 message.

It is assumed that CPE will be able to display at least 40 characters. It is also assumed that new displays will overwrite old displays starting at the first character position rather than appending the new display to the old. Echoing of digits during dialing (for both overlap and enbloc sending) will be at the discretion of the terminal. Display of ICLID and CNAM information that is sent while the user is dialing will also be at the discretion of the terminal. The CPE will display information within fixed boundaries. For example, a CPE should have a 2x20, 2x40, or 1x40 display field.

The CPE is responsible for handling redisplays of local displays (for example, time and date) on receipt of a clearing Display IE sent during CPE refresh.

The CPE is responsible for ignoring or accepting a clearing Display IE sent during the dialing state.

Certain displays are indicated as Timed Displays. If there is no activity on the interface within a timed interval, then the switch will clear the display.

5.2.2.2 Procedures for Network-Provided Displays

5.2.2.2.1 Supported Network-Provided Displays

The call reference value in the message will tie the display information to the corresponding call or feature. Users receive a standard set of Incoming and Outgoing displays when their terminal is assigned as equipped with display capabilities. However, users must subscribe to ICLID to receive calling and/or redirecting party number with Incoming displays, and to CNAM or EDS CND to receive calling and/or original called name with Incoming displays.

All originating displays for basic call and text only terminating displays are available to any terminal that supports network-provided displays. Tags will be included in the display text information element to help guide the terminal in presenting the network display text to the user. If a terminal does not support network-provided display text, it must ignore the display text information element and not send a STATUS message.

5.2.2.2.2 Display Character Set

The required display character set consists of the IA5 printable characters. These include the following:

- Alphabetic A - Z, a - z
- Numeric 0-9
- Tone-tone #,*
- Punctuation (space) , . ! ? ; : ’ " ( ) [ ] { }
- Miscellaneous = + - / \ _ \ “ $ % | < > @

5.2.2.2.3 Display Tag Bit Value

The tags and their values in the following list are supported in NI-2, NI-3, or both.

Bits 8 7 6 5 4 3 2 1	Meaning	National ISDN
1 0 0 0 0 0 0 0	Blank	NI-2, NI-3
1 0 0 0 0 0 0 1	Skip	NI-2, NI-3
1 0 0 0 0 0 1 0	Continuation	NI-2, NI-3
1 0 0 0 0 0 1 1	Called address	NI-2, NI-3
1 0 0 0 0 1 0 0	Cause	NI-2, NI-3
1 0 0 0 0 1 0 1	Progress indicator	NI-2, NI-3
1 0 0 0 0 1 1 0	Notification indicator	NI-2, NI-3
1 0 0 0 0 1 1 1	Prompt	NI-2, NI-3
1 0 0 0 1 0 0 0	Accumulated digits	NI-2, NI-3
1 0 0 0 1 0 0 1	Status	NI-2, NI-3
1 0 0 0 1 0 1 0	Inband	NI-2, NI-3
1 0 0 0 1 0 1 1	Calling address	NI-2, NI-3
1 0 0 0 1 1 0 0	Reason	NI-2, NI-3
1 0 0 0 1 1 0 1	Calling party name	NI-3
1 0 0 0 1 1 1 1	Original called name	NI-3
1 0 0 1 0 1 0 0	Call appearance ID	NI-2, NI-3
1 0 0 1 0 1 0 1	Feature address	NI-2, NI-3
1 0 0 1 1 1 1 0	Text	NI-3

All other values are reserved.

5.2.2.2.4 Display Tags Definitions

The Display text tag definitions, as provided by the American National Standard for Telecommunication - Digital Subscriber Signaling System No. 1, are as follows:

- ***Blank:*** The blank tag will be used by the network to inform the terminal to add a specific number of blanks after some text. A blank tag will have a one octet length and a binary value from 1 to 255.
- ***Skip:*** The skip tag can be used to inform terminals not to overwrite the specific number of characters. A skip tag has a length of one octet and values from 1 to 255. This value shall be interpreted as an unassigned integer.
- ***Continuation:*** Text that is associated with previously tagged information.
- ***Called Address:*** Text regarding the called number.
- ***Cause:*** Text regarding the corresponding cause value.
- ***Progress Indicator:*** Text regarding the contents of the corresponding progress indicator information element.
- ***Notification Indicator:*** Text regarding the contents of corresponding notification indicator information element.

- ***Prompt:*** Text to request the user to input additional information (for example, digits).
- ***Accumulated Digits:*** Text regarding digits input by the user.
- ***Status:*** Text regarding feature condition (for example, the feature has been activated or deactivated).
- ***Inband:*** Text regarding tones or other information that is being provided.
- ***Calling Address:*** Text regarding the calling number.
- ***Reason:*** Text regarding call diversion, for example, the redirecting reason in the redirecting number information element. This is the same as the ICI code.
- ***Calling Party Name:*** Text regarding the calling party's name.
- ***Original Called Name:*** Text regarding the original called party's name (that is, first redirecting name).
- ***Call Appearance ID:*** Text regarding call appearance in key system environment.
- ***Feature Address:*** Text regarding an address associated with a feature.
- ***Text:*** Text that does not have a specific tag.

5.2.2.3 Basic Call Displays

Both Outgoing and Incoming call-related information is provided through a set of standard Basic Call displays to any terminal that supports displays. The ICLID feature is required only to provide calling and/or redirecting party number delivery in Incoming displays.

The following list indicates the various Incoming and Outgoing Basic Call displays.

DISPLAY	DIRECTION
a=[Called address]	Outgoing
a=Dial	Outgoing
a=Not end-to-end ISDN	Incoming
a=Non-ISDN calling	Incoming
a=Connected	Incoming
a=[Called address] Ringing	Outgoing
a=Outgoing Call Ringing	Outgoing
a=Private Number Ringing	Outgoing
a=[Called address] Delay in response	Outgoing
a=[Called address] Connected	Outgoing
a=[Called address] Connected: Non-ISDN	Outgoing
a=[Called address] Connected: Non-ISDN Not end-to-end ISDN	Outgoing
a=[Called address] Number now private	Outgoing
a=[Called address] Number now public	Outgoing
a=Number private Dial	Outgoing
a=Number public Dial	Outgoing
a=Name stat toggled Dial	Outgoing
a=[Called address] Name stat toggled	Outgoing
a=Name& Num Private Dial	Outgoing
a=[Called address] Name & Num Private	Outgoing
a=Name & Num Public Dial	Outgoing
a=[Called address] Name & Num Public	Outgoing

5.2.2.4 Individual Calling Line Identification (ICLID) Displays

The ICLID consists of two main features:

- ***Calling Number Delivery:*** The network uses this capability to send incoming call-related data to the terminating end.
- ***Directory Number Privacy:*** This capability enables an originating customer to inhibit calling DN delivery from being sent to the terminating end.

The ICLID feature provides only the calling and/or redirecting number information for incoming displays.

The displays used with the ICLID service (all are associated with incoming calls) are shown in the following list. ICLID displays both calling number and, if call forwarding has occurred, the first redirecting number (Original Called DN). The “From” displays represent the calling DN; the “for” displays represent the redirecting DN. These DNs are coded in a Text tag preceding the Calling Address or Feature Address tag.

DISPLAY[c]	DIRECTION
a=From ### ###-####	Incoming
a=From ### ###-#### Connected	Incoming
a=From Private Number	Incoming
a=From Private Number Connected	Incoming
a=From Unavailable	Incoming
a=From Unavailable Connected	Incoming
a=Incoming call[a]	Incoming
a=Incoming call Connected[a]	Incoming
a=From [Calling number] Not end-to-end ISDN	Incoming
a=From [Calling number] Non-ISDN calling	Incoming
a=ID Features off[b]	n/a
a=ID Features on[b]	n/a
a=From [Calling #] for [Redirecting #] cfx [Reason]	Incoming
a=From [Calling #] Connected cfx for [Redirecting #] [Reason]	Incoming

Note(s):

a. Incoming call is displayed in lieu of calling/redirecting number digits when the calling/forwarding party is from outside the called DNs terminal group and the "CNIS Intra-group Only Delivery" (CNIGI) option is set to restrict delivery of calling/forwarding party information for calls from within the terminal group only.

b. ISDN Display Features (I-DF) activation/deactivation confirmation displays are provided when the ISDN DN is subscribed to both ICLID and either CNAM or EDS CND displays.

c. The DISPLAY column reflects only the content of the display, not the actual character positions.

5.2.2.5 Calling Name for BRI (CNAM-B) Displays

Calling Name for BRI is available to ISDN BRI DNs when the National ISDN BRI Package Secured Feature is purchased and active. The Calling Name for BRI feature consists of three sub-features:

- Calling Name Delivery (CNAM): The network uses this capability to send calling party name to the terminating terminal. Name information is retrieved by the terminating end-office from an Advanced Intelligent Network (AIN) database (for example, a Service Control Point) using SS7.
- Electronic Directory Service Calling Name Display (EDS CND): The network uses this capability to send intra-business group calling and original called name and number information to the terminating terminal. Name information is retrieved by the terminating end-office from an Applications Processor (AP) name database.
- Name Privacy: This capability enables an originating customer to inhibit delivery of their calling name to a terminating DN subscribed to either CNAM or EDS CND.

5.2.2.5.1 Calling Name Delivery (CNAM)

The displays used with the CNAM service (all are associated with incoming calls) are shown in the following list. CNAM displays calling name information. Additionally, if the ISDN BRI is also subscribed to ICLID, calling name, calling number, and redirecting number information are provided in the incoming call display.

"Private Name," "Unavailable Name," "Incoming call," or up to 15 characters of alpha/numeric IA5 characters are coded in the Calling Name tag. When both the calling party name and number are inhibited from display—private, unavailable, or from outside the subscriber's terminal group—"Private," "Unavailable," or "Incoming call" are coded in the Calling Name tag. The Calling Address tag is excluded from the Display Text IE sent to the terminating terminal.

DISPLAY	DIRECTION
a=From [Calling Name]	Incoming
a=From [Calling Name] Not end-to-end ISDN	Incoming
a=From [Calling Name] Non-ISDN calling	Incoming
a=From [Calling Name] Connected	Incoming
a=From [Calling Name] [Calling #]	Incoming
a=From [Calling Name] [Calling #] Not end-to-end ISDN	Incoming
a=From [Calling Name] [Calling #] Non-ISDN calling	Incoming
a=From [Calling Name] [Calling #] Connected	Incoming
a=From [Calling Name] [Calling #] cfx For [Redirecting #] [Reason]	Incoming
a=From [Calling Name] Call is waiting	Incoming
a=From [Calling Name] [Calling #] Call is waiting	Incoming
a=[Calling Name] Place data call now ### ###-####	Incoming
a=[Calling Name] Place call now ### ###-####	Incoming
a=[Calling Name] Transfer to:	Incoming
a=[Calling Name] Call held	Incoming
a=[Calling Name] Call held [Calling #]	Incoming
a=[Calling Name] to xxx-xxxx	Incoming
a=[Calling Name] [Calling #] to xxx-xxxx	Incoming
a=Name receive off	N/A[a]
a=Name receive on	N/A[a]
a=ID features off	N/A[a]
a=ID features on	N/A[a]

Note(s):

a. These displays are provided as confirmation displays whenever an ISDN BRI DN invokes the ISDN Display Features Activation/Deactivation (I-DF) to turn on or off their incoming call displays. The "ID features on" and "ID feature off" message is provided when the ISDN BRI DN is subscribed to more than one caller identity feature from among ICLID, CNAM, and EDS CND.

5.2.2.5.2 Electronic Directory Service Calling Name Display (EDS CND)

The displays used with the EDS CND service associated with incoming forwarded calls are shown in the following list. Displays used with EDS CND for non-forwarded calls are the same as those listed in "Calling Name Delivery (CNAM)," Section 5.2.2.5.1, for CNAM, where both calling name and calling number information are provided.

EDS CND displays calling name, calling number, original called name, and original called number information for intra-business group calls (where a business group is defined as DNs with the same BCID). Calling number and/or original called number information is displayed for calls from outside the business group, but name information is "unavailable" for inter-business group calls. Original called name and number are provided on forwarded calls.

"Private Name," "Unavailable Name," "Incoming call," or up to 15 characters of alpha/numeric IA5 characters are coded in the Calling Name and/or Original Called Name tags. Calling number is coded in the Calling Address tag and the original called number is coded in the Feature Address tag. When both the calling name and calling number are inhibited from display—private, unavailable, or from outside the subscribers terminal group—"Private," "Unavailable," or "Incoming call" are coded in the Calling Name tag. The Calling Address tag is excluded from the Display Text IE sent to the terminating terminal. Likewise, when both the original called name and original called number are inhibited from display—private, unavailable, or from outside the subscribers terminal group—"Private," "Unavailable," or "Incoming call" are coded in the Original Called Name tag. The Feature Address tag is excluded from the Display Text IE sent to the terminating terminal.

DISPLAY	DIRECTION
a=From [Calling Name] [Calling #] cfx For [Redirecting Name] [Redirecting #]	Incoming
a=From [Calling Name] [Calling #] cfx to ###-#### [Redirecting Name]	Incoming

5.2.2.5.3 Name Privacy Displays

This capability enables an originating customer to inhibit calling name or original called name from being delivered to a CNAM or EDS CND subscriber. Any of three name privacy "actions" may be invoked on a per-call basis by National ISDN BRI users following the stimulus signaling procedures described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. The displays associated with outgoing calls for the name privacy capability are shown in "Basic Call Displays," Section 5.2.2.3, under Basic Call Displays.

5.2.3 SPECIFICATION DESCRIPTION LANGUAGE (SDL) DIAGRAMS

This section contains SDL diagrams (Figures 5.2.3-1, 5.2.3-2, 5.2.3-3, 5.2.3-4, 5.2.3-5, 5.2.3-6, 5.2.3-7, 5.2.3-8, 5.2.3-9, 5.2.3-10, 5.2.3-11, 5.2.3-12, 5.2.3-13, 5.2.3-14, 5.2.3-15, 5.2.3-16, 5.2.3-17, 5.2.3-18, 5.2.3-19, 5.2.3-20, 5.2.3-21, 5.2.3-22, 5.2.3-23, 5.2.3-24, 5.2.3-25, 5.2.3-26, 5.2.3-27, 5.2.3-28, 5.2.3-29, 5.2.3-30, 5.2.3-31, 5.2.3-32, 5.2.3-33, 5.2.3-34, 5.2.3-35, 5.2.3-36, 5.2.3-37, 5.2.3-38, 5.2.3-39, 5.2.3-40, 5.2.3-41, 5.2.3-42, 5.2.3-43, 5.2.3-44, 5.2.3-45, 5.2.3-46, 5.2.3-47, 5.2.3-48, 5.2.3-49, 5.2.3-50, and 5.2.3-51) illustrating the call processing logic for some supplementary services described in this section. The SDLs are provided for the following services: Hold, Conference, Drop, Transfer, and Key-System. The sets of SDLs for the preceding features are independent and do not reflect the interaction of services between the sets. These SDLs do not reflect all possible message and information flows for a terminal subscribing to Terminal Management Services, for example, such a terminal may send or receive an INFOrmation message in the *Null* state. These SDLs will be reviewed and considered with several points in mind.

a. The SDL diagrams represent the interface as viewed from the user side (terminal). This differs from the text, which is written largely from the network perspective. The purpose of the SDLs is to help terminal vendors better understand how to build equipment to work with the *5ESS*® switch.

b. *Most important*, these SDLs are not intended to impose design constraints upon terminals beyond those discussed in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, (that is, are not to be considered design blueprints). The SDLs will be viewed merely as a suggested interpretation of these supplementary services.

These SDLs are meant as an incremental supplement to the SDLs for the Basic Voice Services. These SDLs refer to both supplementary and basic call states. It is assumed that if an SDL refers to a basic call state, the SDL for that call state will be the same as that which appears in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2. In some cases, basic call SDLs have been modified to reflect changes in call processing necessitated by certain supplementary services. In these cases, new basic call processing SDLs have been provided. These are meant to *replace* those particular corresponding SDLs appearing in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

The SDL notation for the supplementary call states reflects both the basic call progress state from which a service request has been generated, and the state of the additional service request, for example, State 30-3, *U3 Hold Request*, indicates that the call is in the *Outgoing Call Proceeding* state as the HOLD request is pending. If the terminal then receives an ALERTing message from the network, the terminal would enter State 30-4, *U4 Hold Request*. At this time, the terminal would expect the same messages it would expect in the *U3 Hold Request* state, except it would no longer expect an ALERTing message from the network. Furthermore, a HOLD REJect message will be received by the terminal while in this state, the terminal would return to State U4 rather than State U3. The terminal thus tracks the progress of both the call and the supplemental service request.

The SDLs are drawn from the perspective of a full state terminal. They provide a clear, detailed picture of the protocol interactions (for example, allowed/desirable message flow) supporting this interface. The actual interface itself, however, supports terminals with less complicated perspectives. Moreover, the internal design of the terminal is transparent to the interface. All that really affects the compatibility of a given terminal is whether the proper interface (that is, the proper messages and information elements at the proper times) is presented to the switch.

The supplementary states defined in the SDLs are not meant to impose implementation restrictions upon the terminal manufacturer. Given this, the terminal is not expected to return these supplementary states in a STATUS message that is sent in response to a STATUS INQuiry message issued by the network. The terminal is expected to return one of the basic call states or one of the recognized defaults as specified in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2.

The SDLs reflect call processing from the perspective of a single user. In some cases, an individual call may be affected by service requests from more than one user, for example, a call placed on hold by one party may be used by the party on the far end of the call as a leg of a transfer request. These types of cases are not explicitly depicted in the SDLs.

These SDLs do not explicitly show all possible message and information flows that result from multiple, unacknowledged service requests for a given call. For example, a terminal in a *Key-System Hold* state may issue a reconnect request followed by a disconnect request. In this case, the terminal is expected to administer messages regarding the first service request through the Any Other Message option.

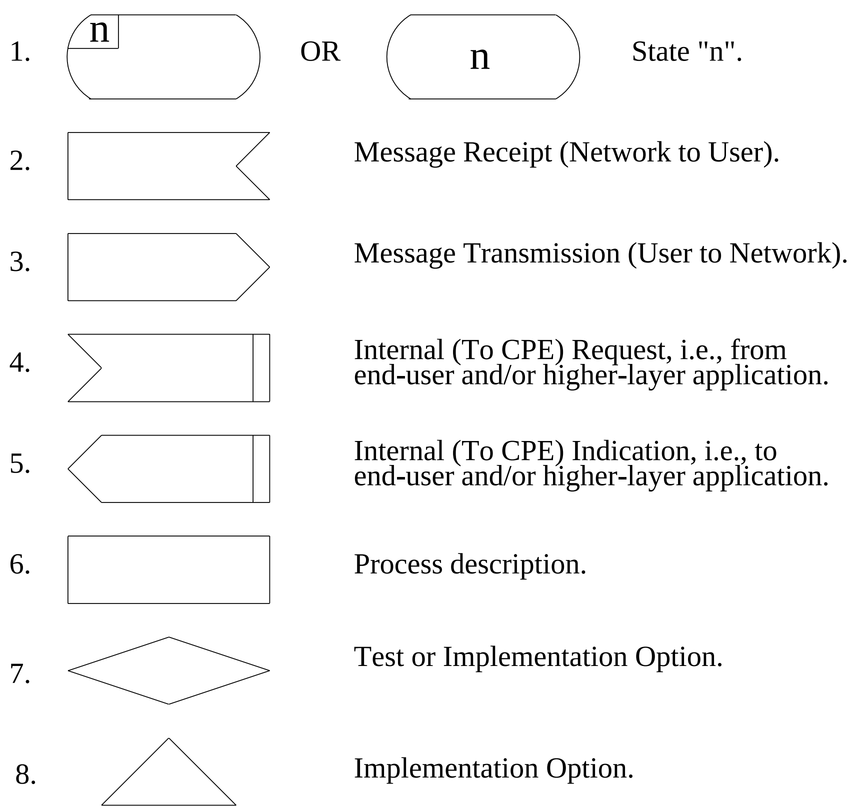


Figure 5.2.3-1 — SDL Symbol Key

EXAMPLE SDL DIAGRAMS FOR KEY-SYSTEM

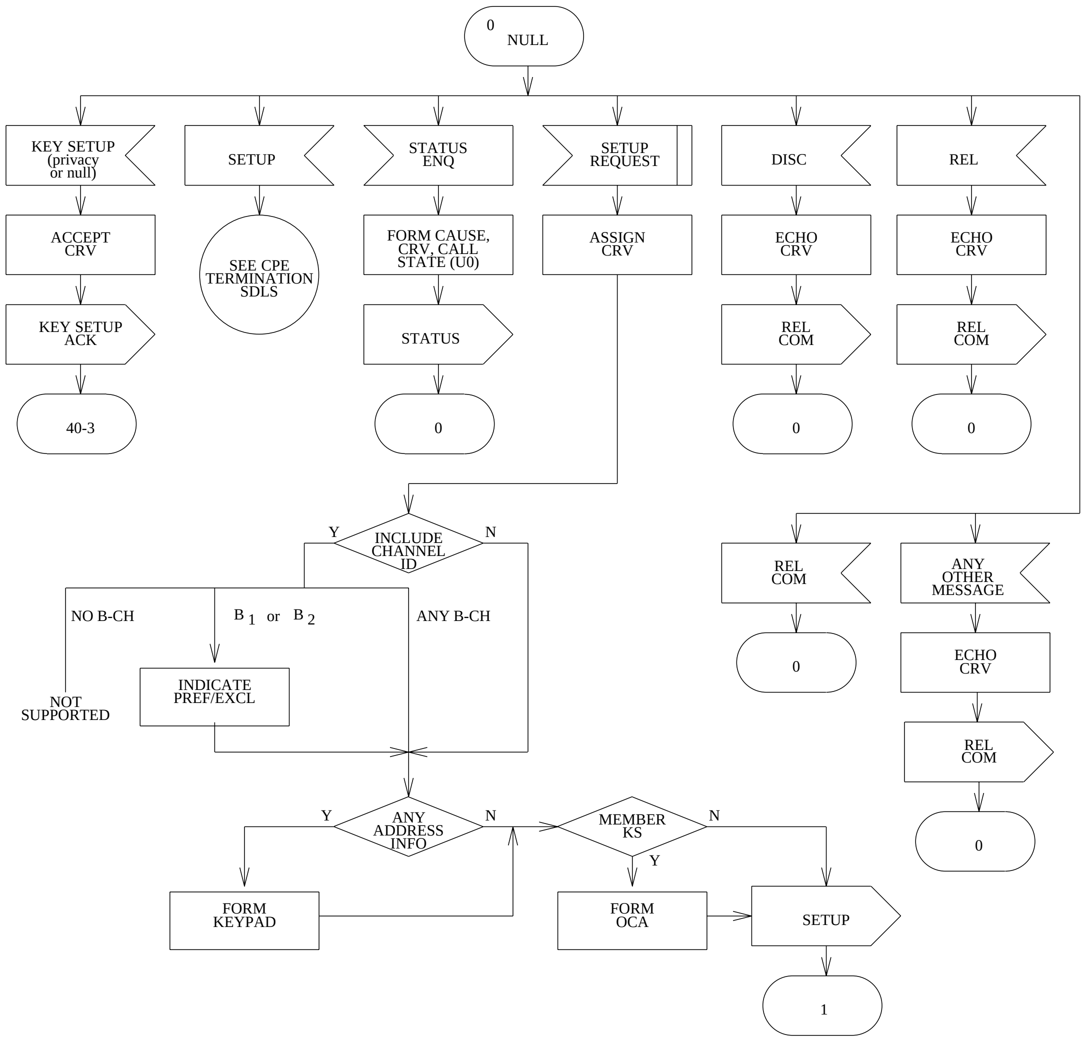


Figure 5.2.3-2 — Call Control—CPE Origination (NULL) (User Side)

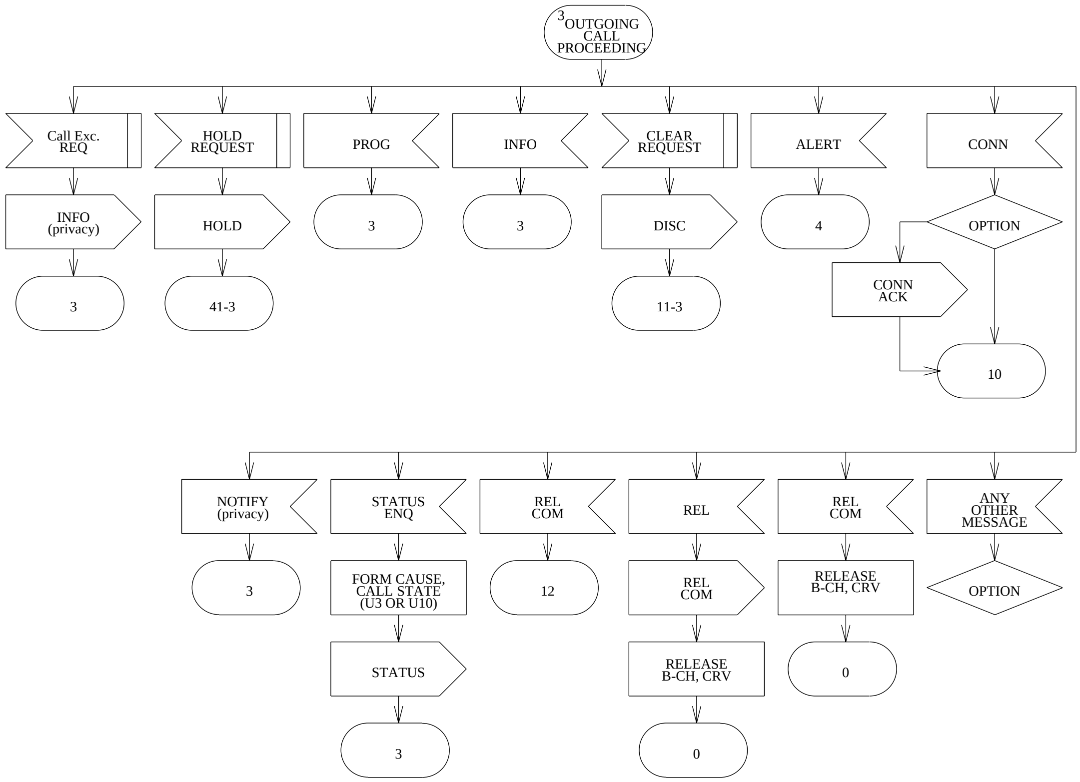


Figure 5.2.3-3 — Call Control—CPE Origination (OUTGOING CALL PROCEEDING) (User Side)

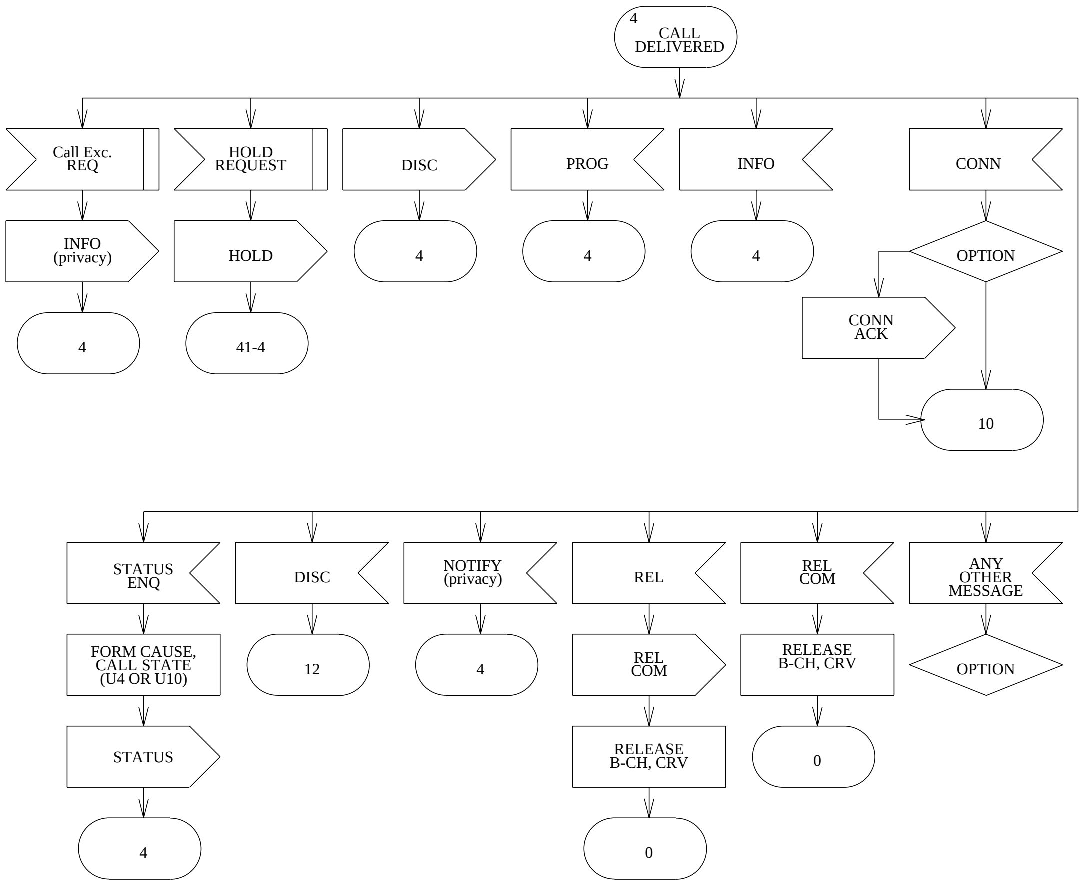


Figure 5.2.3-4 — Call Control—CPE Origination (CALL DELIVERED) (User Side)

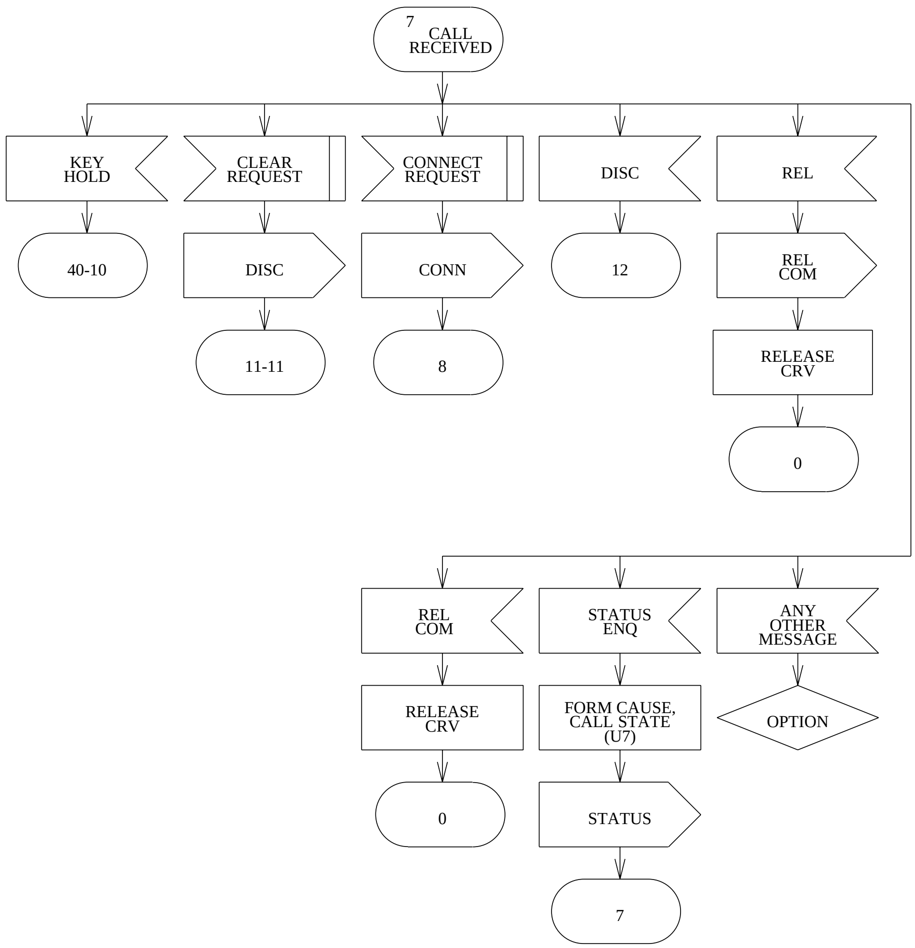


Figure 5.2.3-5 — Call Control—CPE Origination (CALL RECEIVED) (User Side)

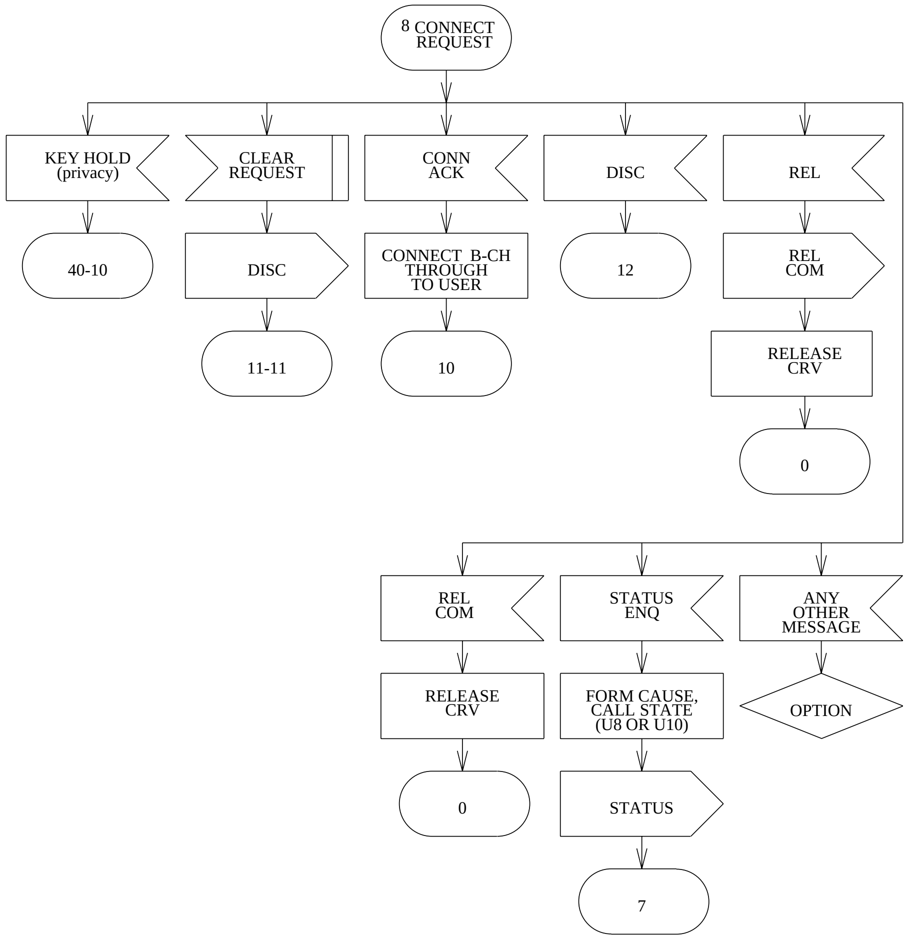


Figure 5.2.3-6 — Call Control—CPE Origination (CONNECT REQUEST) (User Side)

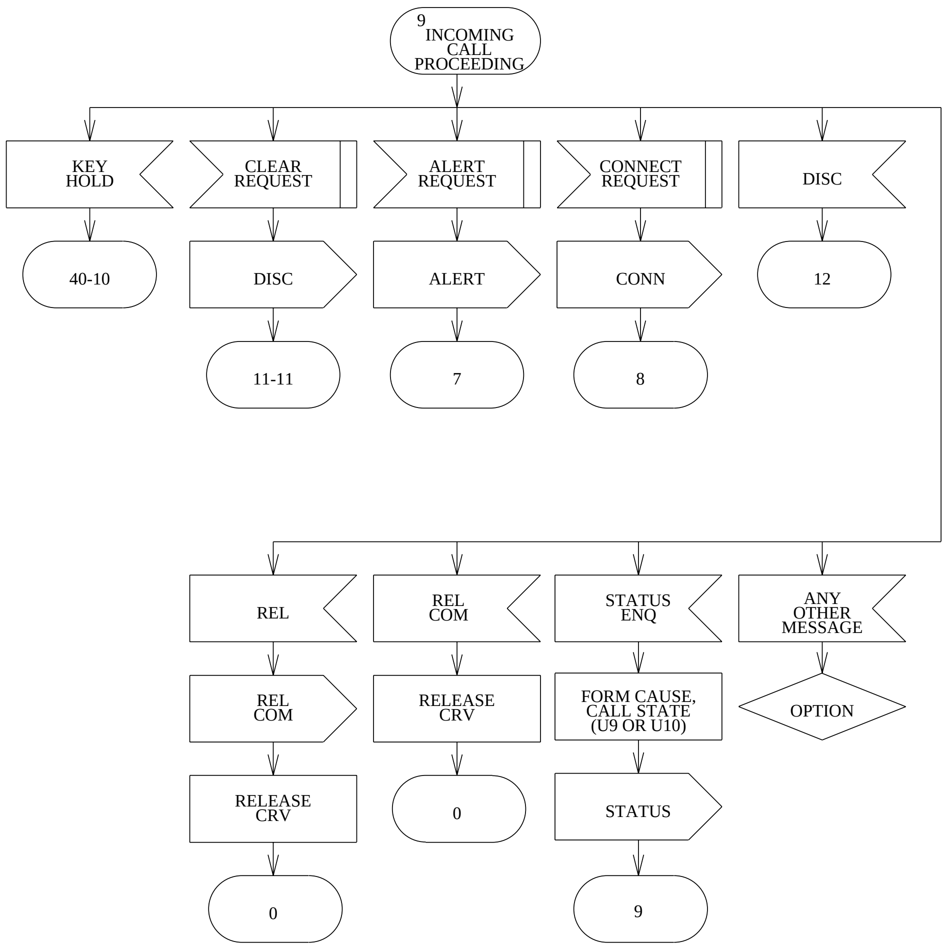


Figure 5.2.3-7 — Call Control—CPE Origination (INCOMING CALL PROCEEDING) (User Side)

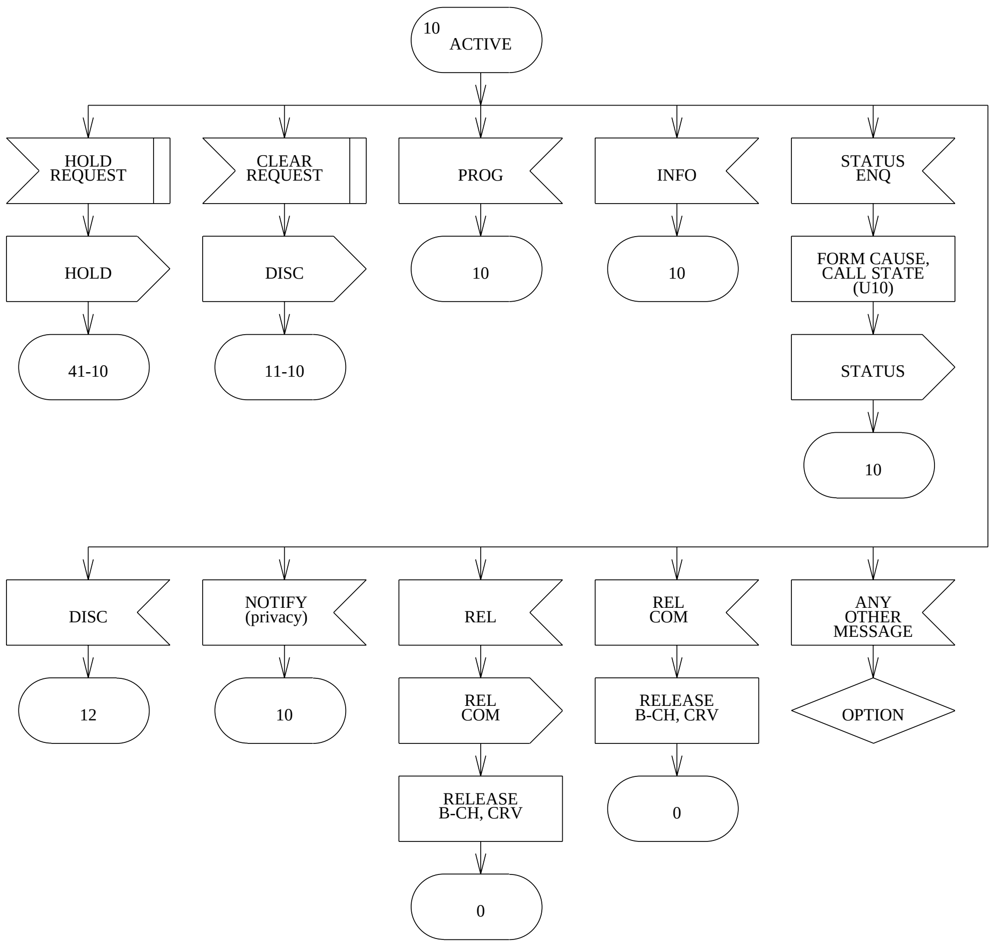


Figure 5.2.3-8 — Call Control—CPE Origination (ACTIVE) (User Side)

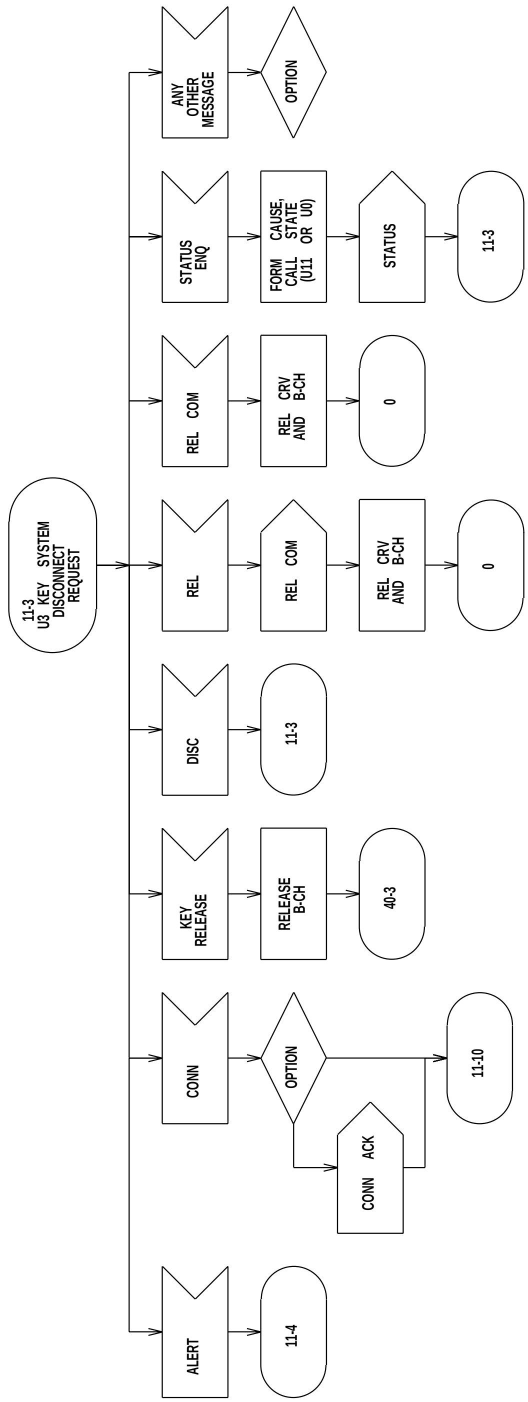


Figure 5.2.3-9 — Call Control—CPE Termination (U3 DISCONNECT REQUEST)

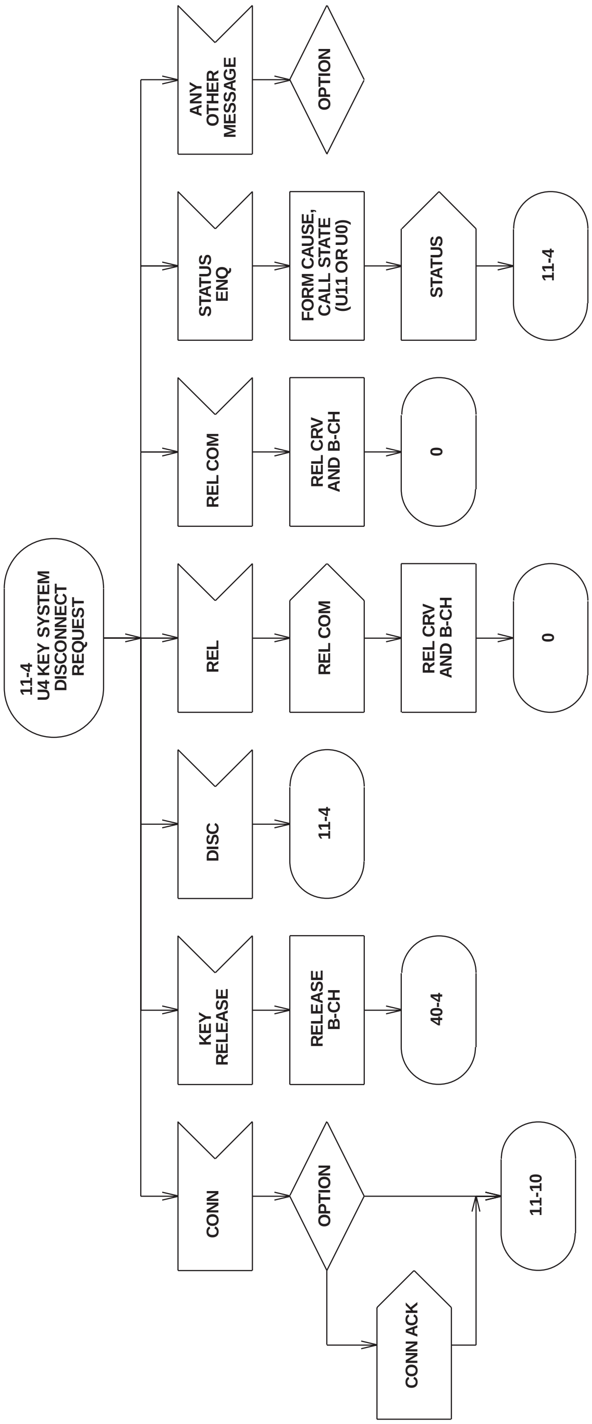


Figure 5.2.3-10 — Call Control—CPE Termination (U4 DISCONNECT REQUEST)

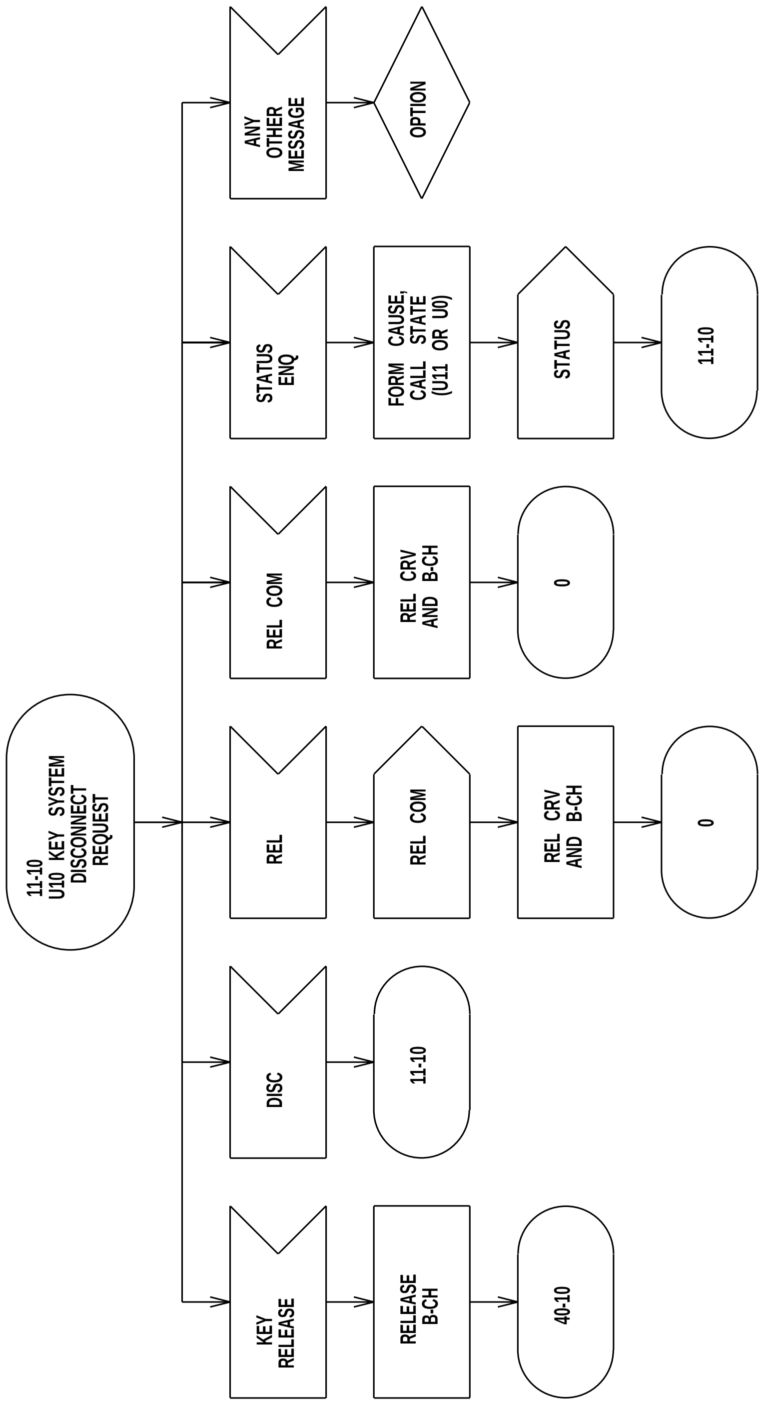


Figure 5.2.3-11 — Call Control—CPE Termination (U10 DISCONNECT REQUEST)

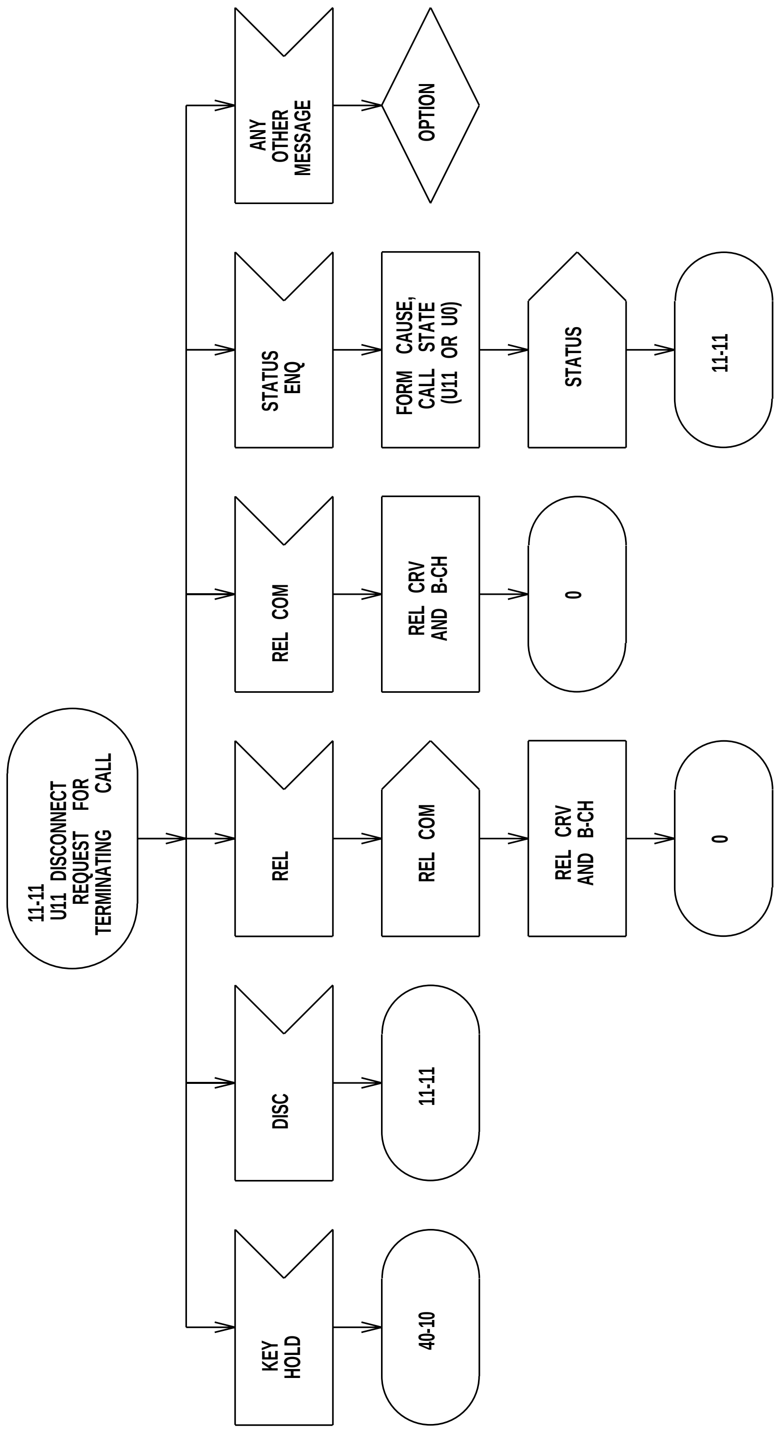


Figure 5.2.3-12 — Call Control—CPE Termination (U11 DISCONNECT REQUEST FOR TERMINATING CALL)

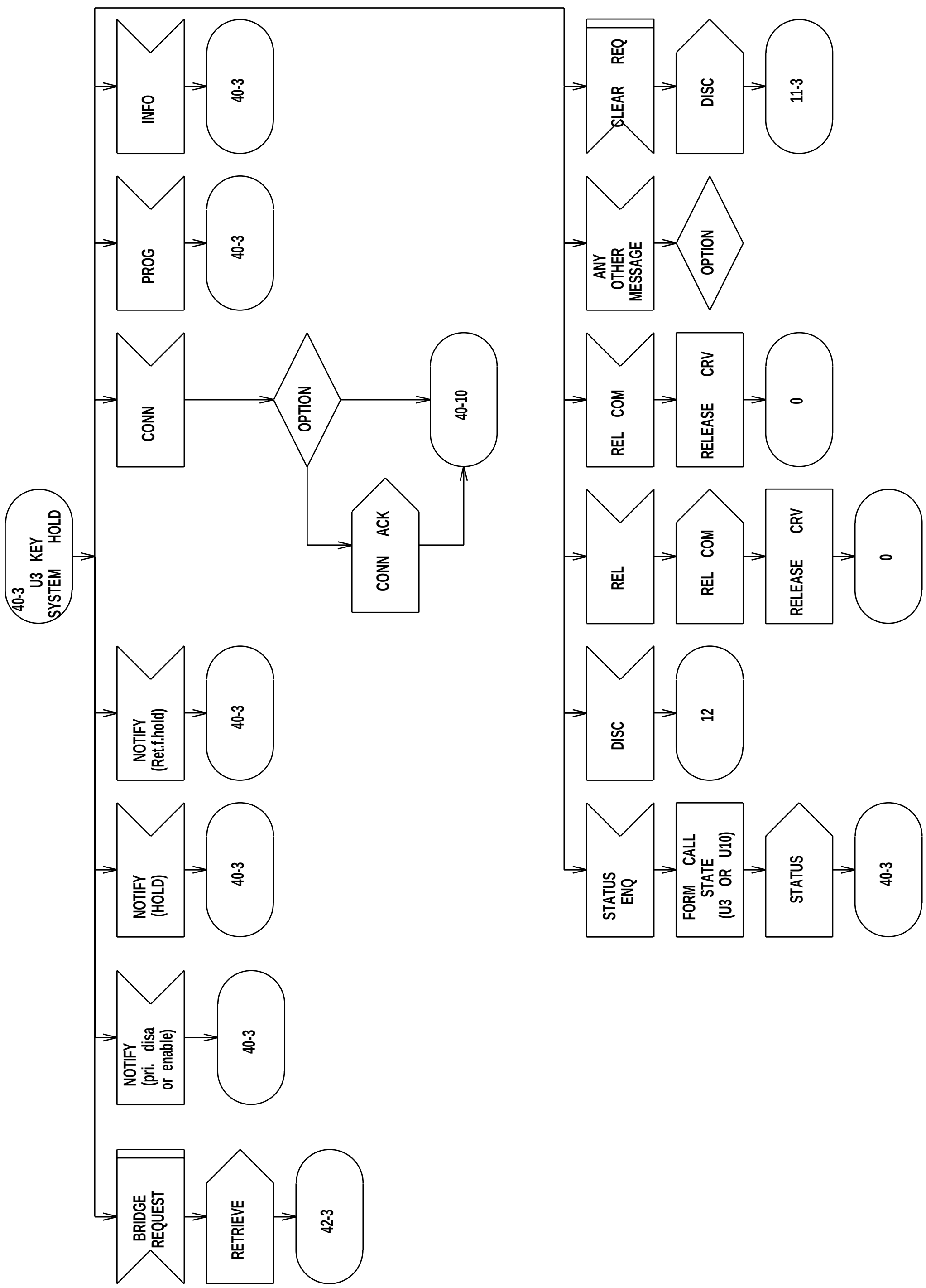


Figure 5.2.3-13 — Call Control—CPE Termination (U3 HOLD—40-3)

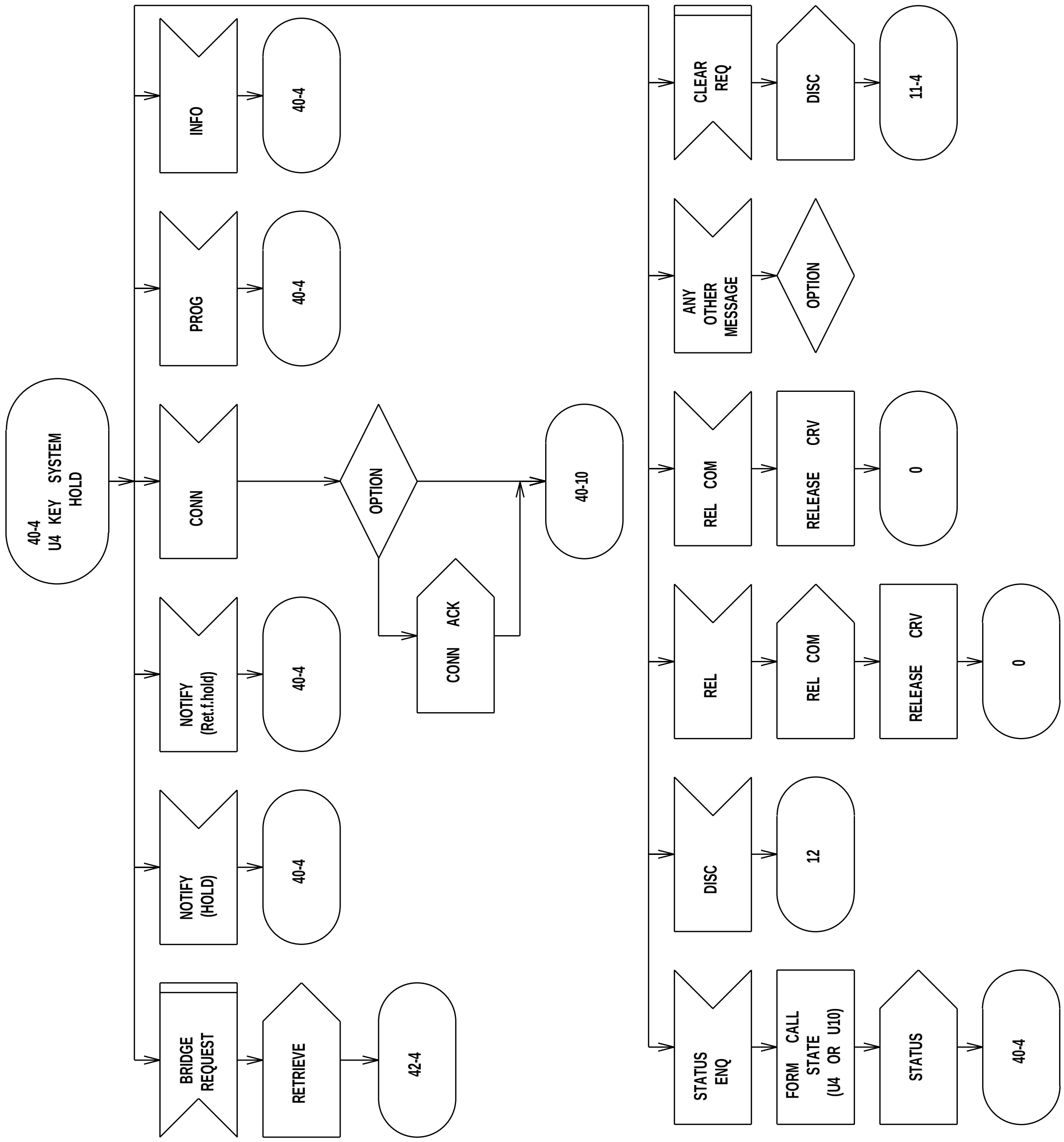


Figure 5.2.3-14 — Call Control—CPE Termination (U4 HOLD—40-4)

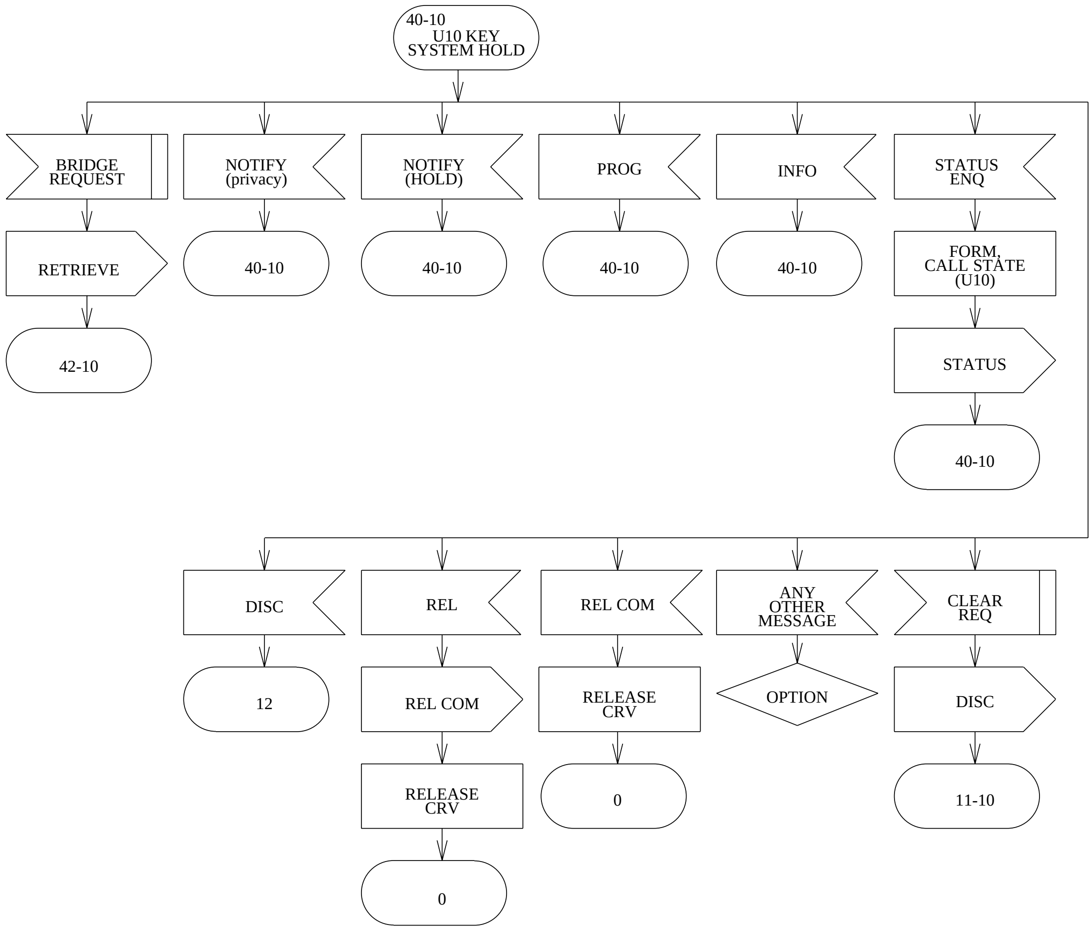


Figure 5.2.3-15 — Call Control—CPE Termination (U10 HOLD—40-10)

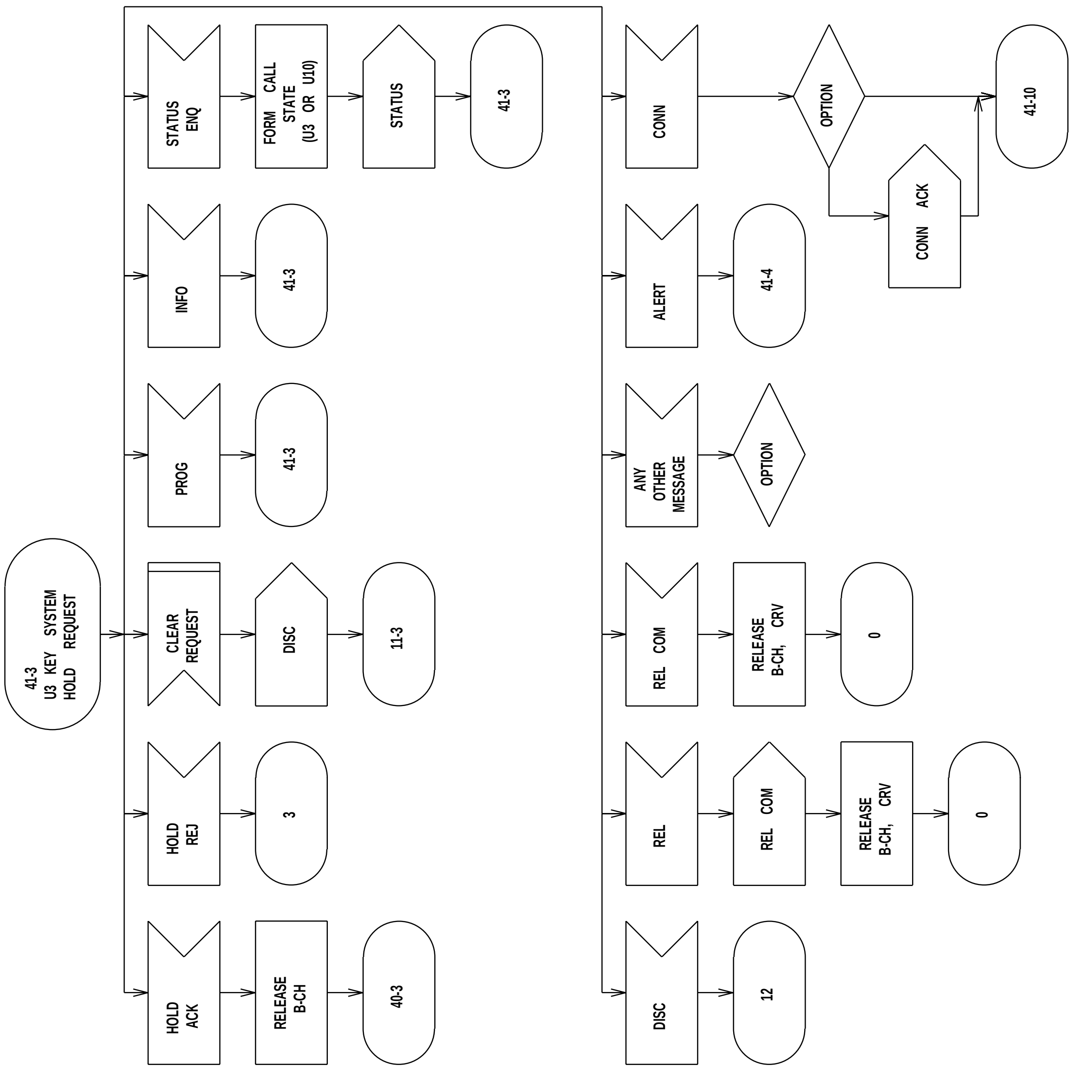


Figure 5.2.3-16 — Call Control—CPE Termination (U3 HOLD REQUEST—41-3)

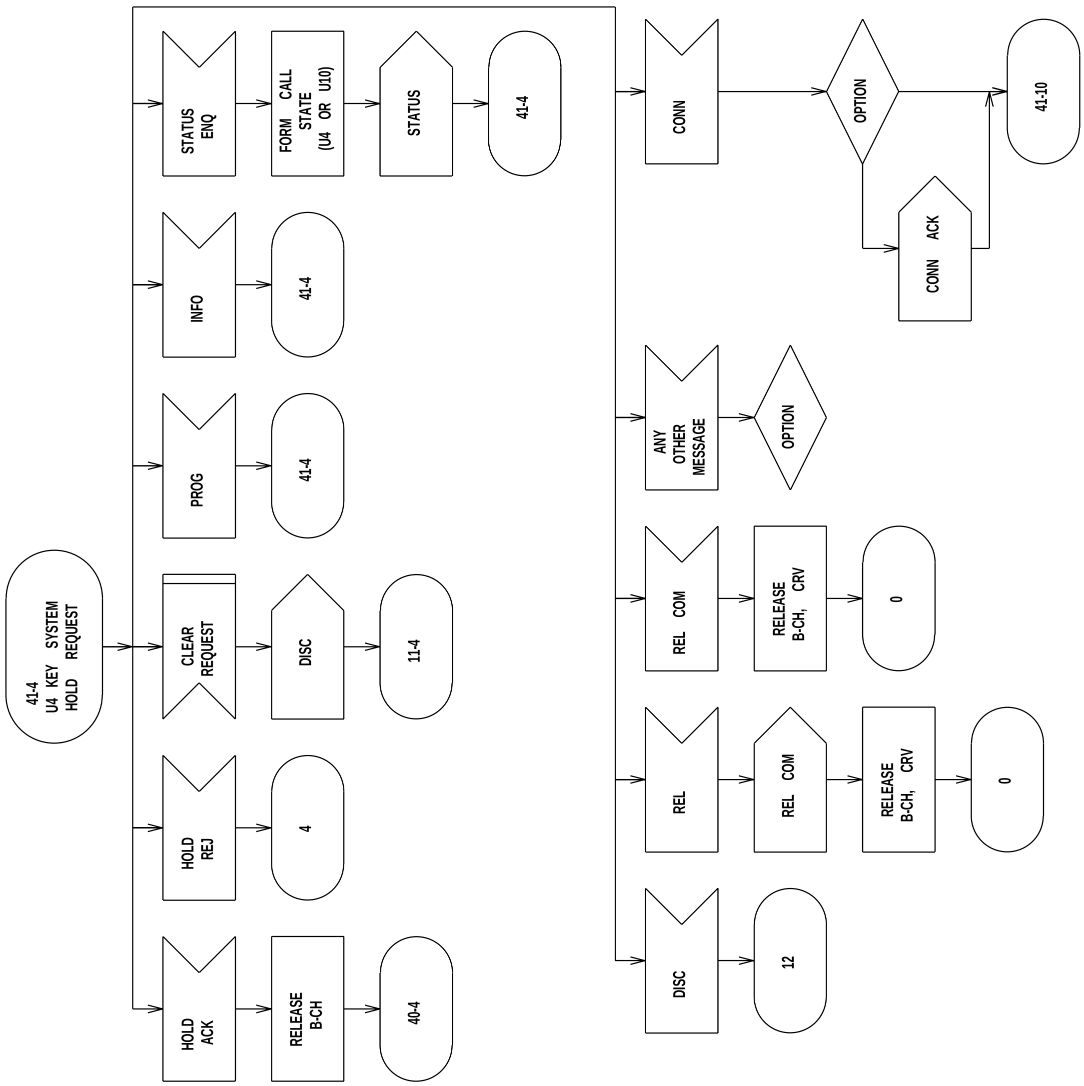


Figure 5.2.3-17 — Call Control—CPE Termination (U4 HOLD REQUEST—41-4)

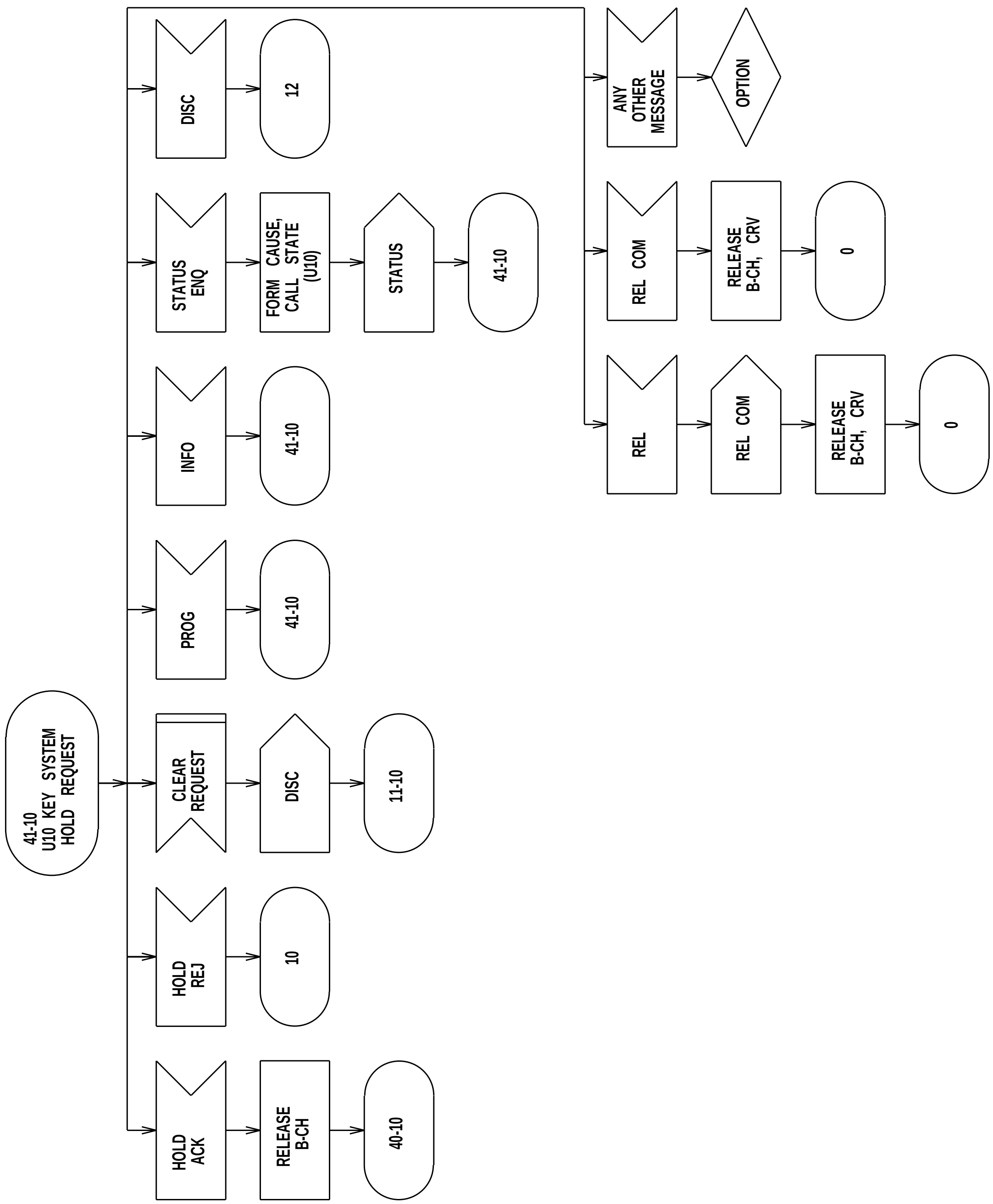


Figure 5.2.3-18 — Call Control—CPE Termination (U10 HOLD REQUEST—41-10)

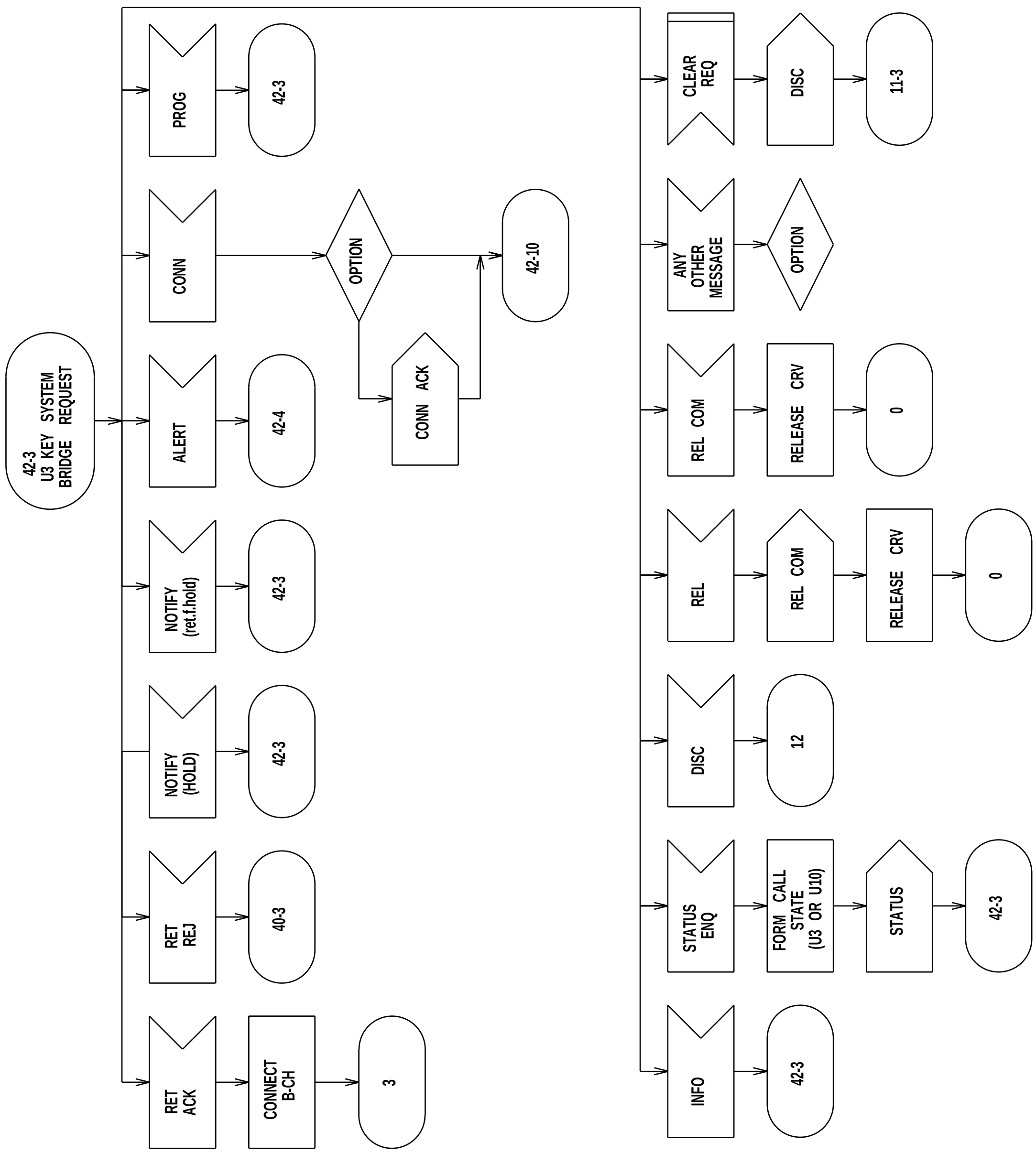


Figure 5.2.3-19 — Call Control—CPE Termination (U3 BRIDGE REQUEST—42-3)

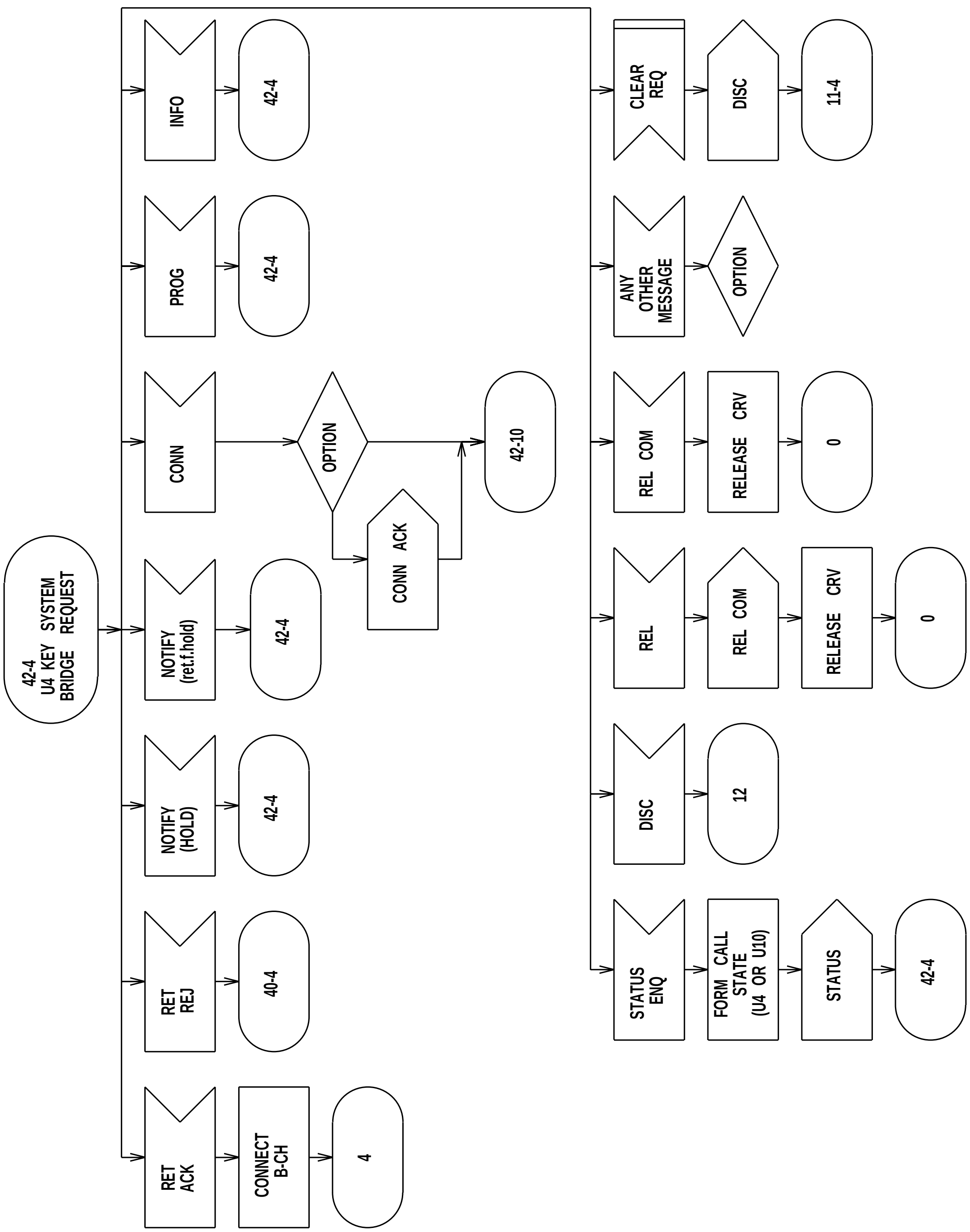


Figure 5.2.3-20 — Call Control—CPE Termination (U4 BRIDGE REQUEST—42-4)

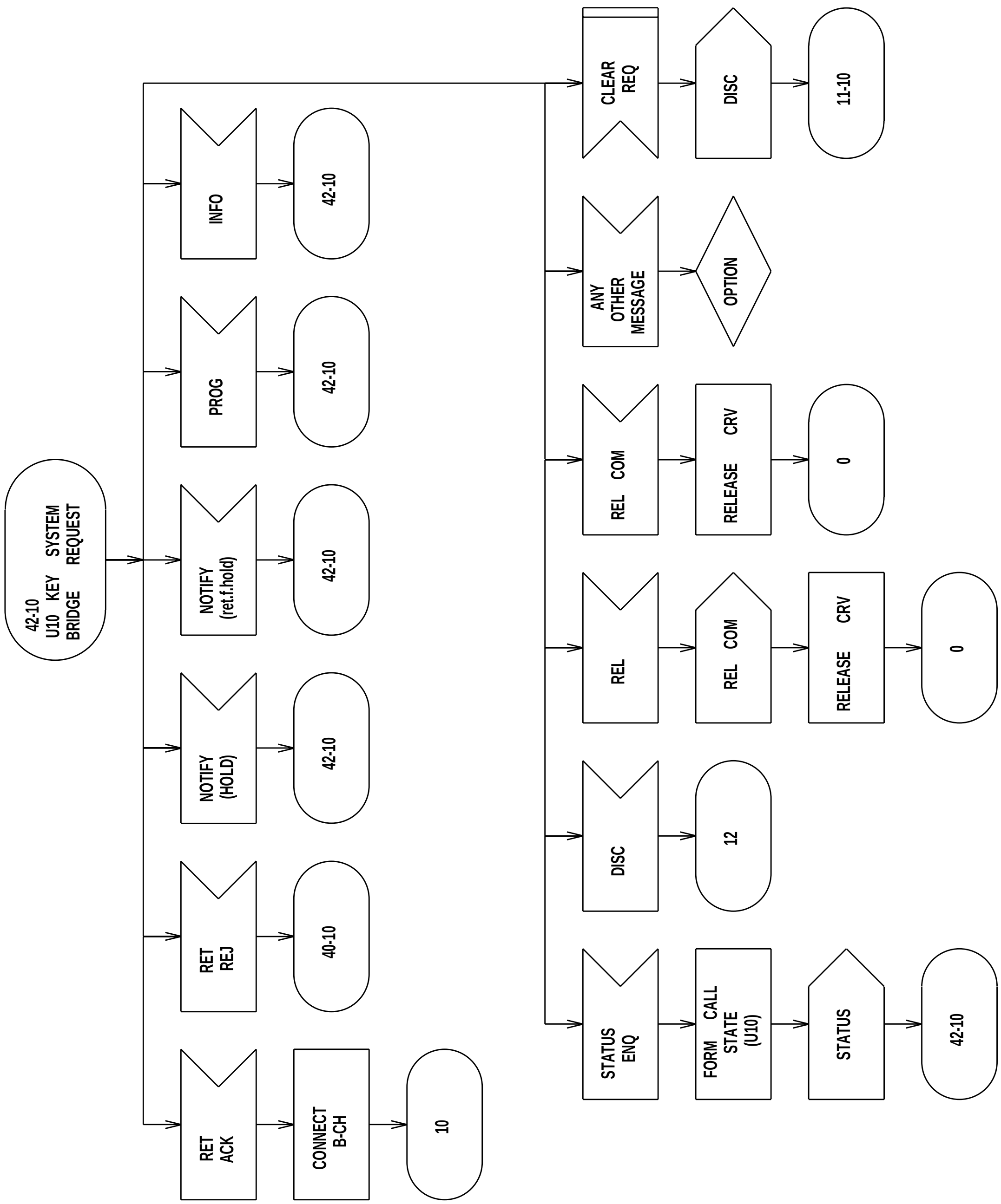


Figure 5.2.3-21 — Call Control—CPE Termination (U10 BRIDGE REQUEST—42-10)

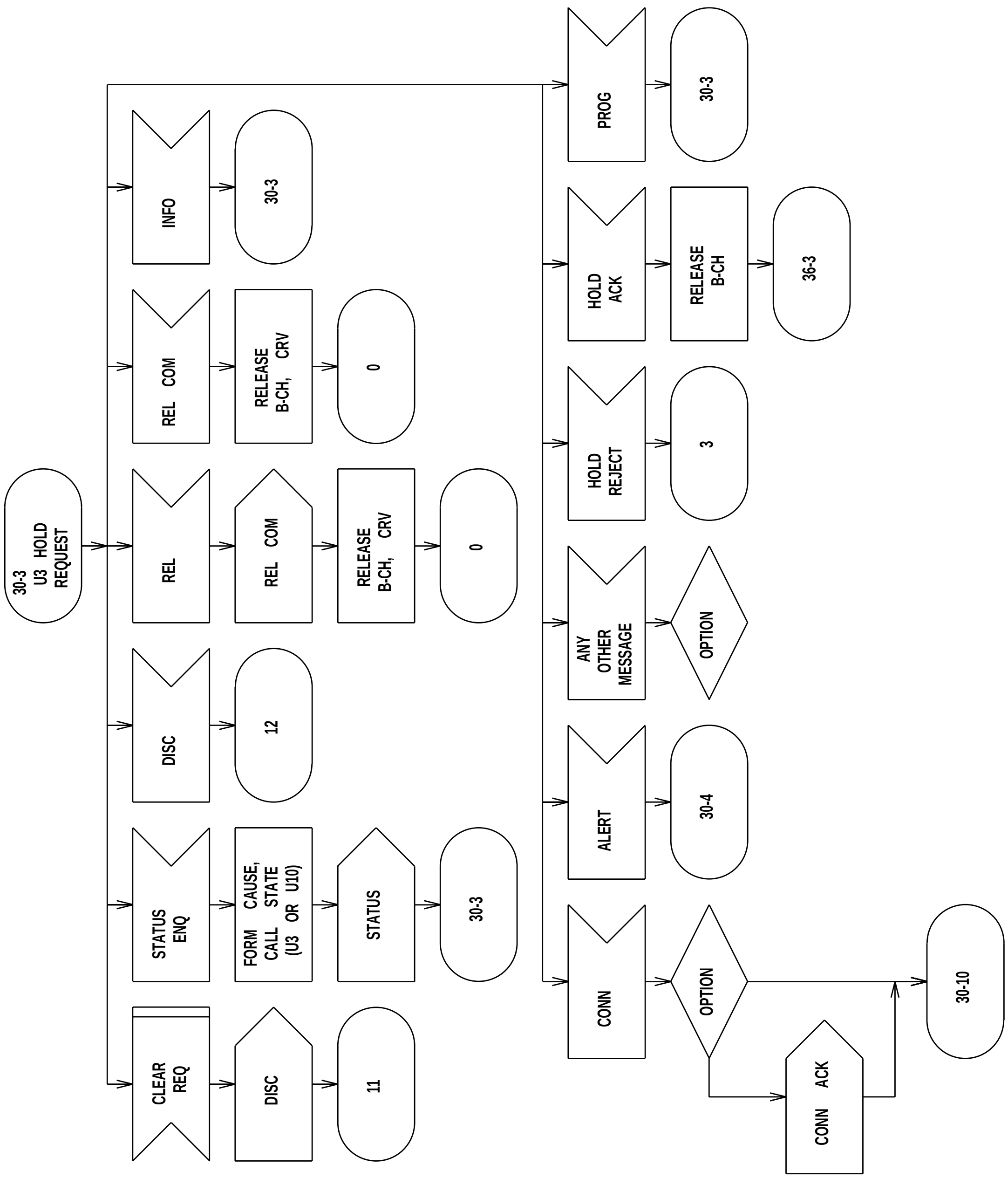


Figure 5.2.3-22 — Call Control—CPE Origination (U3 HOLD REQUEST—30-3)

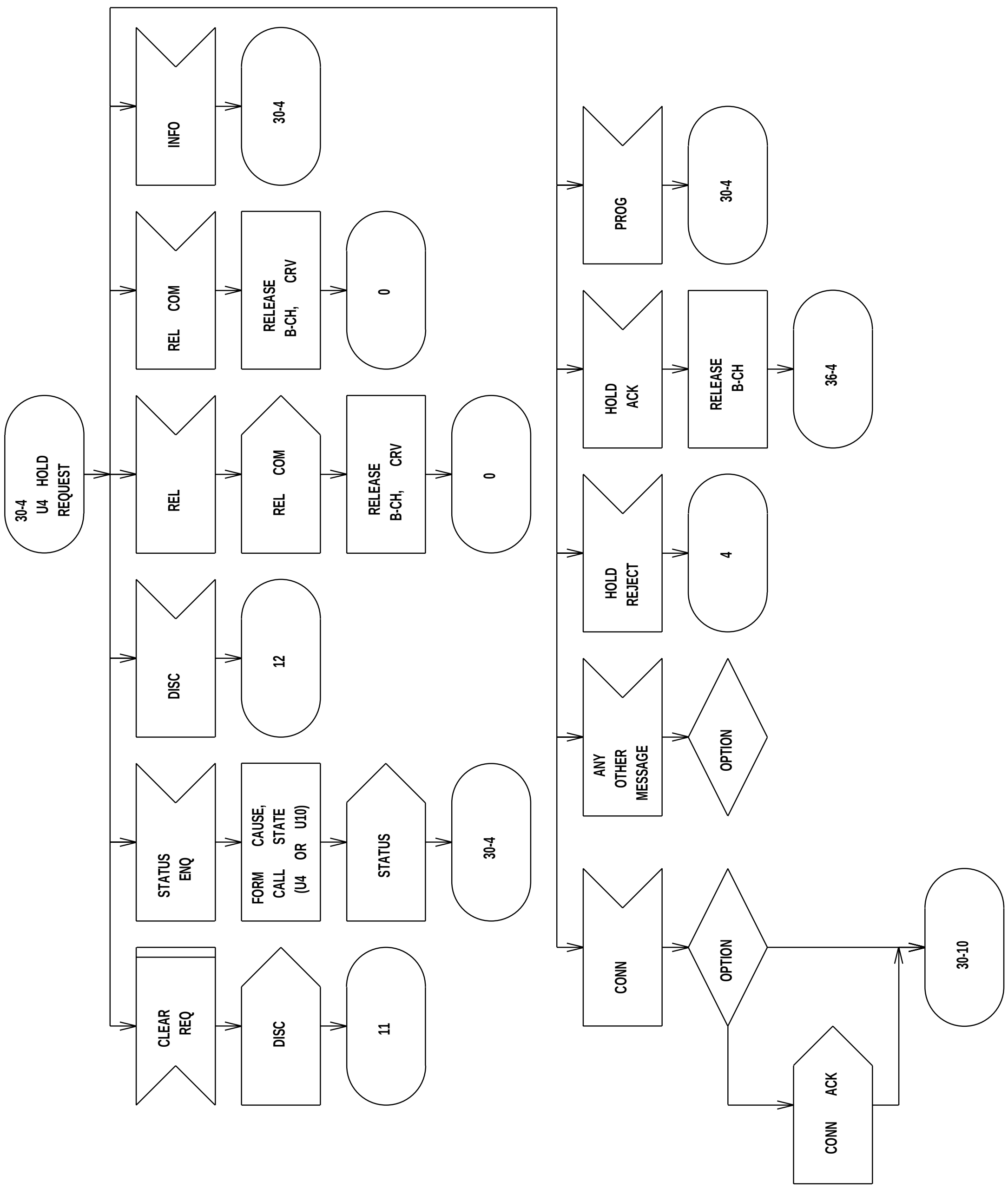


Figure 5.2.3-23 — Call Control—CPE Origination (U4 HOLD REQUEST—30-4)

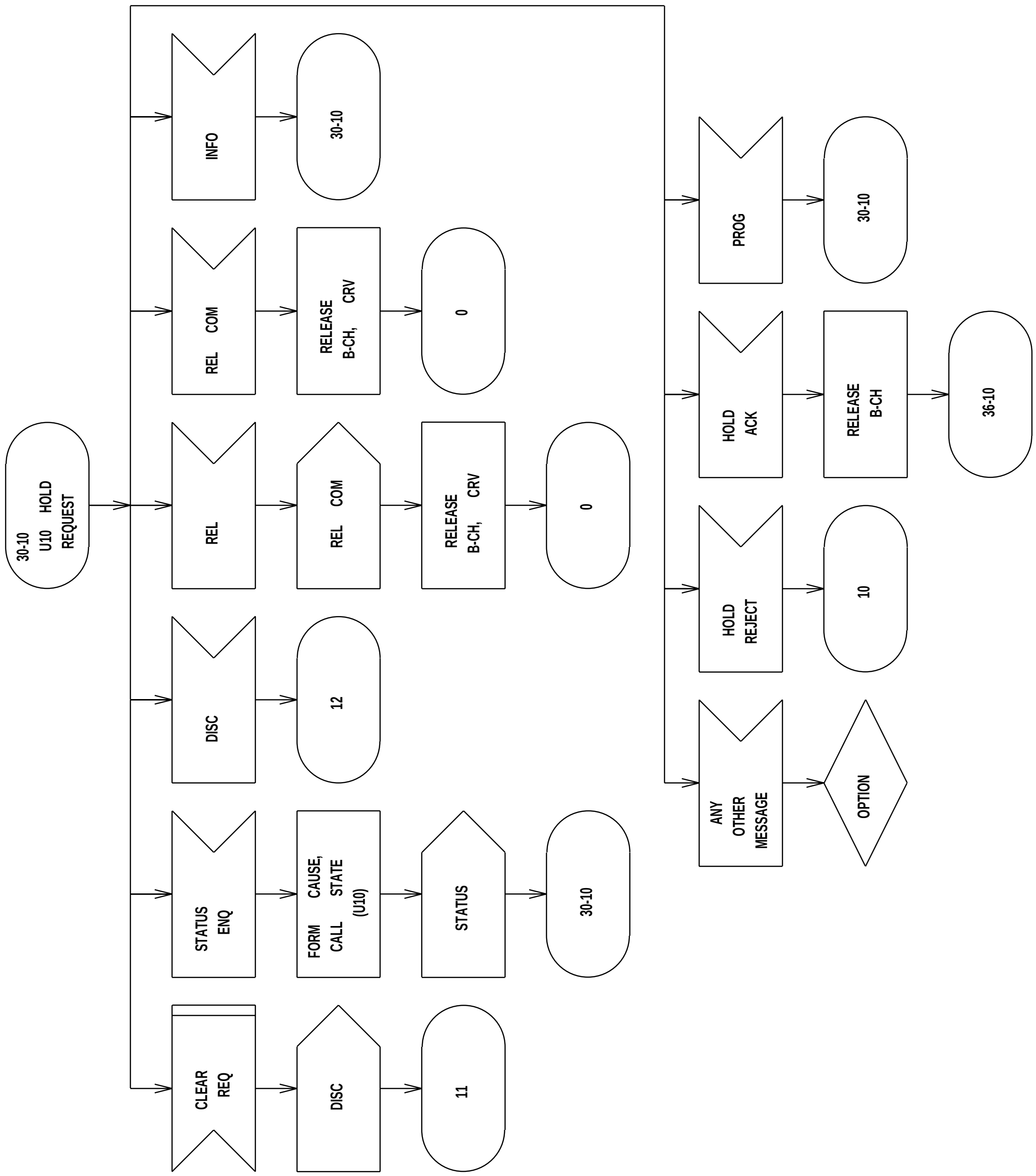


Figure 5.2.3-24 — Call Control—CPE Origination (U10 HOLD REQUEST—30-10)

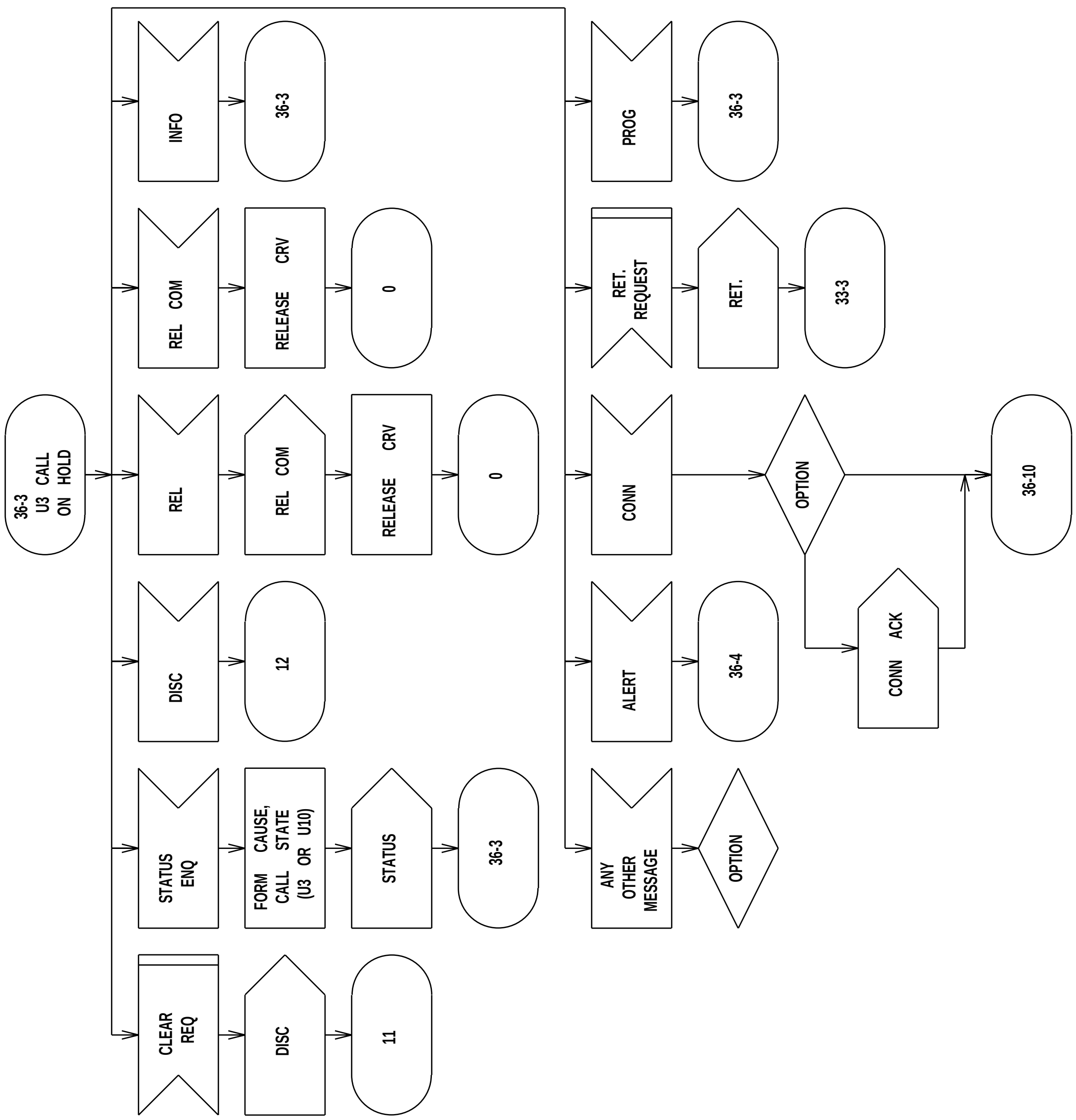


Figure 5.2.3-25 — Call Control—CPE Origination (U3 CALL ON HOLD)

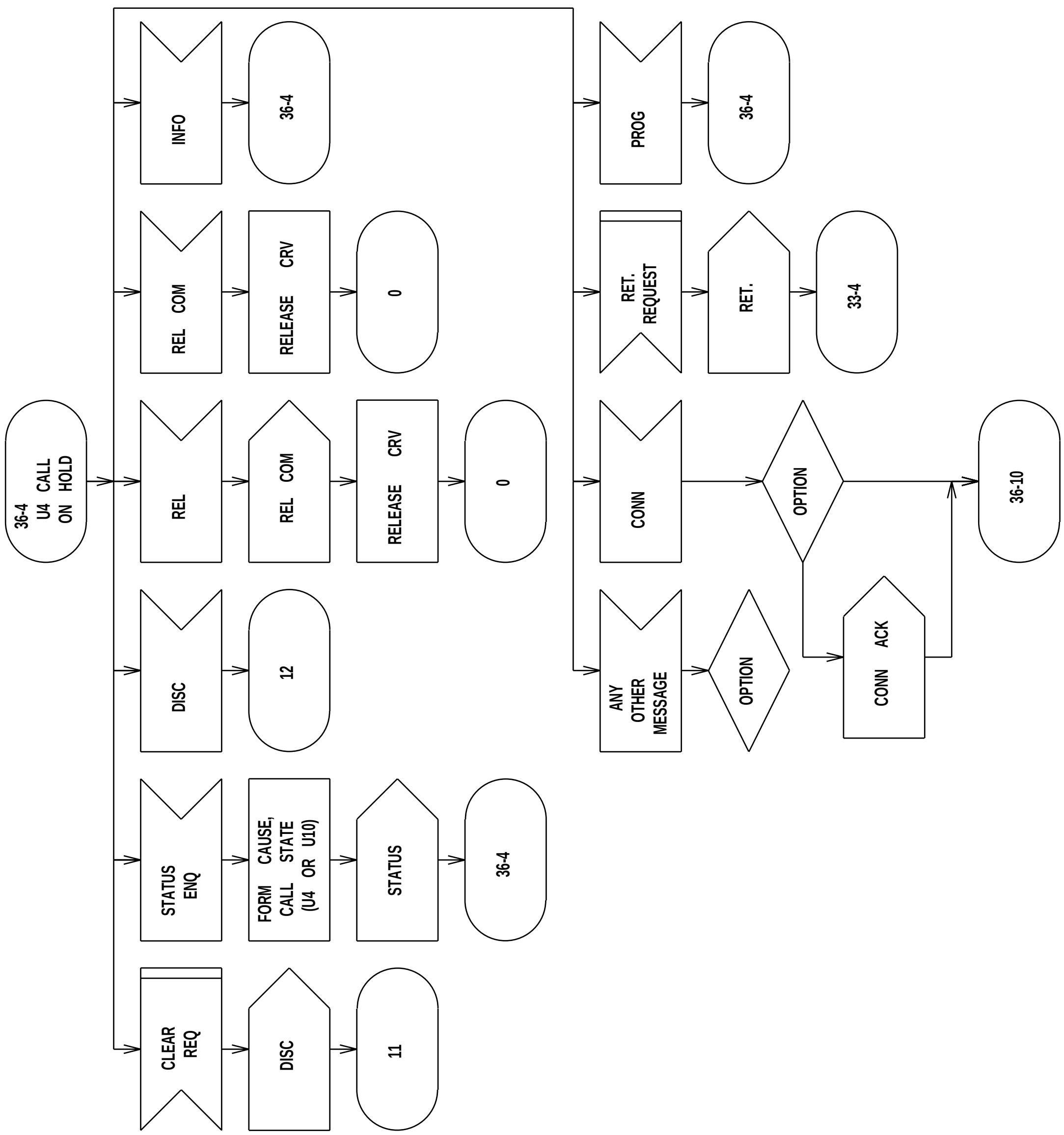


Figure 5.2.3-26 — Call Control—CPE Origination (U4 CALL ON HOLD)

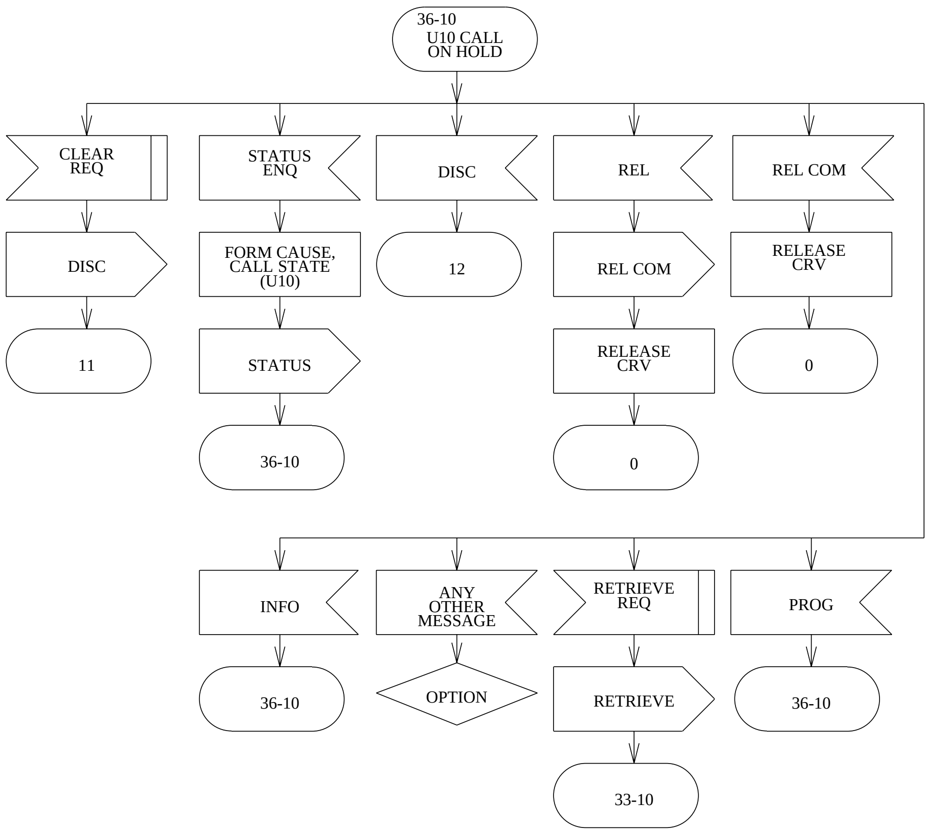


Figure 5.2.3-27 — Call Control—CPE Origination (U10 CALL ON HOLD)

EXAMPLE SDL DIAGRAMS FOR FLEXIBLE CALLING

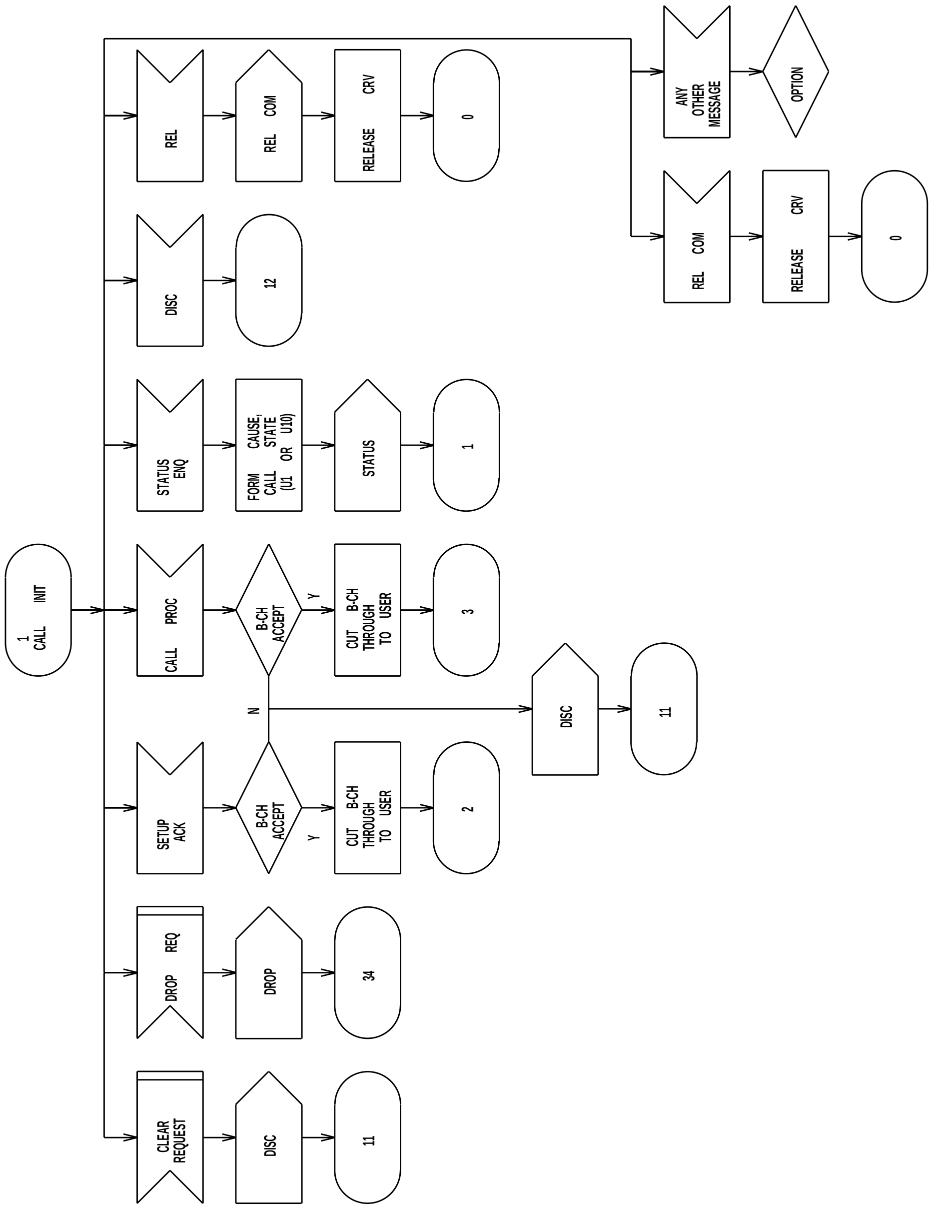


Figure 5.2.3-28 — Call Control - CPE Termination (CALL INIT)

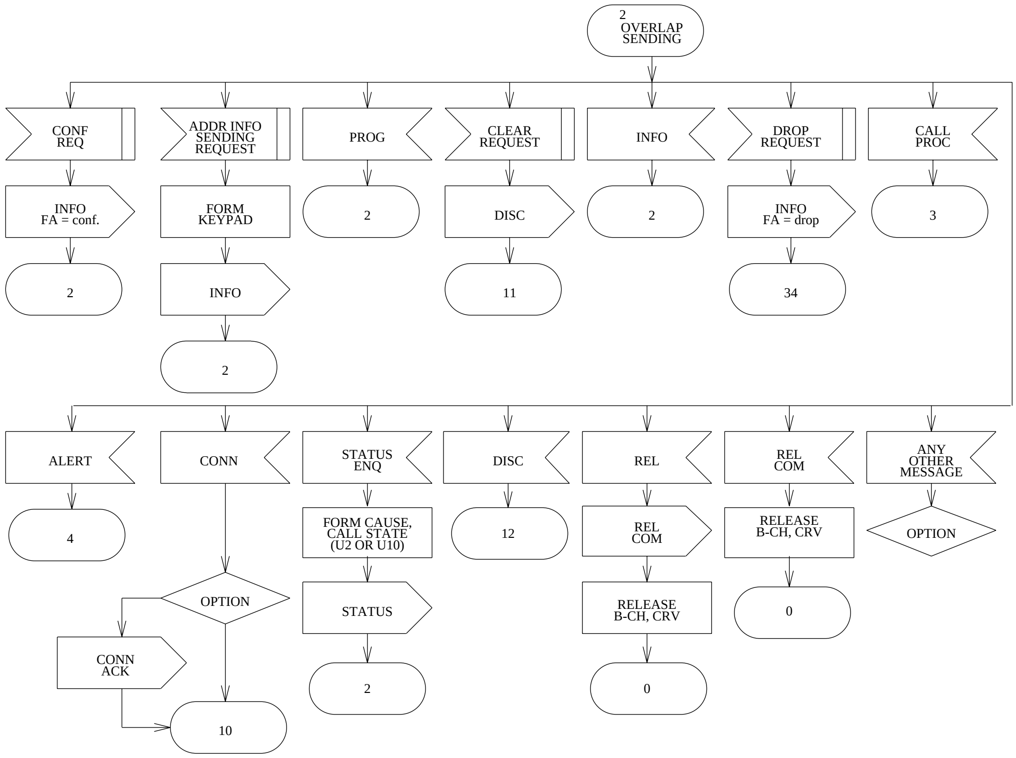


Figure 5.2.3-29 — Call Control - CPE Origination (OVERLAP SENDING)

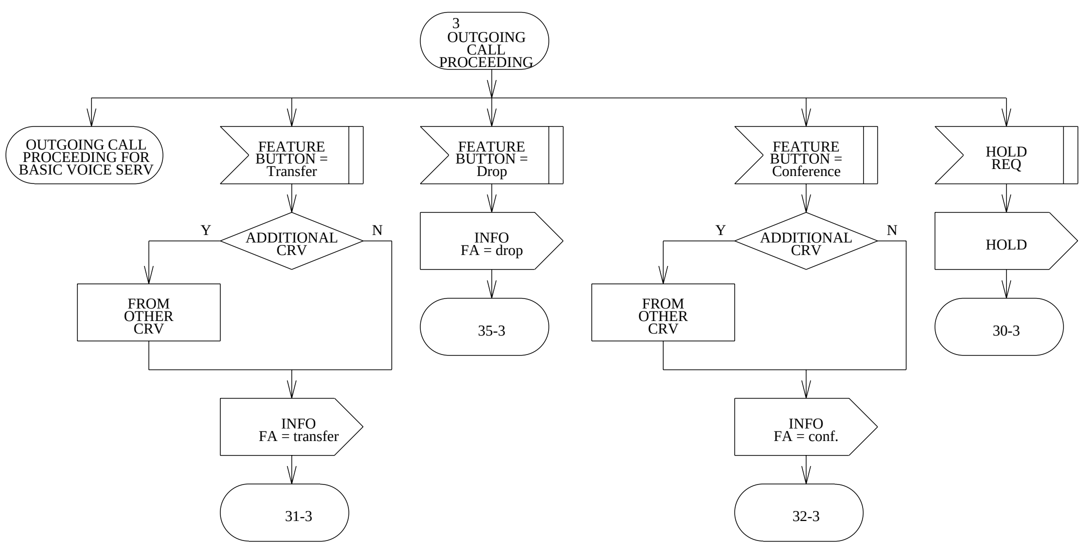


Figure 5.2.3-30 — Call Control - CPE Origination (OUTGOING CALL PROCEEDING)

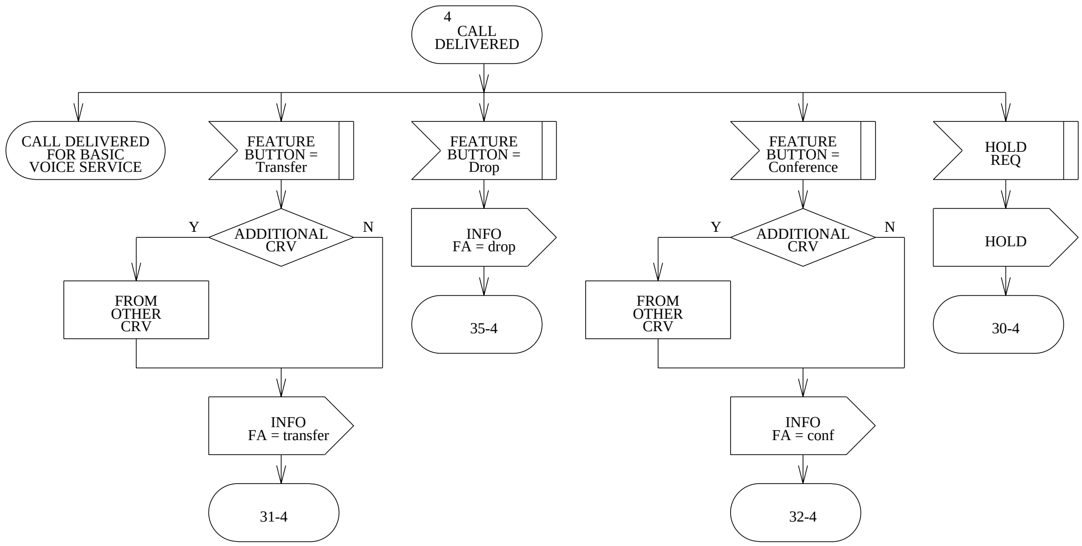


Figure 5.2.3-31 — Call Control - CPE Origination (CALL DELIVERED)

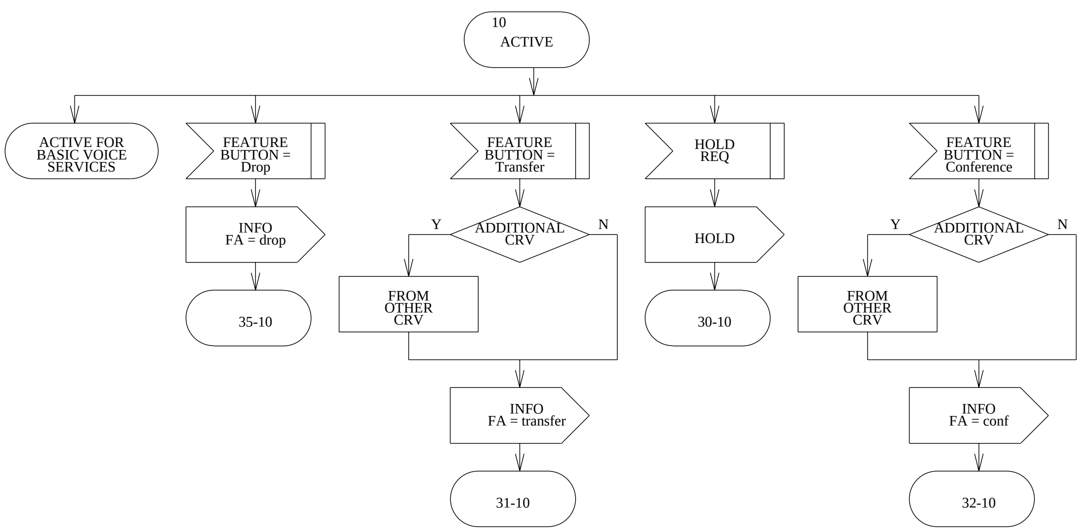


Figure 5.2.3-32 — Call Control - CPE Origination (ACTIVE)

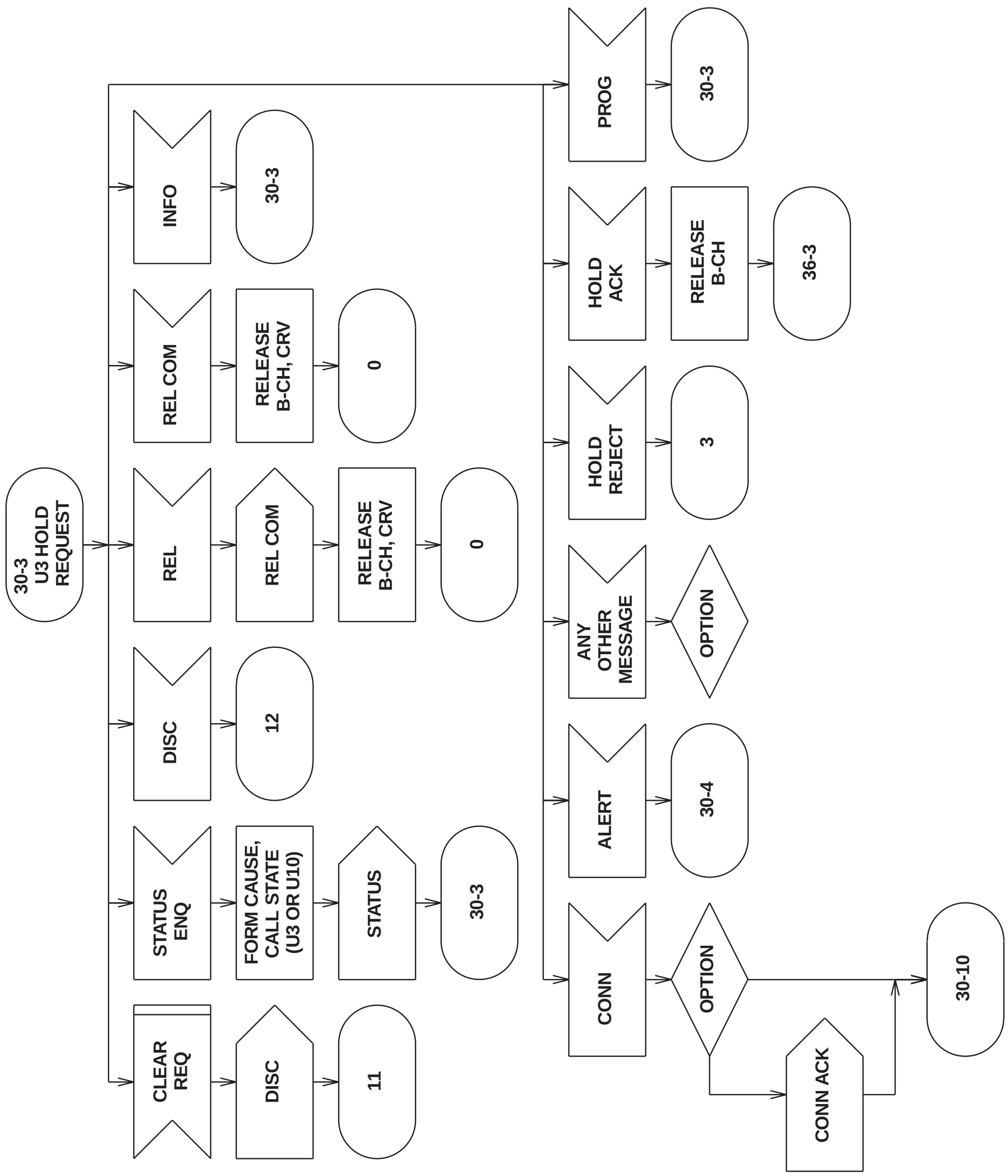


Figure 5.2.3-33 — Call Control - CPE Origination (U3 HOLD REQUEST)

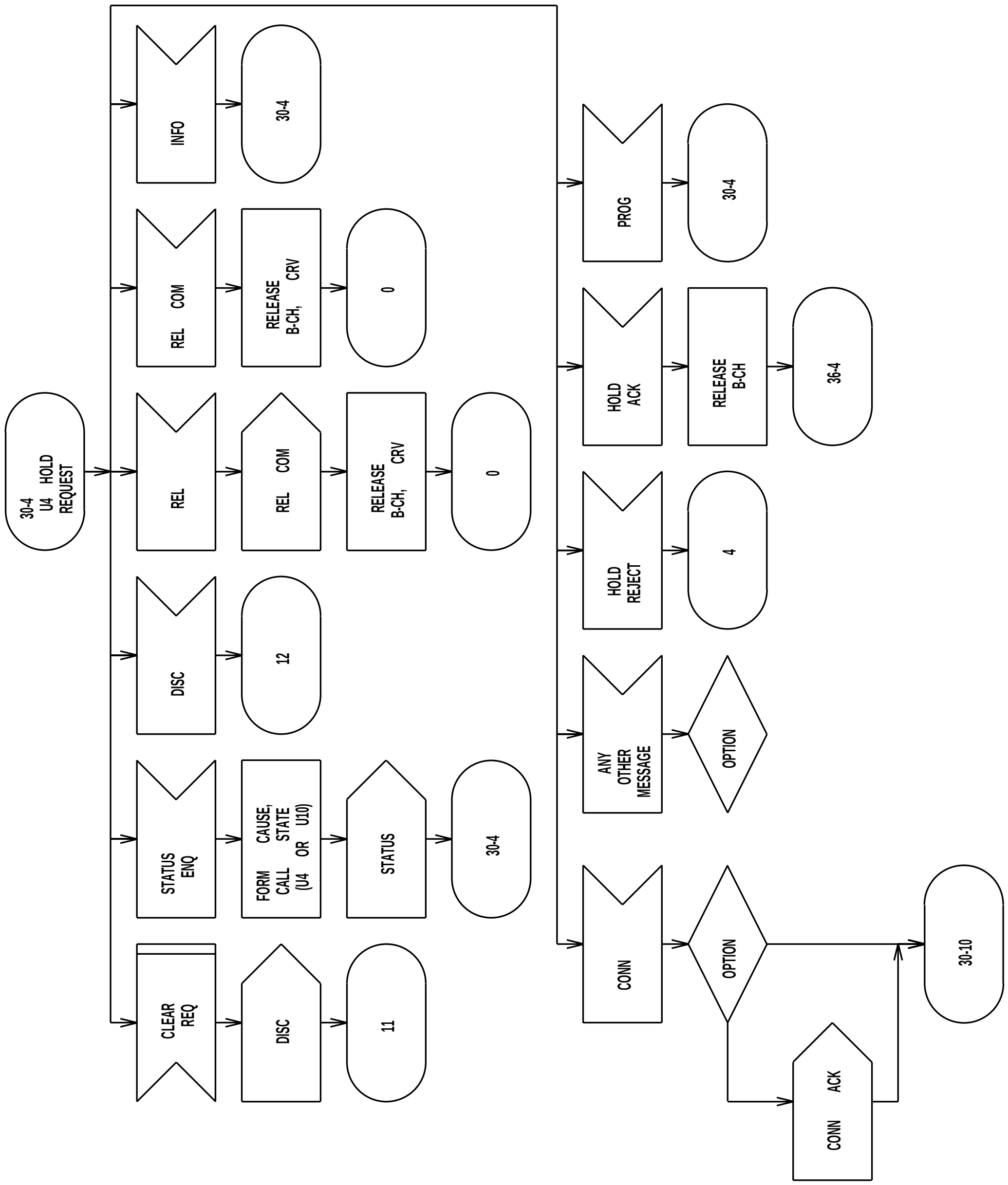


Figure 5.2.3-34 — Call Control - CPE Origination (U4 HOLD REQUEST)

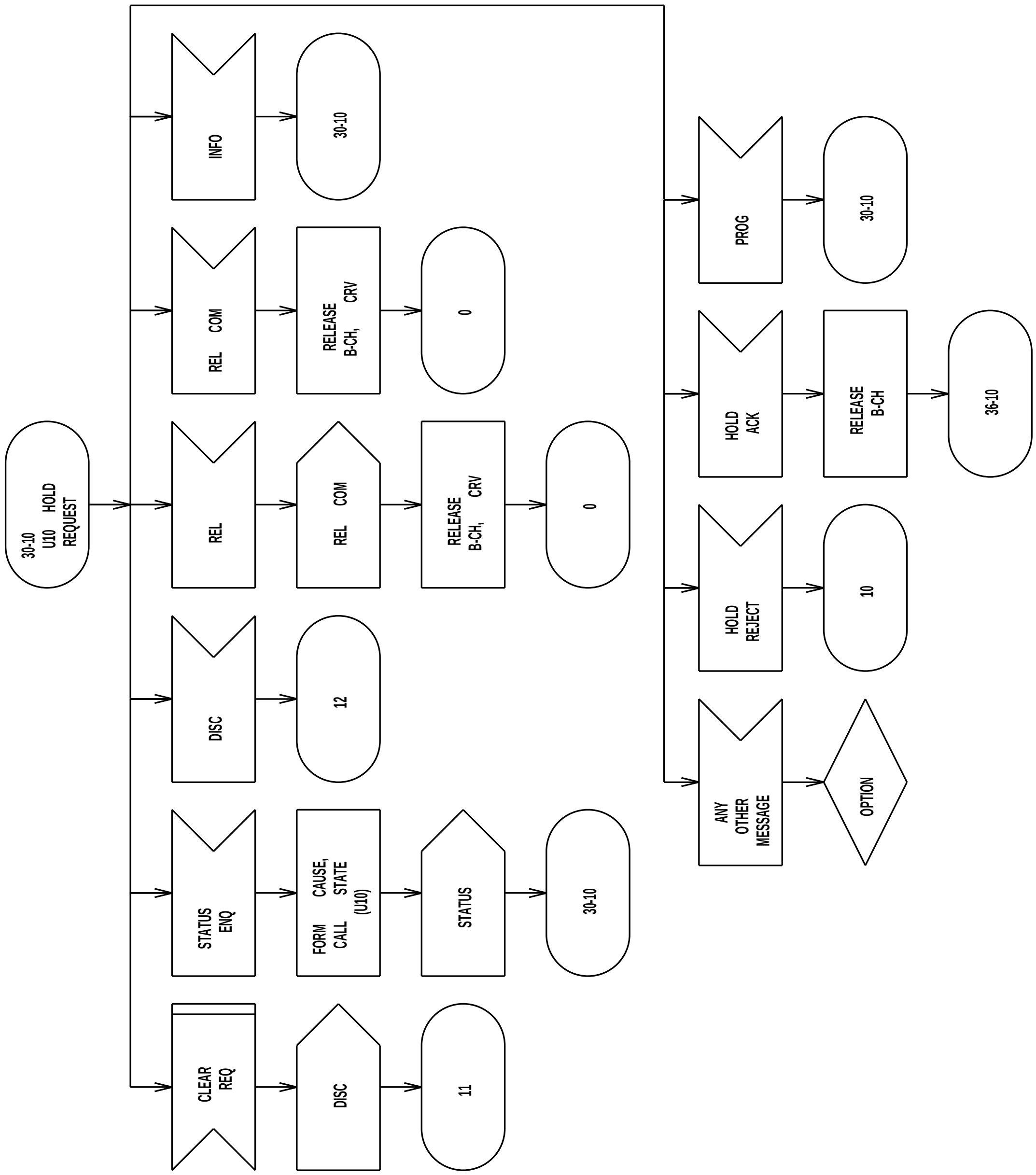


Figure 5.2.3-35 — Call Control - CPE Origination (U10 HOLD REQUEST)

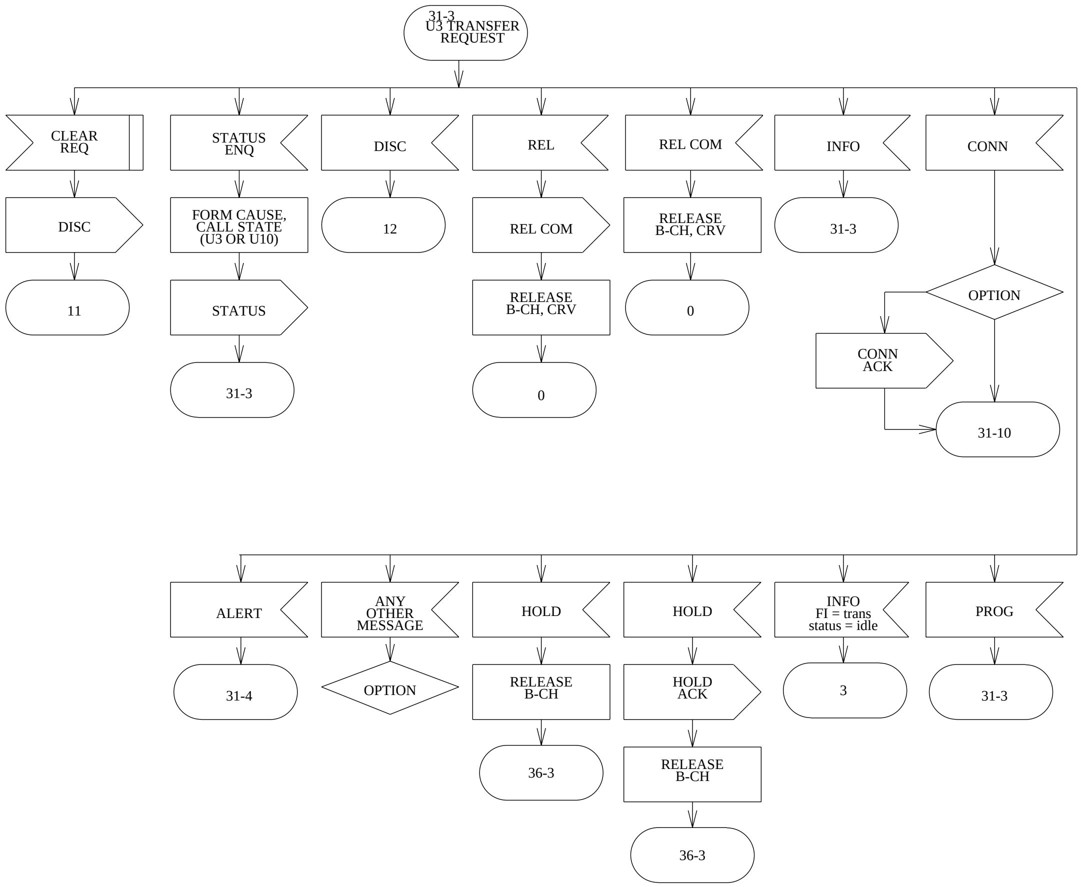


Figure 5.2.3-36 — Call Control - CPE Origination (U3 TRANSFER REQUEST)

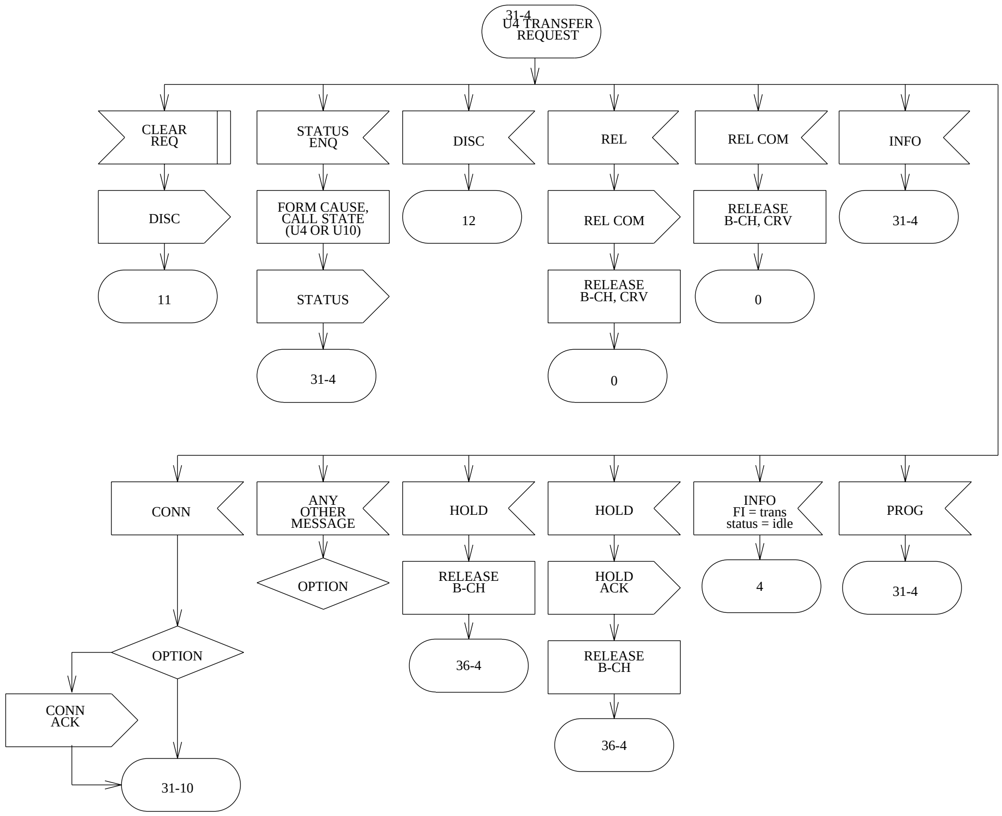


Figure 5.2.3-37 — Call Control - CPE Origination (U4 TRANSFER REQUEST)

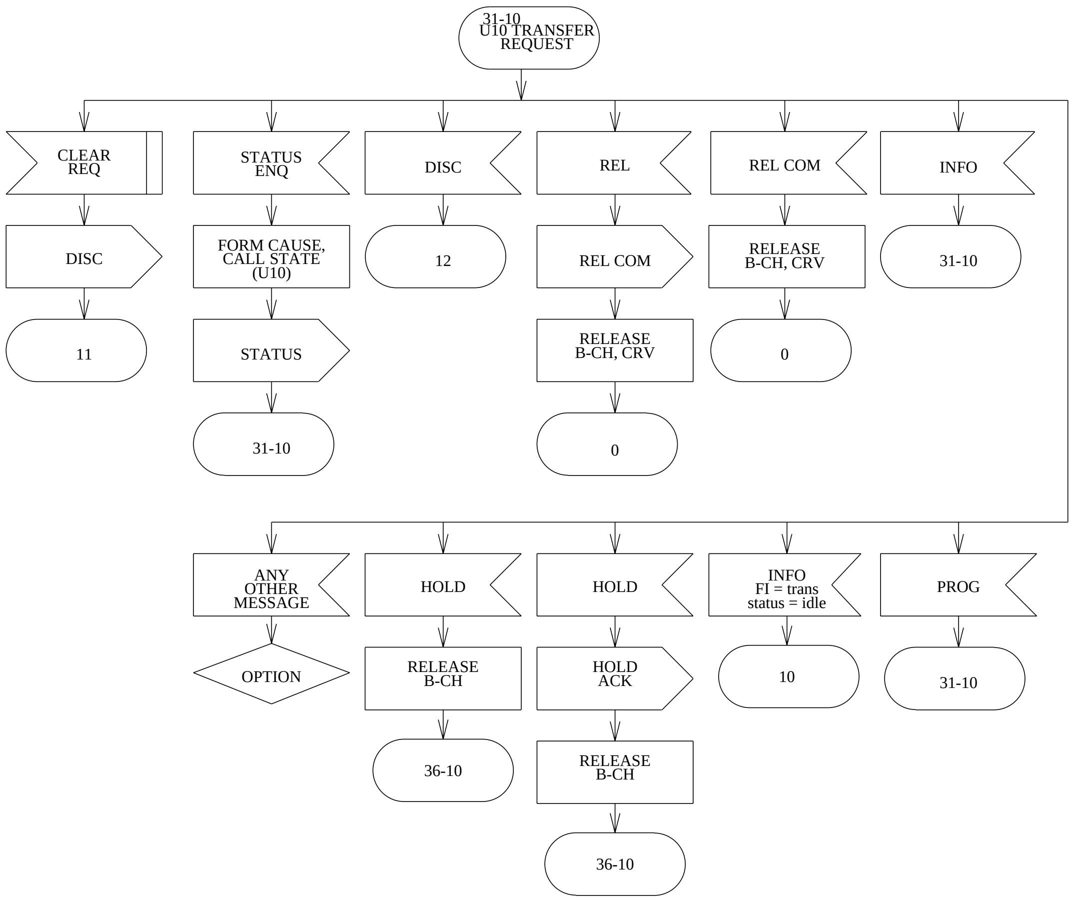


Figure 5.2.3-38 — Call Control - CPE Origination (U10 TRANSFER REQUEST)

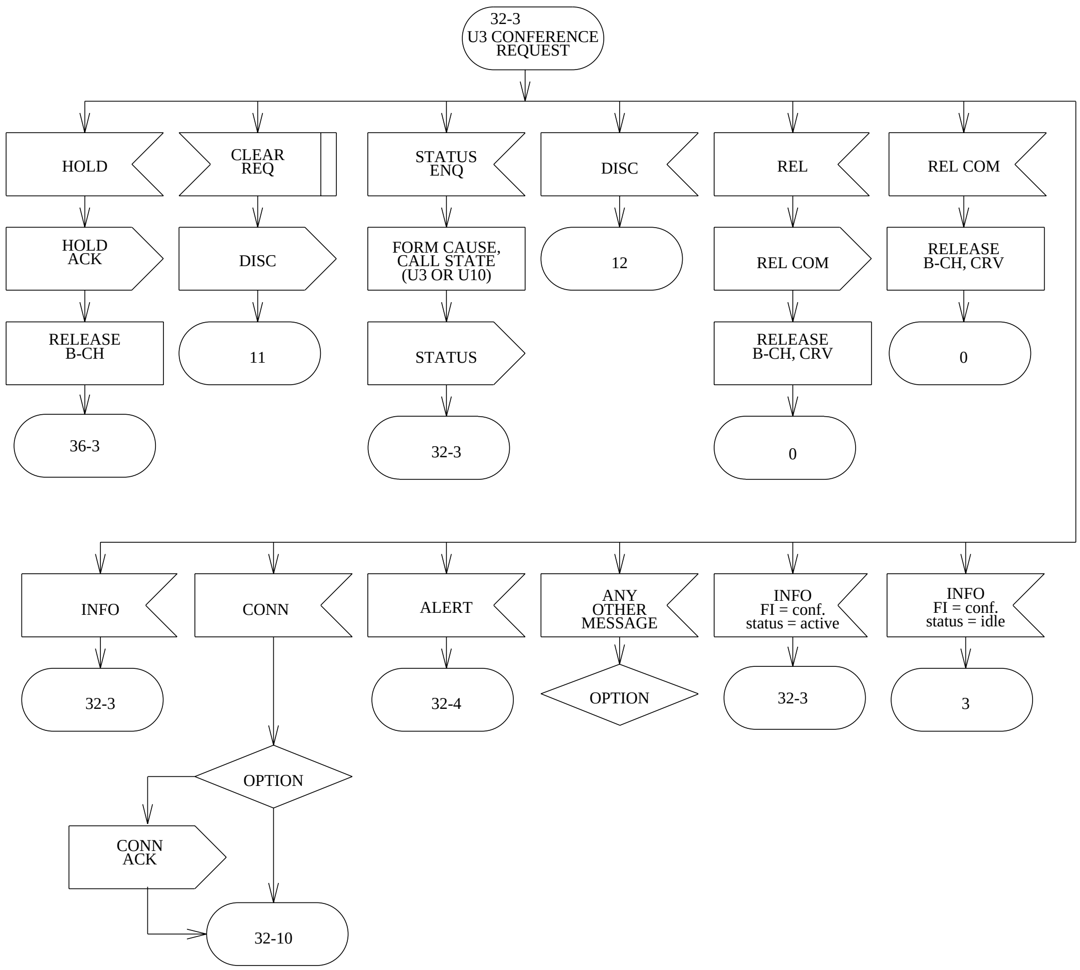


Figure 5.2.3-39 — Call Control - CPE Origination (U3 CONFERENCE REQUEST)

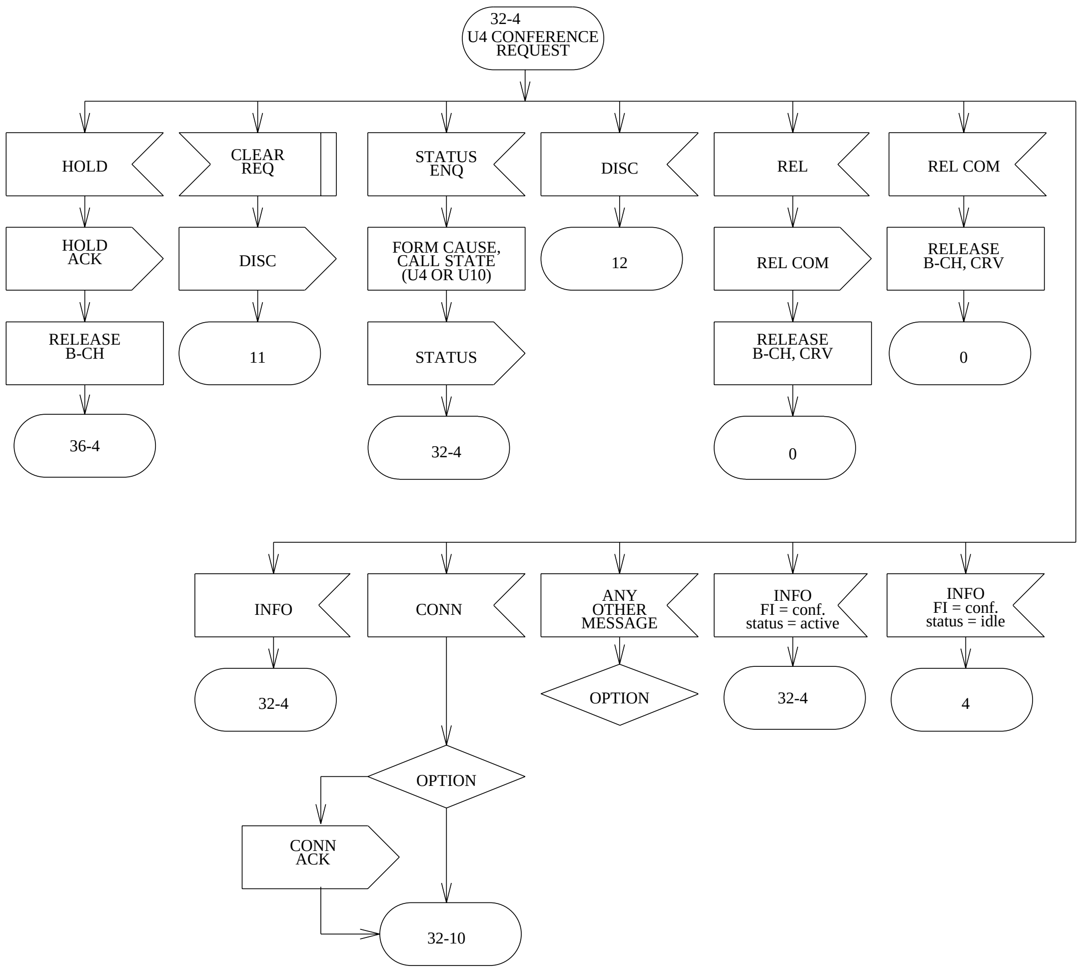


Figure 5.2.3-40 — Call Control - CPE Origination (U4 CONFERENCE REQUEST)

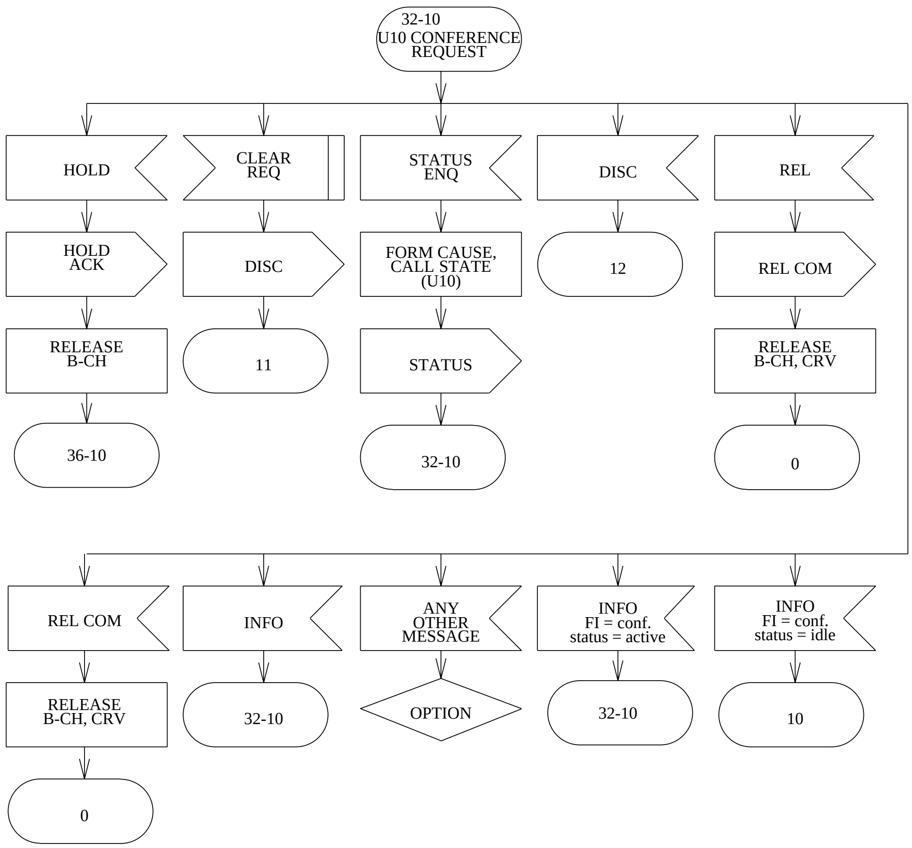


Figure 5.2.3-41 — Call Control - CPE Origination (U10 CONFERENCE REQUEST)

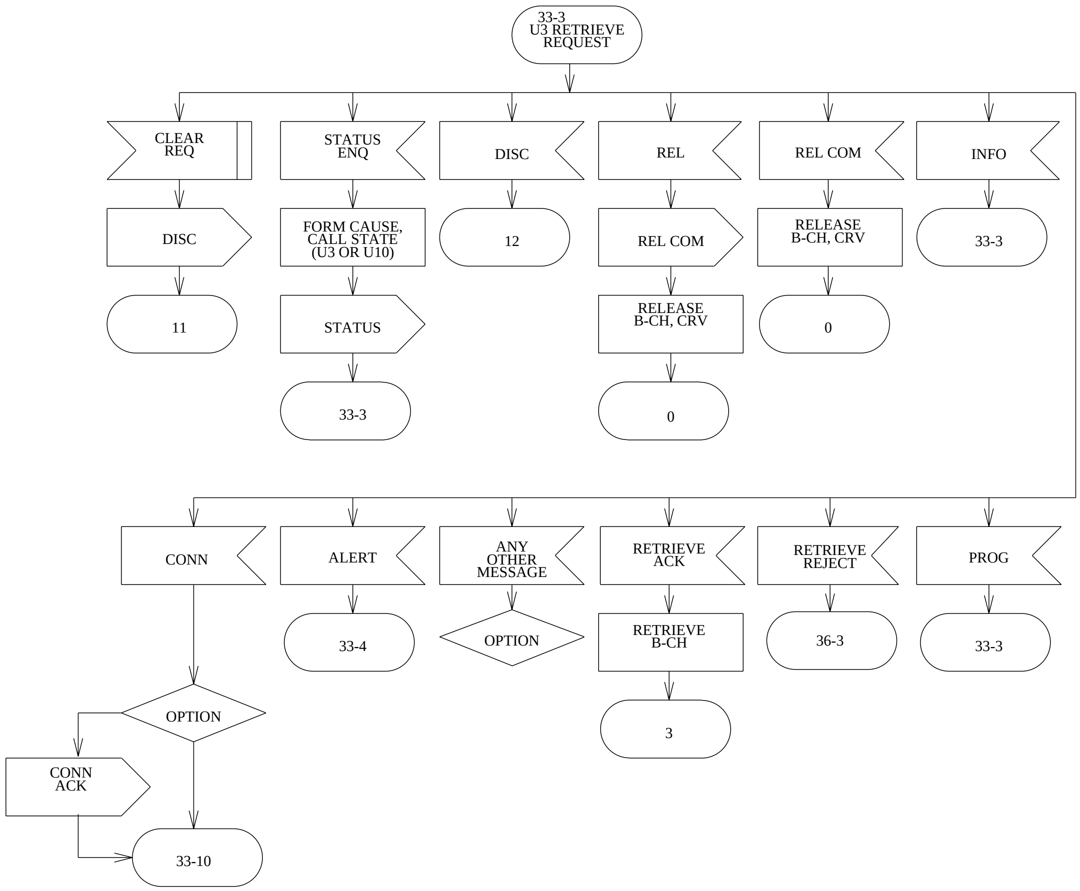


Figure 5.2.3-42 — Call Control - CPE Origination (U3 RETRIEVE REQUEST)

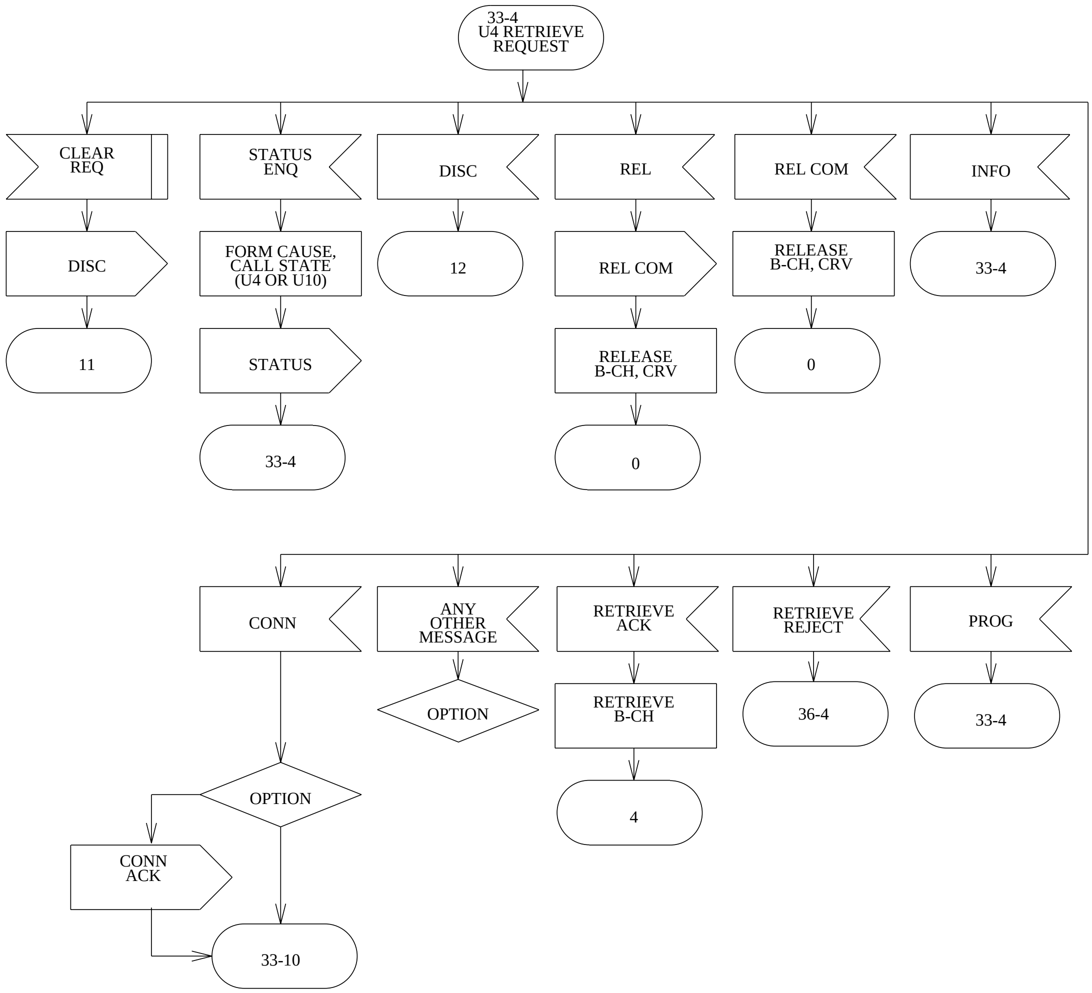


Figure 5.2.3-43 — Call Control - CPE Origination (U4 RETRIEVE REQUEST)

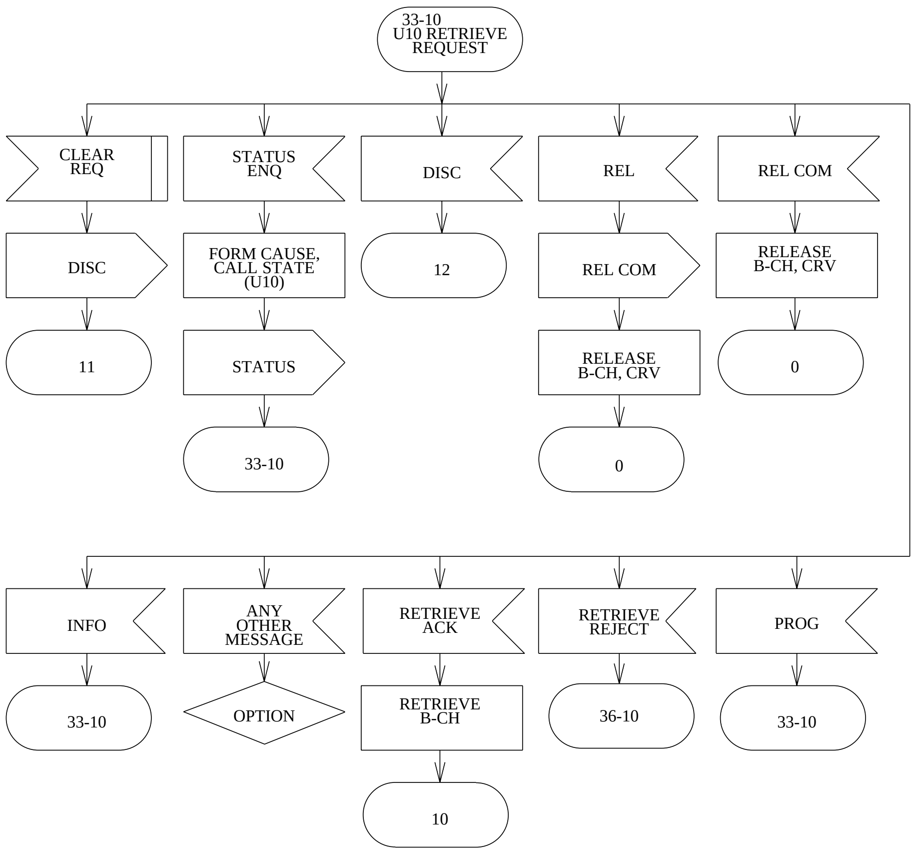


Figure 5.2.3-44 — Call Control - CPE Origination (U10 RETRIEVE REQUEST)

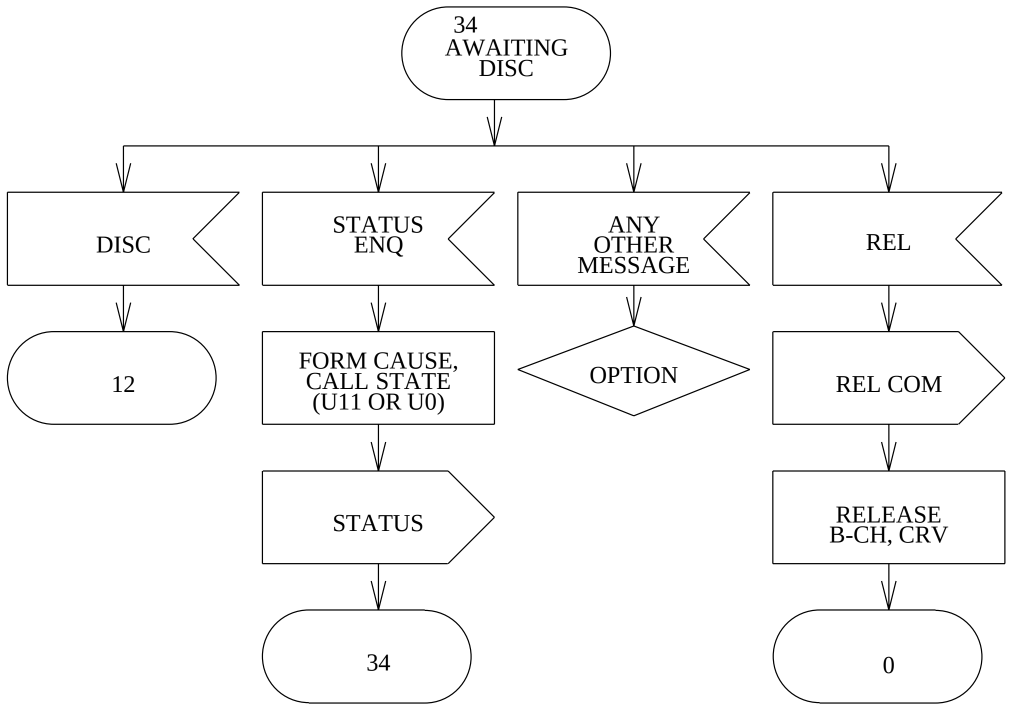


Figure 5.2.3-45 — Call Control - CPE Origination (AWAITING DISC)

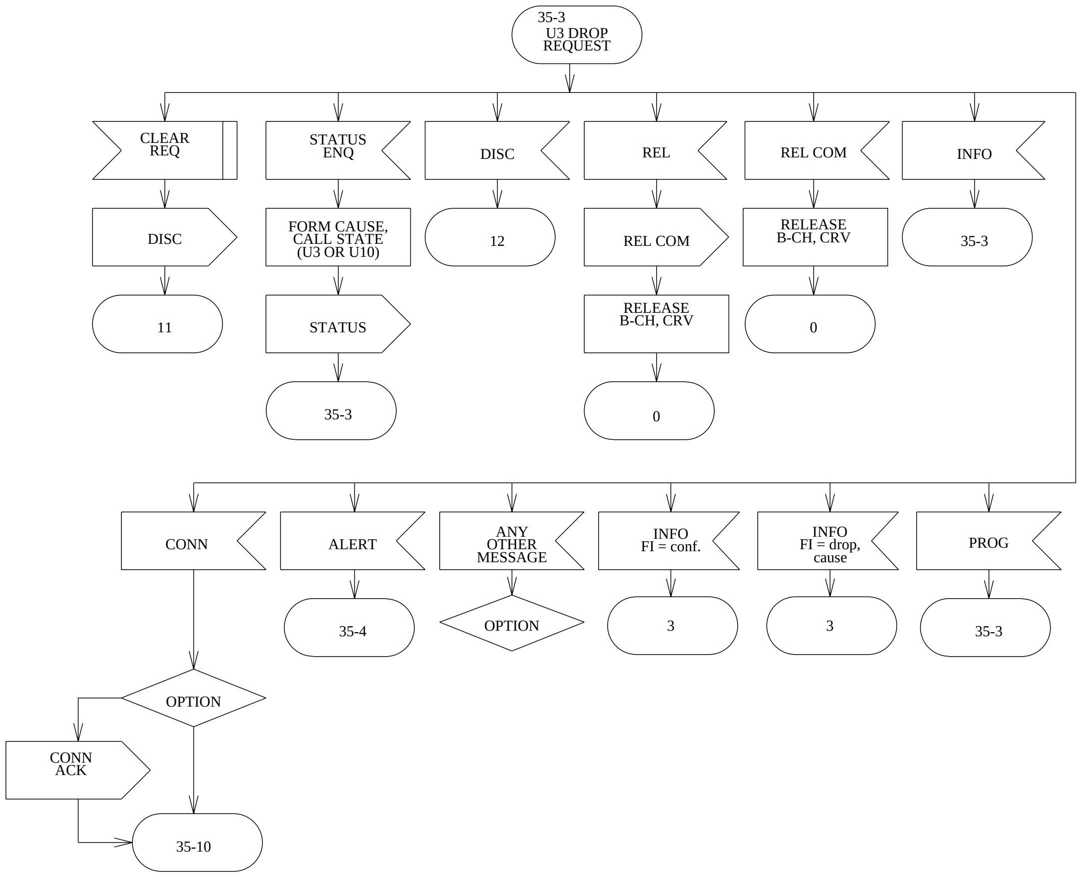


Figure 5.2.3-46 — Call Control - CPE Origination (U3 DROP REQUEST)

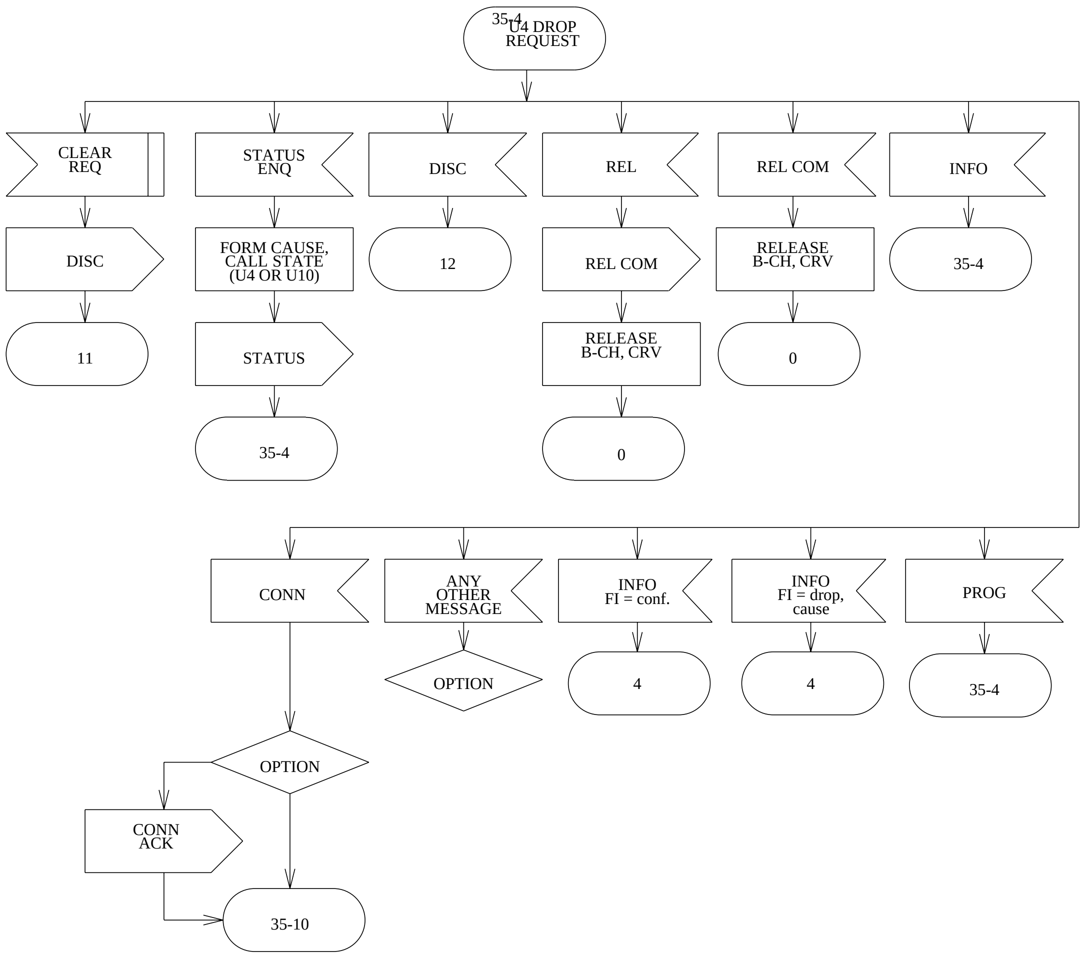


Figure 5.2.3-47 — Call Control - CPE Origination (U4 DROP REQUEST)

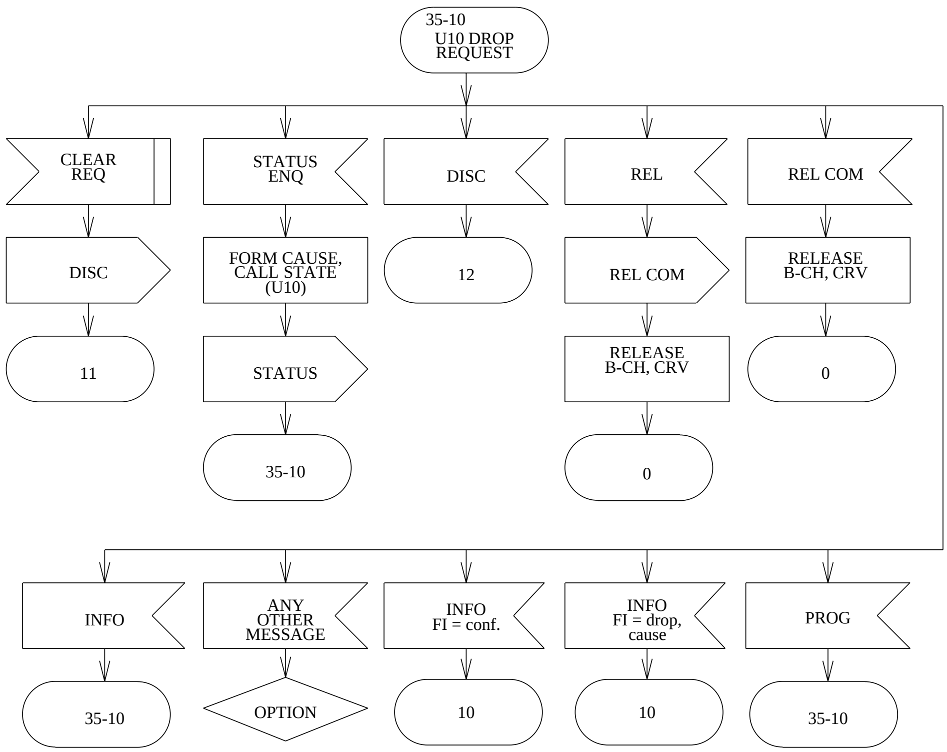


Figure 5.2.3-48 — Call Control - CPE Origination (U10 DROP REQUEST)

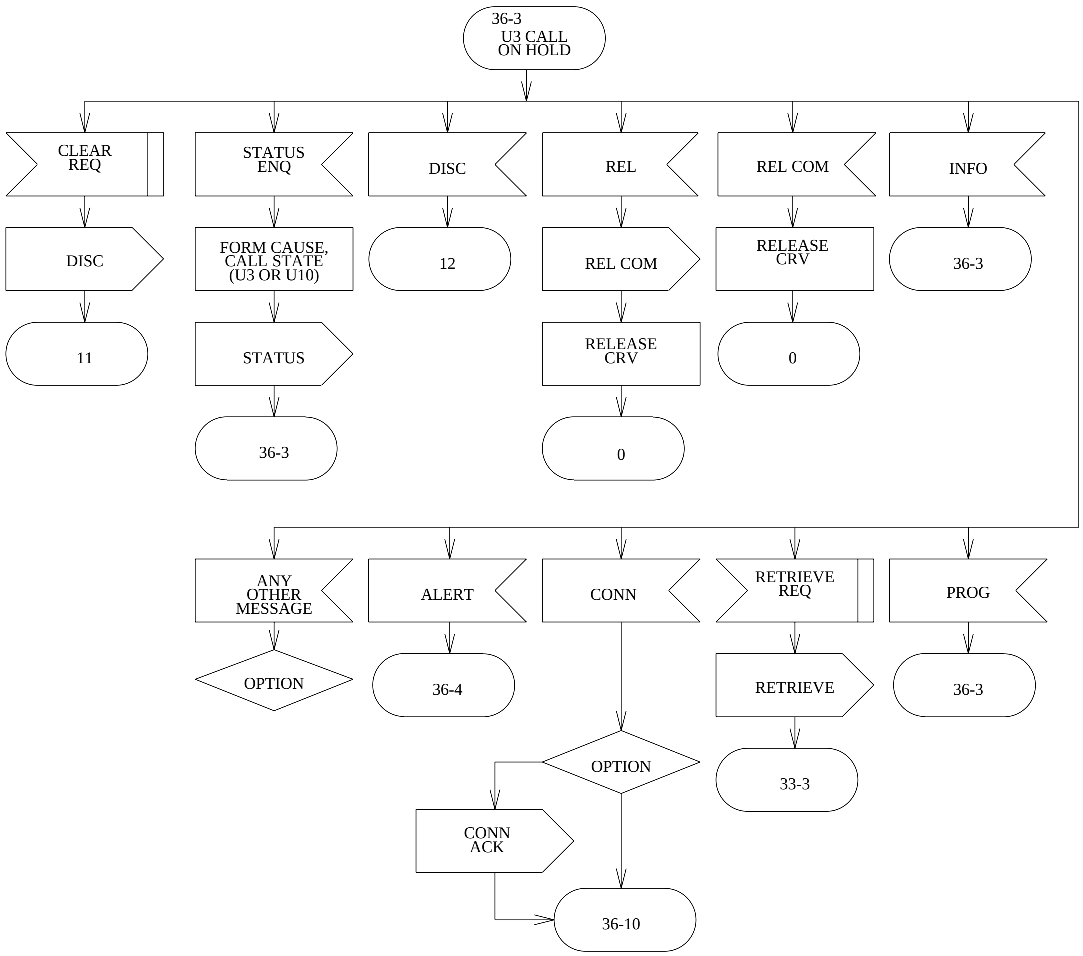


Figure 5.2.3-49 — Call Control - CPE Origination (U3 CALL ON HOLD)

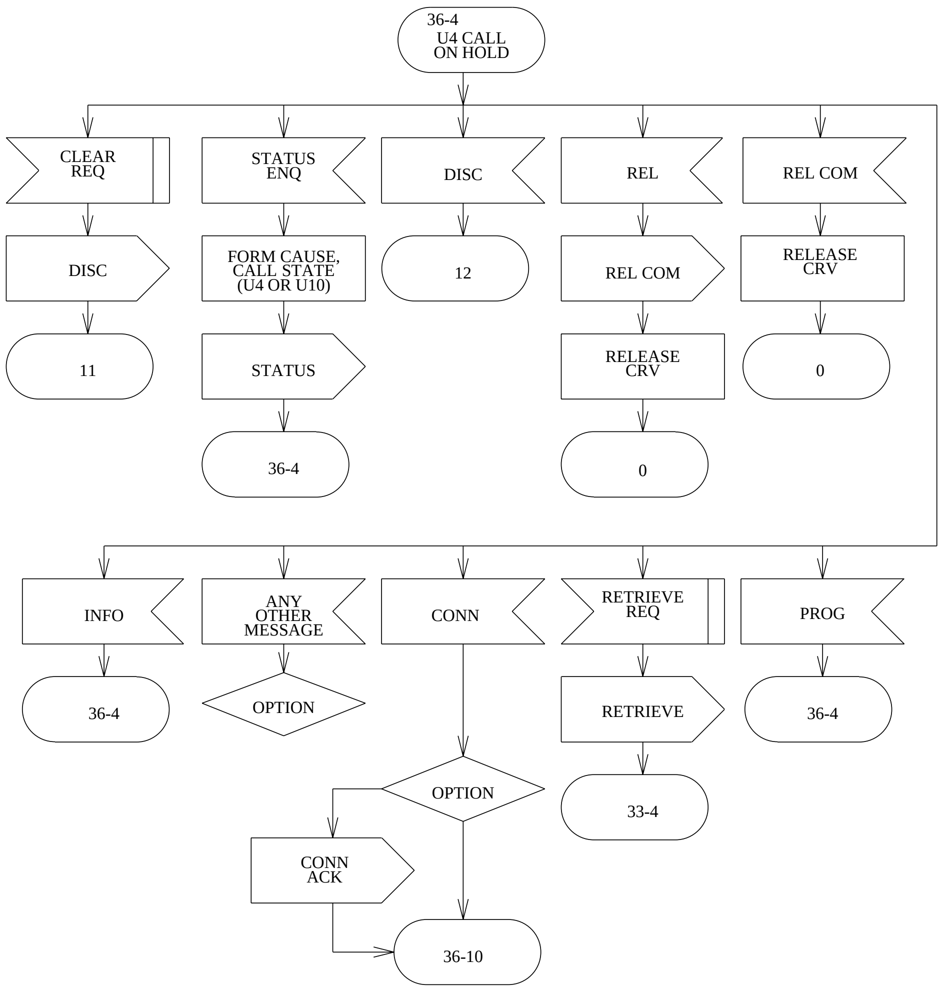


Figure 5.2.3-50 — Call Control - CPE Origination (U4 CALL ON HOLD)

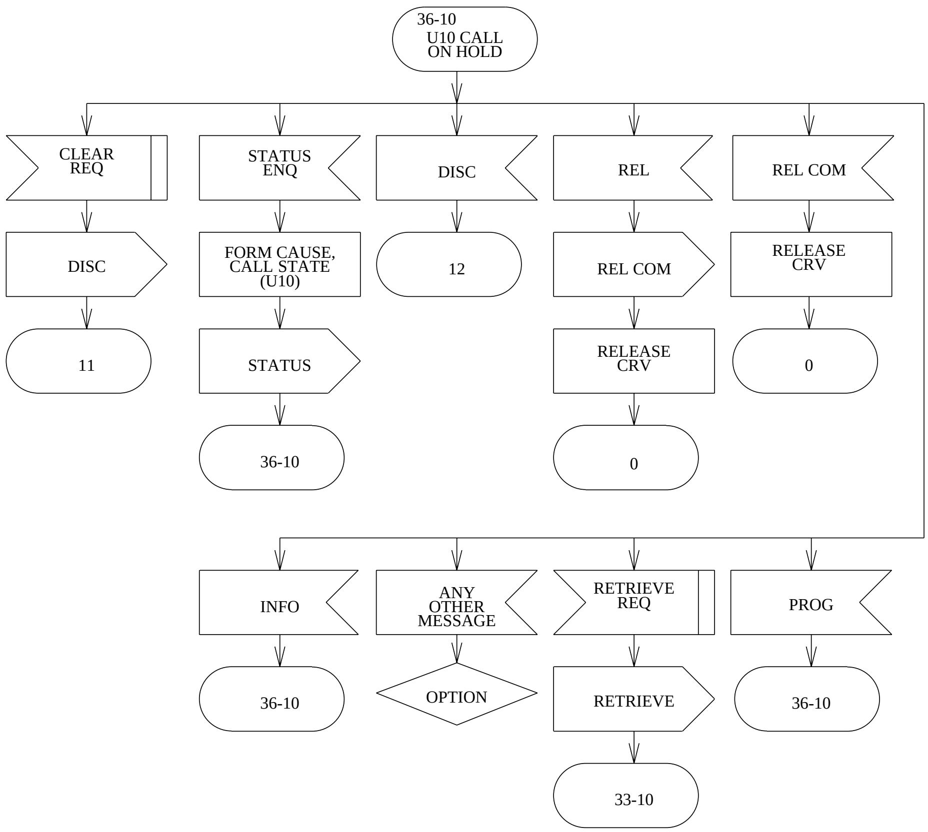


Figure 5.2.3-51 — Call Control - CPE Origination (U10 CALL ON HOLD)

5.3 SUPPLEMENTARY DATA SERVICES

This section describes the procedures for invoking supplementary *data* services for circuit transport mode calls (features such as speed calling) at the *5ESS*® switch Integrated Services Digital Network (ISDN) user-network interface. In general, the protocols and procedures of "Common Protocls and Procedures for Voice and Data Services," Section 5.1, and "Supplementary Voice Services," Section 5.2, are followed in this section. Where there is a major difference, that difference is highlighted. The features listed in this section are the only features supported for circuit-switched data (CSD) calls.

"General Telephony Interface Capability," Section 5.1.1.1, contains guidelines with respect to general interactions between a terminal and the network. "Stimulus Signaling Protocls Capability," Section 5.1.1.2, provides definitions and protocol procedures for stimulus signaling. "Supplementary Voice Services," Section 5.2, describes the procedures for stimulus features for circuit mode voice.

5.3.1 GENERAL TELEPHONY INTERFACE CAPABILITY

The network will not provide any inband call progress tones or announcements on the B-channel for circuit-mode data calls. In other words, the switch will not send a progress indicator information element (IE) coded to 8, "inband tones now available." "Common Protocols and Procedures for Voice and Data Services," Section 5.1, illustrates differences between voice and data for feature invocation scenarios, where the PROGress message is not sent for circuit-mode data.

5.3.2 FEATURE CONTROL FOR SUPPLEMENTARY DATA SERVICES

5.3.2.1 Additional Call Offering (ACO)

The feature control procedures for ACO are defined in "Additional Call Offering," Section 5.2.1.5. Separate parameters are provided for voice and data for the call reference busy limit and the notification busy limit.

5.3.2.2 Automatic Recall (AR)

The feature control procedures for AR are defined in "LASS Automatic Recall (AR)," Section 5.2.1.32. The following are the differences between voice and CSD for AR.

- For CSD, only intraswitch AR is supported, whereas intraswitch and interswitch AR is supported for voice.
- For CSD, AR cannot be activated while busy tone is being applied.

5.3.2.3 Automatic Route Selection (ARS) Features

The ARS features and feature control procedures discussed in "Automatic Route Selection (ARS)," Section 5.2.1.9, apply to CSD.

5.3.2.4 Basic Rate Interface (BRI) Access to Interexchange Carrier Services

This feature allows ISDN users on a BRI to access services provided by an interexchange carrier (IC) for full end-to-end ISDN connectivity. This feature requires an SS7 network interconnection to exist between the local switch and the IC. Access to the following CSD services is available with this feature:

- Access to an IC Private Virtual Network (PVN)
- CSD Long Distance Service (LDS).

Users of the access to an IC PVN CSD service must subscribe from their service provider for the ability to access this service. Once a user has subscribed to the service, the request for such a service is obtained either by dialing an access code or by pressing a feature activation/indication button. The CSD LDS users may request inter-local access and transport area (inter-LATA) data facilities in much the same way as a voice LDS user would request inter-LATA voice facilities. The user would follow the same dialing pattern. The difference between an inter-LATA voice and data call would be determined by the bearer capability IE. A CSD LDS user would code this information in the same fashion as a CSD user would for an intra-LATA call (for example, request a data facility for 64 kbps clear/restricted).

This feature has no additional protocol impact beyond the basic call procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, and previous areas in this section.

5.3.2.5 Call Forwarding

The feature control procedures for call forwarding are defined in "Call Forwarding Features," Section 5.2.1.11. The following are the differences between voice and CSD for call forwarding.

- Unique feature buttons and feature access codes are required to access call forwarding for CSD.
- The network does not provide courtesy calls. Therefore, the following are the only activation procedures supported for CSD.
  - No Directory Number, No Courtesy Call
  - Directory Number, No Courtesy Call.

5.3.2.6 Call Hold

The feature control procedures for call hold are defined in "Call Hold," Section 5.2.1.12. See also "Feature Invocation Scenarios," Section 5.1.2.

5.3.2.7 Calling Name for BRI (CNAM-B)

5.3.2.7.1 Support of CNAM-B

The following CNAM-B subfeatures are supported for Circuit Switched Data calls on National ISDN BRI lines:

- Calling Name Delivery (CNAM)
- Electronic Directory Service Calling Name Display (EDS CND)
- Name Privacy

These sub-features are applicable simultaneously to both CSD and CSV calls. That is, if CNAM or EDS CND is active for circuit-switched data calls, it is also active for circuit-switched voice calls to the subscribed DN. Name privacy may be invoked by a subscribed terminal or in a generally available environment for either a CSV or a CSD call. The CNAM-B feature is described in "Calling Name for BRI (CNAM-B)," Section 5.2.1.13.

5.3.2.7.2 Feature Control Procedures

Feature control procedures for Name Privacy and CNAM or EDS CND display activation or deactivation (that is, I-DF) follow the Stimulus Signaling procedures described in "Stimulus Signaling Protocols Capability," Section 5.1.1.2. Single feature button operation is supported for I-DF activation/deactivation.

5.3.2.8 Custom Dialing Features

The custom dialing features and feature control procedures discussed in "Supplementary Voice Services," Section 5.2, apply to CSD. Only speed calling and customer changeable speed calling require special consideration.

5.3.2.8.1 Speed Calling

Refer to "Speed Calling/Customer Changeable Speed Calling," Section 5.2.1.45. The speed call list is shared for voice and circuit transport mode data calls.

5.3.2.8.2 Customer-Changeable Speed Calling

Refer to "Speed Calling/Customer Changeable Speed Calling," Section 5.2.1.45. The speed call list is shared for voice and circuit transport mode data calls.

5.3.2.9 Individual Calling Line Identification (ICLID)

The following ICLID features are supported for CSD:

- Calling Number Delivery
- Directory Number Privacy.

This feature is applicable simultaneously to both CSD and circuit-switched voice (CSV). That is, if calling number delivery (or directory number privacy) is active for circuit-switched calls, it is also active for CSV calls.

The ICLID features and feature control procedures discussed in "Individual Calling Line Identification (ICLID) Displays," Section 5.2.2.4, apply to CSD.

5.3.2.10 Intraswitch/Interswitch Called Party Number/Button Number (CPN/BN) to Terminating User

The feature description and feature control procedures are defined in "Supplementary Voice Services," Section 5.2.

5.3.2.11 Message Detail Recording (MDR)

Refer to "Message Detail Recording (MDR)," Section 5.2.1.39, for a discussion of this feature.

5.3.2.12 Multiline Hunt Service

5.3.2.12.1 Support of Multiline Hunt Service

Hunting groups provide a software-defined search, within a group, for an idle terminal to which a circuit transport mode data call can complete. This service is supported for endpoint initializing terminals in multiple terminal operation. The following features are supported in conjunction with the multiline hunt service:

- Member Make Busy
- Group Make Busy
- Stop Hunt
- Queuing.

5.3.2.12.2 Feature Control Procedures

Normal hunting terminations follow those procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, and "Packet Services," Section 4.3.

Activation/deactivation of the member make-busy, group make-busy and stop hunt features follows the procedures described in "Common Protocols and Procedures for Voice and Data Services," Section 5.1. For the member make-busy feature, a single terminal in the group can have the ability to mark a subset of terminals in the group busy.

Activation/deactivation of the queuing feature is done through recent change procedure.

5.3.2.12.3 Queuing

This feature enables CSD calls to a CSD hunt group to be automatically queued when all members of a hunt group are busy.

When a call is queued, the calling party is informed, through out-of-band Q.931 signaling, that the call has been queued. The call will remain queued until it can be completed or the calling party initiates disconnect procedures.

When a call is queued, the network will inform the calling party by sending a PROGress message with progress indicator IE, a cause IE, and a display IE. The progress IE will contain a progress description of 1.

The cause IE will be coded as follows:

- Coding Standard = Standard Specific to Identified Location
- Cause class = Resource Unavailable
- Cause value = 35 (Queued).

The display field IE will have display mode = "Normal," and display information = "Please Wait . . . Your call is queued."

5.3.2.13 Private Facility Features

The private facility features and feature control procedures discussed in "Private Facility Access (PFA)," Section 5.2.1.43, apply to CSD.

5.3.2.14 Terminal Group Features

The following terminal group features apply for circuit transport mode data calls, and have no additional terminal impact beyond the basic call procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, and "Packet Services," Section 4.3.

- Business Group Line
- Unrestricted Lines
- Semirestricted Lines
- Fully Restricted Lines
- Special Intercept Announcements
- Centrex Complex
- Uniform Numbering.

The following are the differences between voice and CSD for terminal group features.

- Main satellite service is not supported for CSD, whereas it is supported for voice.

5.3.2.15 Features with No Additional Terminal Impact

The following features have no additional terminal impact on the network beyond the basic call procedures described in "Basic Call Control for Circuit Mode Voice and Data Services," Section 4.2, "Packet Services," Section 4.3, and previous areas in this section. These features are assigned to a terminal for both voice and circuit transport mode data (for example, a terminal that is assigned denied origination will not be allowed to originate voice or circuit transport mode data calls).

- Denied Origination
- Denied Termination
- Code/Toll Restriction
- Code/Toll Diversion.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF TABLES

6. TERMINAL INITIALIZATION

6.1 OVERVIEW

This section of the basic rate interface (BRI) describes the terminal initialization requirements for terminals used on the Bellcore standard interface. These requirements are derived from the terminal initialization sections of TR-847, which are also consistent with the terminal initialization procedure described in the 1988 International Telegraph and Telephone Consultative Committee (CCITT) Recommendation Q.932. The following terms are used in this section:

- ***Fully-Initializing Terminal (FIT):***
  A FIT is a terminal that follows the TR-TSY-000847 procedure for terminal initialization. A service profile identifier (SPID) sent to the switch by a FIT is used to associate the terminal with its user service order profile (USOP). A FIT can support circuit and/or packet services and may or may not present a calling DN in call originations.

- ***Non-Initializing Terminal (NIT):***
  A NIT is any terminal that does not attempt, or does not successfully complete, the terminal initialization procedure per Bellcore TR-TSY-000847. A FIT that fails to successfully initialize is treated by the switch as a NIT. A NIT can support circuit and/or packet services and may or may not present a calling DN in call originations.

- ***Service Profile Identifier (SPID):***
  In an INFOrmation message to the network at the time of terminal initialization, the FIT identifies itself by using a 3- to 20-digit SPID. This SPID consists of:

  — A 1- to 18-digit user service profile identifier (USPID) that was derived by the service provider during service subscription. These are the most significant digits. This USPID is both unique to the terminal and unique on the switch, which associates these digits not only with the terminal but also with any DN feature information.

  — A 2-digit terminal identifier (TID) assigned from the range 00 through 62 by the user. These are the least significant digits. The switch includes these digits in the TID field of the endpoint identifier (EID) that it sends to the terminal.

  The FIT keeps the SPID stored in its permanent memory.

- ***User Service Order Profile (USOP):***
  The USOP is the term applied to the collection of provisioned information that defines the service [for example, directory number (DN) features] to be used by a terminal. The USPID is a "key" to this information in the switch. The Custom USOP definition is applied on the standard interface—that is, a USPID is used to associate a terminal with both terminal and DN feature information. The USOP is not directly accessible by the end user or operations support (OS).

- ***Universal SPID:***
  The Universal SPID is a predetermined, standardized SPID value used only during terminal initialization. It is used by a terminal, as described in "Automatic SPID Download (Auto SPID)," Section 6.2, to signal to the switch that the terminal expects, and is able to receive, the valid SPID(s) and other service profile information for the interface. The value of the Universal SPID is "01010101010101." This value is reserved for this use and, therefore, will never be used by the service provider as a SPID valid for identifying a set of user’s services.

The following is a list of general assumptions regarding the support of NITs and FITs for National ISDN. The switch assumptions regarding the customer premises equipment (CPE) state transitions are provided in Tables 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, and 6-7.

- A terminal provisioned with FIT-required services must perform initialization before requesting any circuit or packet services. CSV, CSD, PVC on D-channel, and packet multiline hunt group (MLHG) without an individual DN *do not* require FITs. FIT-required services include EKTS, MLHG for circuit-mode calls, any service requiring the use of feature buttons, a PVC without the assignment of a Fixed TEI, and assignment as a packet MLHG member without also having an individual DN.
- The ODB and D-channel packet are not FIT-required services.
- The switch will allow either fixed or automatic terminal endpoint identifier (TEI) to be used on a terminal.
- A service request from a terminal that has failed to successfully initialize is accepted, provided the terminal follows the NIT operation described in "Non-Initializing Terminals," Section 6.6.
- Integrated circuit/packet terminal:
  - An integrated circuit/packet terminal that uses a common TEI may receive service as a NIT or a FIT.
  - If an integrated circuit/packet terminal uses different TEIs for circuit and packet calls, the switch will treat them as two terminals.
  - A single physical terminal may use more than one TEI. The switch will support up to 8 TEIs per digital subscriber line (DSL). Each TEI is viewed as a terminal and is separately provisioned.
- Terminating SETUP messages will be sent out except for circuit MLHG and electronic key telephone set (EKTS) regardless of whether the terminating terminal has initialized. However, the switch will reject responses from a CPE for FIT-required services if the CPE has not initialized.
- The switch will not send an initialization request to the terminal when the terminal makes a service request without having initialized.
- Any terminal may initialize, but it must do it successfully to be provided services.

6.2 AUTOMATIC SPID DOWNLOAD (Auto SPID)

The Automatic SPID Download (Auto SPID) feature implements the network procedures for Automated SPID Selection, defined in *Generic Requirements for Automated SPID Selection*, October 1996, Issue 1, (GR-2941-CORE). These procedures simplify the setup of initializing ISDN terminals. The terminal initiates the procedures by requesting initialization, using the Universal SPID. Then switch completes the procedures by sending the terminal a series of INFOrmation messages that contain all the valid SPIDs that the terminal is permitted to use for initialization. The terminal, perhaps with input from the end user, selects one of the SPID values and begins a new initialization sequence with this selected SPID, following the procedure described in "Initialization—Terminal Initiated," Section 6.3. The terminal thus avoids a common error that results from storing a valid SPID in the terminal, and that blocks successful ISDN terminal installation.

This procedure assumes that the terminal has the Universal SPID programmed in the terminal's permanent memory. A terminal that supports Automated SPID Selection (Auto SPID) procedures is expected to request initialization automatically in the first Layer 3 message (INFOrmation message) sent to the network after Layer 2 is established. This INFOrmation message is coded with a null call reference and the Universal SPID value coded in the SPID information element (IE).

At any time, the network will recognize an INFOrmation message with a null call reference that carries the Universal SPID received from a terminal, and will respond as follows with the list of SPIDs.

If some other IE(s), for example Feature Activation, is also received in the same message used to request initialization, or if the INFOrmation message carrying the SPID contains any call reference other than the null call reference, the switch will discard that IE and attempt to process the initialization. If the INFOrmation message carrying the Universal SPID contains any call reference other than the null call reference, the switch will process it according to one of the following cases.

Note: These cases are the same as for Terminal Initiated Initialization:

- ***Case 1:*** The INFOrmation message received contains an established call reference value (CRV) and carries the SPID IE only.

  In this case, the switch will not attempt initialization and will send a STATUS message to the terminal with Cause 99, "information element non-existent or not implemented (location: public network serving the local user; diagnostic: SPID IE identifier)." The call state information IE is coded with the state associated with the CRV of the INFOrmation message received. The switch will apply appropriate error treatment.

- ***Case 2:*** The INFOrmation message received contains an established CRV and carries the SPID IE and some other IEs.

  In this case, the switch will not attempt initialization; however, after discarding the SPID IE, the switch will process the remaining IEs. In addition, the switch will send a STATUS message to the terminal with Cause 99, "information element non-existent or not implemented (location: public network serving the local user; diagnostic: SPID IE identifier)." The call state information IE is coded with the state associated with the CRV of the INFOrmation message received. The switch will apply appropriate error treatment.

- ***Case 3:*** The INFOrmation message received contains a new or nonexistent CRV and carries the SPID only, or the SPID and some other IEs.

  This case is covered under the basic call control procedures, as the receipt of an "invalid call reference value (a message other than a SETUP or RELEASE COMPLETE message containing an unallocated call reference value)." In this case, the switch will not carry out initialization.

Upon receipt of an initialization request containing the Universal SPID, the switch will retrieve a list of the valid USPIDs for the USOPs provisioned for the interface. If the terminal is already bound to a Fixed TEI USOP (see "Fixed TEI USOP," Section 6.6.3), then the list generated will include only the USPID for the profile to which the terminal is bound. If the terminal is not already bound to a Fixed TEI USOP, then the USPID associated with any Fixed TEI USOP will not be included in the generated list.

The USPID associated with a Default DN USOP (see "Default DN USOP, Default Service USOP," Section 6.6.2) will not be included in the generated list.

For each USPID in the list, the switch will send to the terminal an INFOrmation message coded as follows:

- The Call Reference Value IE will be coded as "null."
- The SPID IE will contain the USPID value with a Terminal Identifier (TID) of "01" added on as the two least significant digits.
- The switch will include one Bearer Capability (BC) IE in the INFOrmation message for each call type provisioned in the USOP (up to a maximum of three BC IEs) as follows:
  — If Circuit Switched Voice is provisioned, then a BC IE will be included, coded as "speech."
  — If Circuit Switched Data is provisioned, then a BC IE will be included, coded as "64-kbps, unrestricted digital information, circuit-mode."
  — If either On-Demand B-channel packet or D-channel packet service is provisioned, then a BC IE will be included, coded as "Unrestricted digital information, packet-mode."

  Note: Octet 6 will indicate "LAPD signaling," but this should be ignored. The packet BC indicates only that the service profile supports the packet Call Type.
- The Called Party Number IE will contain the value of the Primary Directory Number.
- If there is a terminal already bound to the USOP associated with the USPID, then the Cause IE will be included, coded to Cause 63, "service or option not available, unspecified."
- The INFOrmation message containing the last SPID value will have the Information Request IE included, coded with the Information Request Indicator set to "prompt for additional information" and the Type of Information set to "terminal identification." These codings communicate to the terminal that no further SPID values will be forthcoming.

After sending this list of INFOrmation messages, the switch will wait for the terminal to attempt a new initialization. In many cases, this list may contain only a single SPID, and the terminal may receive only a single INFOrmation message. After receiving this list, the terminal will select a SPID appropriate to use, based on user input or driven by other terminal-controlled means. This specification places no requirements on how the SPID is selected.

If the switch determines that no SPID values that can be sent to the terminal exist, it will send an INFOrmation message coded with a null CRV and a Cause IE coded to Cause 29, "facility rejected."

Once the terminal has determined a SPID to be used for initialization, it will send a new initialization request, using the selected SPID, following the procedures described in "Initialization—Terminal Initiated," Section 6.3. It is also expected to store this SPID in its non-volatile memory for use in future re-initializations, as necessary. The

Primary DN received in the Called Party Number IE may also be used by the terminal for incoming call screening and for outgoing calls, if required.

6.3 INITIALIZATION—TERMINAL INITIATED

Initialization assumes that the customer enters an SPID (assigned by the service provider at subscription time) into the terminal's permanent memory. A terminal that supports initialization is expected to automatically request initialization in the first Layer 3 message (INFOrmation message) that is sent to the network. However, the switch should recognize an INFOrmation message with a null call reference carrying an SPID received from a terminal, at any time, as a request for initialization. If some other information element(s) (IEs), for example, feature activation information element(s), is also received in the same message used to request initialization, the switch should discard that information element(s) and attempt to process initialization. If the INFOrmation message carrying the SPID contains any call reference other than null call reference, the switch will process it in one of the following cases.

- ***Case 1:*** INFOrmation message received contains an established call reference value (CRV) and carries the SPID IE only.

  In this case, the switch will not attempt initialization and will send a STATUS message to the terminal with Cause 99, "information element nonexistent or not implemented (location: public network serving the local user; diagnostic: SPID IE identifier)." The call state information IE is coded with the state associated with the CRV of the INFOrmation message received. The switch will apply appropriate error treatment.

- ***Case 2:*** INFOrmation message received contains an established CRV and carries the SPID IE and some other IEs.

  In this case, the switch will not attempt initialization. However, after discarding the SPID IE, the switch will process the remaining IEs. In addition, the switch will send a STATUS message to the terminal with Cause 99, "information element nonexistent or not implemented (location: public network serving the local user; diagnostic: SPID IE identifier)." The call state information IE is coded with the state associated with the CRV of the INFOrmation message received. The switch will apply appropriate error treatment.

- ***Case 3:*** INFOrmation message received contains a new or nonexistent CRV and carries the SPID only, or the SPID and some other IEs.

  This case is covered under the basic call control procedures, as the receipt of an "invalid call reference value (a message other than a SETUP or RELease COMplete message containing an unallocated call reference value)." In this case, the switch will not carry out initialization.

Upon receipt of the initialization request, the switch will examine the SPID parameter for its validity on the interface and will respond to the terminal as described in the following scenarios:

Scenario 1: If the switch recognizes the USPID as valid on that interface and the USPID is not already associated with another terminal, and the requesting terminal has no active circuit switched or ODB calls in progress, the switch shall then assign the EID (USID and TID) to that terminal. The switch should then transmit the EID (USID/TID) to the terminal in an INFOrmation message containing a null call reference and an interpreter bit set to "0". In this EID, the switch will use the last two digits of the SPID as the TID. The switch should not expect from the terminal an acknowledgment of receipt of the EID. In addition, the switch should associate that TEI with a USOP associated with that terminal's SPID.

Scenario 2: If the USPID part of the SPID received by the switch in an initialization request is not valid (is not assigned to that interface), or if the TID part (the two least significant digits) of the SPID is outside the 00 to 62 range allowed for a TID value, the switch should indicate an unsuccessful initialization attempt by sending an INFOrmation message containing a null call reference and a cause information element with cause value 100. This INFOrmation message indicates "Invalid information element contents (location: public network serving the local user; diagnostic: service profile identification information element)." The switch should also apply appropriate protocol error treatment. In this case, there is no association of the terminal with any USOP. The terminal will not receive any service.

Scenario 3: If an identical USPID parameter value is already associated with another TEI, the switch will attempt to determine whether that previous TEI is in a TEI-unassigned state. If necessary, the switch will perform a TEI check procedure to determine whether that TEI is responsive. If the switch determines that the TEI from which the USPID was previously received is *not responsive to a TEI check*, then the association of the identified USOP with the previous TEI will be cleared and the current initialization procedure with the new TEI will proceed.

Scenario 4: As in Scenario 3, if an identical USPID parameter value is already associated with another TEI, the switch will attempt to determine whether that previous TEI is in a TEI-unassigned state. If necessary, the switch will perform a TEI check procedure to see whether that TEI is responsive. If the switch determines, as it did not in Scenario 3, that the TEI from which the USPID was previously received is *currently active or responsive to a TEI check*, then the current initialization request from the new TEI will be rejected with cause value 100, indicating "Invalid information element contents (location: public network serving the local user; diagnostic: service profile identification information element)" and the switch will apply appropriate error treatment.

The switch assumes that a terminal will not send an initialization request to the switch while any call is in progress. However, the following switch requirement describes the action to be taken by the switch in case the terminal does send an initialization request while any call is in progress.

Scenario 5: This scenario applies if at least one of the following is in progress on a TEI:

- An active CSV, CSD, or ODB call on the TEI
- A notification for the TEI
- An Automatic Terminal Setup (ATS) download on the TEI.

In this scenario, each activity above is considered an "active call," a distinction that excludes an associate call on an EKTS terminal, or a PPD call. Thus, call clearing for an "active call" indicates clearing of a CSV, CSD, or ODB call, the termination of a notification procedure, or the end of a download session.

If the request for initialization is received during an active call and the USPID received in the request is different from the USPID previously received from that TEI, or if the new TID received is invalid (outside the range 00 to 62), then the request will be rejected. The switch will send an INFOrmation message that contains a null call reference and a cause information element with cause value 100, indicating "Invalid information element contents (location: public network serving the local user; diagnostic: service profile identification information element)." The active call(s) is not disturbed by the switch and the SPID and TEI association will continue for the duration of the call(s). After the active call(s) is cleared, the switch will disassociate the old SPID and will request the CPE to initialize (see "Initialization—Switch Initiated," Section 6.4). PPD calls will be preempted only after the last active call has been cleared.

After the last active call has been cleared, and any PPD calls preempted, the switch will release the Layer 2 SAPI=16/TEI link by sending an LAPD disconnect command to the terminal. The SAPI=16 link is then expected to move to the TEI-assigned state. The SAPI=0 logical link should be unaffected. This procedure is a means to inform the terminal to initiate an outgoing call that will cause re-associate to take place.

Scenario 6: If a request for initialization is received and the USPID in the request is different from the USPID previously received from that TEI and no call reference is currently established on that TEI, the switch should honor the request for initialization per the appropriate scenario previously described. Any PPD calls in progress will be preempted.

Scenario 7: If the USPID parameter value received is identical to the one with which the terminal (TEI) is currently bound to (irrespective of whether the TID part of the SPID is the same or different), the switch will accept the initialization request and successfully complete the initialization by sending the EID to the terminal. Any active calls (CSV, CSD, ODB, or PPD) will continue unaffected.

6.4 INITIALIZATION—SWITCH INITIATED

The switch may request that a terminal on an interface initiate the initialization procedure described in the previous section.

Instances in which the switch will request a terminal to initialize are as follows:

- When that terminal had not requested initialization within Timer TI-T1 after assignment of TEI (or receipt of the first SABME from the terminal in the case of nonautomatic TEI terminal)
- When a switch loses its associate with a terminal
- When the CPE's request for initialization has been rejected because of active call(s) in progress.

In the last case, the switch will request the CPE to send its initialization request after all the active CSV, CSD, and ODB calls are cleared and any PPD calls are torn down.

To initiate TI, the switch sends an INFOrmation message containing a null call reference and an information request IE containing the codepoint corresponding to "terminal identification requested."

Terminals that support initialization are expected to respond to this request by initiating the procedure described in the previous section within the expiry of Timer TI-T1. If the terminal responds by sending its SPID, the switch should process the initialization request as described in "Initialization—Terminal Initiated," Section 6.3.

If the terminal does not respond within TI-T1, the switch should send to that terminal an INFOrmation message containing the information request IE coded to indicate that the request for information has been completed. Any abnormal response to the initialization request will receive appropriate protocol error treatment from the switch. When a terminal does not respond to the initialization procedure from the switch within Timer TI-T1, the switch should consider that terminal to be a noninitializing terminal.

In all cases where the switch has requested a CPE to initialize, the switch will respond to the SPID received from the CPE with an INFOrmation message. Irrespective of whether initialization is successful, this INFOrmation message should include the information request (IR) information element with the information request indicator field coded to "information request completed."

The switch will make the following assumptions regarding the CPE. Upon receipt of an INFOrmation message from the switch requesting initialization, the terminal shall maintain the status of the dial keypad (that is, not change the disposition of the dial keypad for the purpose of sending address digits through D-channel signaling). In addition, the terminal shall consider the "information request" to be complete after any of the following events occur.

- The terminal receives an INFOrmation message from the switch that contains the response to the terminal's initialization request (for example, the endpoint information element) and the information request indicator field in the information request information element coded to "information request completed."
- The terminal receives an INFOrmation message that contains only the response to the terminal's initialization request (that is, the information request information element is not included).
- Timer T-SPID expires.

The terminal shall ignore any unexpected information request information elements with the information request indicator field coded to "information request completed" (for example, when the terminal did not receive an information request information element with the information request indicator field coded with "prompt for additional information").

If the terminal responds to a switch-initiated initialization request with the Universal SPID, then the switch will follow the same procedures as described in "Automatic SPID Download (Auto SPID)," Section 6.2.

6.5 REINITIALIZATION

It is assumed that any terminal that has lost its selection parameters—USID and TID—will not respond to any messages containing the EID IE until it has been reinitialized. Any requests from a terminal for reinitialization should be processed by the switch according to the appropriate scenarios described in the previous section.

The switch will not send an initialization request to the terminal when the terminal makes a service request without having been initialized. Additional information regarding the treatment of a service request from a terminal in various scenarios is provided.

- The switch starts the TI-T1 timer when it assigns a TEI to a terminal of the automatic TEI type or when it receives the first SABME from a terminal using the nonautomatic TEI. If, prior to receiving the CPE's initialization request, the switch receives a request for service from the CPE, the switch will discard the service request or send a RELease COMplete message as appropriate. The switch will not, at this time, ask the CPE to send its initialization request.

- The switch receives an initialization request from the CPE. However, before the switch completes processing the request, the CPE sends a request for service. The switch will discard this request but will not ask the CPE to send its initialization request again.
- The TI-T1 timer, started as previously described, expires. The switch then asks the CPE to send its initialization request and starts the TI-T1 timer. The timer expires again without the CPE sending its initialization request. At this time, the switch concludes that the CPE is a noninitializing terminal. If a request for service is then received from the CPE (after the expiry of the timer), the switch will not ask the CPE again to send its initialization request.

Tables 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, and 6-7 describe the switch assumptions about the CPE state transitions with respect to terminal initialization. Also included are the necessary state transitions at Layer 2. In order to successfully interoperate with the *5ESS*®-2000 switch, a CPE must satisfy these assumptions; therefore, these assumptions represent requirements on the CPE.

The states identified in the following tables are mostly self-explanatory. However, the following brief definitions are provided for completeness.

- ***DOWN state:*** The CPE is disconnected from the power source.
- ***AWAIT-ASSIGN:*** The CPE has requested a TEI assignment from the switch and is awaiting a response.
- ***AWAIT-ESTABLISH:*** The CPE has requested Layer 2 establishment and is awaiting a response from the switch.
- ***AWAIT-INIT:*** The CPE has sent its request for initialization and is awaiting a response from the switch.
- ***INIT:*** The CPE has successfully completed initialization and has received an EID (USID and TID) from the switch.
- ***NOT-INIT:*** The CPE moves into this state when, in response to its initialization request, the switch has sent Cause 100, "invalid SPID."
- ***INIT-NOT-SUPPORTED:*** The CPE moves into this state when, in response to its initialization request, the switch has sent a Cause 99.

6.6 NON-INITIALIZING TERMINALS

As previously stated, a Non-Initializing Terminal (NIT) is any terminal that does not attempt, or does not successfully complete, terminal initialization. NITs can be used for any call type, including usage with PVCs.

A standard NIT can support the circuit and packet services CSV, CSD, ODB and PPD, as well as D-channel Permanent Virtual Circuits (PVCs). NIT support falls into three general categories: NITs associated with USOPs that do not contain services requiring initialized terminals, NITs associated with Default DN USOPs or Default Service USOPs, and NITs associated with Fixed TEI USOPs. For the last two of these categories, the NIT is not required to send its calling DN in a call request.

With the exception of the Fixed TEI USOP, a NIT is not associated with a USOP until it originates or responds to a call. The NIT is associated with the USOP at the start of the call. Once the terminal is successfully associated with a USOP, normal call processing takes over for the duration of the call. When the call is complete, the terminal remains associated with the USOP, but any other terminal can make a call request or respond to a call for the same USOP, and become associated with the USOP. When this happens, the first terminal's association with the USOP is removed.

A terminal's association with a USOP will not be removed as long as it has an active Circuit or ODB call, or if it has a notification (for example, for Automatic Recall) in progress. While such a call or notification is in progress, no other terminal will be associated with the same USOP.

6.6.1 USOPs WITHOUT FIT-REQUIRED SERVICES

A NIT can be associated with, and receive the services from, any USOP on the interface that does not have any services assigned that require a FIT. These services are listed in "Overview," Section 6.1. A NIT can be associated with this USOP by including in its call request one of the DNs associated with the USOP for the requested call type. If a NIT is already associated with one USOP, it can change its association by sending the DN for another USOP on the same interface. If it sends an invalid DN, then the NIT will be associated with a Default DN USOP or a Default Service USOP, if applicable, or else the call will be denied.

For incoming calls to a DN associated with a non-FIT-required USOP, the switch will accept the first valid response it receives, and will reject all subsequent responses to the same call. NITs are still expected to have a DN programmed in order to screen terminating calls, the same as FITs, and follow normal call termination procedures for terminals.

6.6.2 DEFAULT DN USOP, DEFAULT SERVICE USOP

A standard NIT is not required to send a calling DN in every call request, because support has been added for a "default" circuit and/or packet DN for the interface, and for Default Service. (Default Service permits a terminal to access a very limited set of services, including Emergency Service, the service provider's business office, and various test facilities.) When a NIT sends a call request with no calling DN, or with an invalid calling DN, the switch attempts to associate the NIT with the appropriate Default DN (DDN) USOP (that is, the USOP containing the Default DN for the requested call type), or with Default Service (only applicable for circuit voice calls).

The service provider may assign one Circuit Default DN (C-DDN) and one Packet Default DN (P-DDN) to each interface. Each is associated with a single USOP, and may be associated with the same USOP. When the C-DDN and P-DDN are in the same USOP, they may have the same DN or different DNs. When they are in different USOPs, then they must be different DNs. The implication for a NIT is that, if the C-DDN and P-DDN are in different USOPs, then two terminals on the same interface can be active on the DDNs at the same time, one circuit-mode and one packet-mode. If the DDNs are in the same USOP, then only a single NIT can be active on either DDN. This is an operational limitation of the switch.

6.6.3 FIXED TEI USOP

A standard NIT can be used with a PVC if it can be programmed with a fixed TEI value. This same TEI value is also provisioned in the switch in the USOP that contains the provisioning for the PVC. This allows the switch to associate the NIT with the USOP for the PVC as soon as Layer 2 is established. The switch requires an association between a terminal and a USOP before it receives the X.25 Reset

Indication, so that it distinguished whether the Reset Indication is in reference to a PVC. Without association with a USOP, the switch cannot determine the PVC, if any, to which the terminal should be connected.

When a NIT that is associated with a Fixed TEI USOP sends a call request, for either circuit-mode or packet-mode, the switch will honor the request as long as the requested service is assigned in the Fixed TEI USOP. If the call request does not contain a calling DN that is the same as the DN provisioned in the USOP for the call type, the switch will use the provisioned DN as the calling DN. For call terminations to a DN associated with a Fixed TEI USOP, the switch will only honor a response from a terminal already associated with the USOP. A response from any other terminal will be rejected.

Table 6-1 — DOWN State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT ENDPOINT STATE
DOWN	POWER_ON	Automatic TEI Endpoint: REQUEST_TEI (u->n)	AWAIT-ASSIGN
		Fixed TEI Endpoint: REQUEST_LAYER_2 (u->n)	AWAIT-ESTABLISH

Table 6-2 — AWAIT-ASSIGN State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT ENDPOINT STATE
AWAIT-ASSIGN	TEI_ASSIGN (n->u)	REQUEST_LAYER_2 (u→n)	AWAIT-ESTABLISH
	TEI_ID_DENIED	REQUEST_TEI (u→n)	AWAIT-ASSIGN
	N202 Reached[a]	Reset N202 REQUEST_TEI (u→n)	AWAIT-ASSIGN
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. N202 is the Layer 2 parameter that indicates the maximum number of retransmissions of the TEI identity request message. These retransmissions, if required, are separated by Timer T202. When the number of retransmissions equals N202, the CPE will reset N202 and will repeat the TEI identity request procedure.

Table 6-3 — AWAIT-ESTABLISH State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT ENDPOINT STATE
AWAIT-ESTABLISH	LAYER_2_ESTABLISHED (n→u)	INIT_REQUEST (u→n) Start Timer (15)	AWAIT-INIT
	LAYER_2_DISCONNECTED	REQUEST_LAYER_2 (u→n)	AWAIT-ESTABLISH
	N200 Reached[a]	Reset N200 REQUEST_LAYER_2 (u→n)	AWAIT-ESTABLISH
	TEI_REMOVE (Automatic TEI Endpoints)	REQUEST_TEI (u→n)[b]	AWAIT-ASSIGN
	TEI_REMOVE (Fixed TEI Endpoints)	REQUEST_LAYER_2 (u→n)[b]	AWAIT-ESTABLISH
	RECEIVE_ANY_MSG (broadcast) (n→u)	Process Message	AWAIT-ESTABLISH
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. N200 is the Layer 2 parameter that indicates the maximum number of retransmissions of a frame (the SABME frame in this case). These retransmissions, if required, are separated by Timer T200. When the number of retransmissions equals N200, the CPE will reset N200 and will repeat the Layer 2 establishment request procedure.

b. When the TEI_REMOVE is received by the terminal, the terminal will release all call reference values (SAPI=0) and return the user interface to an idle condition, that is, turn off all call appearances and feature indicators. In addition, D-channel packet calls will be torn down.

Table 6-4 — AWAIT-INIT State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT ENDPOINT STATE
AWAIT-INIT	INIT_REQUEST (n→u)	INIT_REQUEST (u→n) Restart Timer (15)	AWAIT-INIT
	ASSIGN_USID-TID (n→u)	Map USID-TID into Volatile Memory Clear Timer (15)	INIT
	RECEIVE_CAUSE_VALUE_100 (n→u) (Invalid SPID IE)	Clear Timer (15)	NOT-INIT
	RECEIVE_CAUSE_VALUE_99 (n→u) (initialization not supported) in response to initialization request	Clear Timer (15)	INIT-NOT-SUPPORTED
	RECEIVE_ANY_OTHER_MSG (broadcast or pt-pt) with no USID-TID (n→u)	Process Message	AWAIT-INIT
	RECEIVE_ANY_OTHER_MSG (broadcast) with USID-TID (n→u)[a]	Discard Message	AWAIT-INIT
	USER_ASSIGNS_SPID	INIT_REQUEST (u→n) Restart Timer (15) Reset feature lamps Continue existing calls	AWAIT-INIT
	ANY_OTHER_USER_ACTION	Process User Message	AWAIT-INIT
	LAYER_2_DISCONNECTED	REQUEST_LAYER_2 (u→n)	AWAIT-INIT
	LAYER_2_ESTABLISHED	NO_ACTION	AWAIT-INIT
	Timer (15) expires	INIT_REQUEST (u→n) Start Timer (15)	AWAIT-INIT
	TEI_REMOVE (Automatic TEI Endpoints)	REQUEST_TEI (u→n) Clear Timer (15)[b]	AWAIT-ASSIGN
	TEI_REMOVE (Fixed TEI Endpoints)	REQUEST_LAYER_2 (u→n) Clear Timer (15)[b]	AWAIT-ESTABLISH
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. The switch will include an EID in a SETUP message only after the EID has been assigned to a terminal after successful completion of initialization. Dummy EIDs will not be included.

b. When the TEI_REMOVE is received by the terminal, the terminal will release all call reference values (SAPI=0) and return the user interface to an idle condition, that is, turn off all call appearances and feature indicators. In addition, D-channel packet calls will be torn down.

Table 6-5 — INIT State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT ENDPOINT STATE
INIT	INIT_REQUEST (n→u)	INIT-REQUEST (u→n) Start Timer (15) Reset feature lamps Continue existing call	INIT
	RECEIVE_CAUSE_VALUE_100 (n→u) (Invalid SPID IE)	Clear Timer (15). Remove EID from volatile memory (existing calls will continue)	NOT-INIT
	ASSIGN_USID-TID (n→u)	Map USID-TID into Volatile Memory Clear Timer (15)	INIT
	RECEIVE_CAUSE_VALUE_99 (n→u) (Initialization not supported) in response to initialization request	Clear Timer (15)	INIT-NOT-SUPPORTED
	RECEIVE_ANY_MSG (n→u) with no USID-TID or with matching USID-TID	Follow Applicable Call Processing Rules	INIT
	RECEIVE_ANY_MSG with non-matching USID-TID	Discard Message	INIT
	USER_ASSIGNS_SPID	INIT_REQUEST (u→n) Remove EID from volatile memory Reset feature lamps Continue existing calls Start Timer (15)	AWAIT-INIT
	ANY_OTHER_USER_ACTION	Normal Processing	INIT
	LAYER_2_DISCONNECTED	REQUEST_LAYER_2	INIT
	TEI_REMOVE (Automatic TEI Endpoint)	REQUEST_TEI[a]	AWAIT-ASSIGN
	TEI_REMOVE (Fixed TEI Endpoint)	REQUEST_LAYER_2[a]	AWAIT-ESTABLISH
	Timer (15) expires	INIT_REQUEST (u→n) Start Timer (15)	INIT
	LAYER_2_ESTABLISHED	NO_ACTION	INIT
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. When the TEI_REMOVE is received by the terminal, the terminal will release all call reference values (SAPI=0) and return the user interface to an idle condition, that is, turn off all call appearances and feature indicators. In addition, D-channel packet calls will be torn down.

Table 6-6 — NOT-INIT State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT STATE
NOT-INIT	USER_ASSIGNS_SPID	INIT_REQUEST (u→n) Start Timer (15)	AWAIT-INIT
	INIT_REQUEST (n→u)	INIT_REQUEST (u→n) Start Timer (15)	AWAIT-INIT
	ANY_OTHER_USER_ACTION (other than SPID assignment)	NO_ACTION	NOT-INIT
	RECEIVE_ANY_OTHER_MSG (broadcast or pt-pt) with no USID-TID (n→u)	Process Message	NON-INIT
	RECEIVE_ANY_OTHER_MSG (broadcast) with USID-TID (n→u)[a]	NO_ACTION	NOT-INIT
	LAYER_2_DISCONNECTED	REQUEST_LAYER_2 (u→n)	NOT-INIT
	N200 Reached	Reset N200 REQUEST_LAYER_2 (u→n)	NOT-INIT
	LAYER_2_ESTABLISHED	NO_ACTION	NOT-INIT
	TEI_REMOVE (Automatic TEI Endpoints)	REQUEST_TEI (u→n)[b]	AWAIT-ASSIGN
	TEI_REMOVE (Fixed TEI Endpoints)	REQUEST_LAYER_2 (u→n)[b]	AWAIT-ESTABLISH
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. The switch will include an EID in a SETUP message only after the EID has been assigned to a terminal after successful completion of initialization. Dummy EIDs will not be included.

b. When the TEI_REMOVE is received by the terminal, the terminal will release all call reference values (SAPI=0) and return the user interface to an idle condition, that is, turn off all call appearances and feature indicators. In addition, D-channel packet calls will be torn down.

Table 6-7 — INIT-NOT-SUPPORTED State

CURRENT ENDPOINT STATE	EVENT	ACTION(S)	NEXT
INIT-NOT-SUPPORTED	RECEIVE_ANY_MSG	Normal Processing	INIT-NOT- SUPPORTED
	USER_ASSIGNS_SPID	NO_ACTION	INIT-NOT- SUPPORTED
	ANY_OTHER_USER_ACTION	Normal Processing	INIT-NOT- SUPPORTED
	LAYER_2_DISCONNECTED	REQUEST_LAYER_2	INIT-NOT- SUPPORTED
	TEI_REMOVE (Automatic TEI Endpoint)	REQUEST_TEI[a]	AWAIT-ASSIGN
	TEI_REMOVE (Fixed TEI Endpoints)	REQUEST_LAYER_2[a]	AWAIT-ESTABLISH
	N200 Reached	Reset N200 REQUEST_LAYER_2	INIT-NOT- SUPPORTED
	LAYER_2_ESTABLISHED	NO_ACTION	INIT-NOT- SUPPORTED
	POWER_OFF	NO_ACTION	DOWN

Note(s):

a. When the TEI_REMOVE is received by the terminal, the terminal will release all call reference values (SAPI=0) and return the user interface to an idle condition, that is, turn off all call appearances and feature indicators. In addition, D-channel packet calls will be torn down.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

7. COMMON ELEMENT PROCEDURES FOR SERVICE CONTROL

This section contains an overview of a subset of Layer 7 protocols and the implementation of those protocols by Lucent Technologies. The reader should be familiar with the Bellcore SR-4620,[1] which specifies generic guidelines for terminal equipment utilizing Layer 7 protocols.

The Common Element Procedures provide a functional mechanism for the user and network to exchange supplementary service information for service control. There are four components defined for this control. The components are a structured sequence of octets used to carry service-specific information in both the terminal-to-network and the network-to-terminal directions. The common element procedures are defined in the Bellcore TR-NWT-000864.[2]

1. SR-4620, *National ISDN Basic Rate Interface (BRI) Customer Premises Equipment Generic Guidelines*, 1999.
2. TR-NWT-000864, Common Element Procedures for Service Control, Bellcore, Issue 1, March 1991.

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

7.1 SIGNALING PROCEDURES

7.1.1 COMPONENT SIGNALING PROCEDURES

The protocol and procedures herein are based on the ROSE services and ROSE protocol defined in the ITU-T Recommendations X.219 and X.229. The four components are the following:

- Invoke Component

  The Invoke component is sent to request that an operation be performed. The Invoke component begins a new component exchange or is a response to an Invoke component. The Invoke component contains a parameter to identify the requested operation and any other parameters (arguments) needed to perform the requested operation.

- Reject Component

  The Reject component is sent in response to an Invoke, Return Error, or Return Result component as an indication of a protocol error.

- Return Error Component

  The Return Error component indicates the unsuccessful completion of the requested operation. The Return Error component contains the reason for failure and may also contain service-specific parameters.

- Return Result Component

  The Return Result component indicates the successful completion of the requested operation. The Return Result component may contain service-specific parameters to be returned to the requester.

7.1.1.1 Receipt of an Invoke Component

When the switch receives an Invoke component from a terminal, it expects it to contain the following data elements coded as described in Table 4.1.3-46 and "Invoke," Section 4.1.3.5.4.1:

- Component type

  The switch expects the component type to be coded as "Invoke."

- Invoke Identifier
- Operation value
- Argument(s), if defined for the operation

The switch saves the invoke identifier (ID) it receives from the terminal since it may be used in a reply component sent back to the terminal.

7.1.1.2 Sending an Invoke Component

Table 4.1.3-46 and "Invoke," Section 4.1.3.5.4.1, describe the coding details for the various data elements of the Invoke component. The Invoke component contains the following data elements:

- Component type
  The switch codes the component type as "Invoke."

- Invoke ID
  The switch includes an invoke ID, chosen as described in "Invoke IDs in Components Received by the Switch," Section 7.1.1.10.1.
- Linked ID
  If the Invoke component is a linked Invoke, the switch codes the linked ID to the same value as the invoke ID in the originally received Invoke component. If this Invoke is not a linked Invoke, the switch does not include this data element.
- Operation value
  The switch includes the operation value of the requested operation.
- Arguments
  The switch includes arguments only if defined for this particular operation.

7.1.1.3 Receipt of a Reject Component

Table 4.1.3-47 and "Reject," Section 4.1.3.5.4.2, describe coding details for the various elements of the Reject component. The Reject component contains the following data elements:

- Component type

  The component type will be coded as "Reject."
- Invoke ID

  The switch expects the invoke ID to be coded to the same value as the invoke ID sent in the Invoke component.
- Problem value

  The problem value will indicate one of four categories of errors. A *General problem* is a protocol error independent of a particular component, such as an unrecognized component, a mistyped component, or a badly structured component. An *Invoke problem* indicates protocol errors with a received Invoke component. A *Return Result problem* indicates protocol errors with a received Return Result component. A *Return Error problem* indicates protocol errors with a received Return Error component.

7.1.1.4 Sending a Reject Component

Table 4.1.3-47 and "Reject," Section 4.1.3.5.4.2, describe coding details for the various data elements of the Reject component. The Reject component contains the following data elements:

- Component type
  The switch codes the component type as "Reject."
- Invoke ID
  The switch codes the invoke ID to the same value as the invoke ID in the received Invoke component. If the invoke ID in the Invoke component sent by the terminal is invalid, the switch will choose a valid invoke ID to include in the Reject component.
- Problem
  Invoke problems are used to indicate protocol errors with a received Invoke component.

7.1.1.5 Receipt of a Return Error Component

Table 4.1.3-48 and "Return Error," Section 4.1.3.5.4.3, describe the coding details for the various data elements of the Return Error component. The Return Error component contains the following data elements:

- Component type

  The component type will be coded as "Return Error."

- Invoke ID

  The switch expects the invoke ID to be coded to the same value as the invoke ID sent in the Invoke component.

- Error value

  This data element is expected to carry service-specific error information.

- Parameter(s)

  This data element is included if there are any arguments defined for the indicated error value. The parameters are included as part of the Object identifier, defined in "Object Identifier Value," Section 4.1.3.5.5.8.

7.1.1.6 Sending a Return Error Component

Table 4.1.3-48 and "Return Error," Section 4.1.3.5.4.3, describe coding details for the various data elements of the Return Error component.

The switch sends a Return Error component as an indication that it can not perform the operation identified in the Invoke component received from the user. The Return Error component contains the following data elements:

- Component type

  The switch codes the component type as "Return Error."

- Invoke ID

  The switch codes the invoke ID to the same value as the invoke ID in the Invoke component received from the terminal.

- Error value

  The switch codes the error value to indicate which error has occurred.

7.1.1.7 Receipt of a Return Result Component

Table 4.1.3-49 and "Return Result," Section 4.1.3.5.4.4, describe the coding details for the various data elements of the Return Result component. The Return Result component contains the following data elements:

- Component type

  The component type will be coded as "Return Result."

- Invoke ID

  The switch expects the invoke ID to be coded to the same value as the invoke ID sent in the Invoke component.

- Sequence, Operation value, and Results

The Sequence and Operation value data elements are included only if service-specific Results are included.

7.1.1.8 Sending a Return Result Component

Table 4.1.3-49 and "Return Result," Section 4.1.3.5.4.4, describe coding for the various data elements of the Return Result component. The Return Result component contains the following data elements:

- Component type

  The switch codes the component type as "Return Result."

- Invoke ID

  The switch codes the invoke ID to the same value as the invoke ID in the Invoke component received from the terminal.

- Sequence, Operation value, and Results

  The Sequence and Operation value data elements are included only if service-specific Results are included.

7.1.1.9 Operation Class

There is an operation class specified for each operation value (see "Operation Value," Section 4.1.3.5.5.4). The operation class defines the allowable responses to an invoke operation. The operation class is not contained in the protocol between the switch and the terminal, however, it is expected to be known to both. There are synchronous and asynchronous operation modes. Synchronous operation mode requires a reply from the performer to the invoker before invoking another operation. Asynchronous operation mode allows continuous invocation of operations without waiting for a reply. ATS and NESS support only asynchronous operation mode and the following operation classes:

- Operation Class 2: Asynchronous, reporting success or failure (result or error)

  The Class 2 operation is defined in the user-to-network direction for the invoking of a download request (see "Call References Used in Messages Sent by the Switch," Section 7.1.2.6.2). The components the switch may send in response to an Invoke component are Invoke, Reject, Return Error and Return Result.

- Operation Class 5: Asynchronous, outcome not reported

  Class 5 operations are defined in both the network-to-user and the user-to-network directions. The switch may send the Reject component as a response to a Class 5 Invoke component; however, the switch does not expect a response from the terminal after sending an Invoke component with a Class 5 operation.

7.1.1.10 Invoke Identifier Administration

The invoke ID identifies the particular component exchange at the local user-network interface to which a component applies. The invoke ID is present in every component, enabling the reply to be correlated with the request.

7.1.1.10.1 Invoke IDs in Components Received by the Switch

The switch accepts an invoke ID value as being valid in an Invoke component if it is one or two octets long and within the range of -128 - 127. If the invoke ID contained in the Invoke component is determined to be invalid, the switch sends a RELease COMplete message to the terminal.

7.1.1.10.2 Invoke IDs Used in Components Sent by the Switch

The switch includes an invoke ID (one or two octets long) when it sends an Invoke component to the terminal. The invoke IDs sent by the switch are sequentially numbered starting from one plus the valid value that the terminal used to request the download. If the invoke ID exceeds +127, the switch will wrap around to -128. Since the invoke IDs are sequentially numbered, the terminal can optionally distinguish whether any messages were lost and subsequently request another download to be done at a later time.

Responses to the terminal are linked with the linked identifier (ID), which is the same value as the Invoke ID received from the terminal in the download request.

Note: An invoke ID with a value of 0 (length of 1) is not the same as a null invoke ID (length of 0).

7.1.1.11 Parameters

The parameters included in a component (such as the arguments in an Invoke component or the parameters in a Return Error component) are included in the definition of an operation.

7.1.2 NON-CALL-ASSOCIATED SIGNALING PROCEDURES

The Non-Call-Associated procedures are a subset of the Common Element Procedures for Service Control defined in TR-NWT-000864.

For Non-Call-Associated (NCA) service control, the terminal and the network exchange components to request services that are not call processing-related (that are independent of a call). The components are carried within the Extended Facility Information Element (EFIE) or Facility Information Element (FIE), which may be carried in the REGister, FACility (EFIE only) and RELease COMplete messages.

The switch allows only one Non-Call-Associated Call Reference (NCACR) to exist per terminal at any time. The switch uses an NCACR counter that currently has a maximum value of one. (Not all services utilizing Common Element Procedures make use of a NCACR. For example, see the description of NESS in "NESS Feature Description," Section 7.3.1.)

7.1.2.1 Establishing a Signaling Connection

7.1.2.1.1 Receipt of a REGister Message

When the switch receives a REGister message from a terminal, it interprets it as a request to establish a non-call-associated call reference value over which subsequent component exchanges may take place. In some cases, components are included in only the REGister message. "REGister," Section 4.1.2.18, describes the encoding of the REGister message.

The switch accepts the following information elements (IEs) in the REGister message:

- Protocol Discriminator coded as "Q.931"
- Call Reference, coded as indicated in "Call Reference," Section 4.1.3.1.2
- Message Type coded as "REGister"
- Either Extended Facility, coded as indicated in "Extended Facility," Section 4.1.3.5.1, or Facility, coded as indicated in "Facility," Section 4.1.3.5.2

7.1.2.1.2 Sending of a REGister Message

The switch sends a REGister message to the user to begin a component exchange provided that an established NCACR value is not to be used. "REGister," Section 4.1.2.18, describes the encoding of the REGister message.

The REGister message will contain the following information elements:

- Protocol Discriminator, coded as "Q.931"
- Call Reference, coded as indicated in "Call Reference," Section 4.1.3.1.2
- Message Type, coded as "REGister"
- Facility, coded as indicated in "Facility," Section 4.1.3.5.2

7.1.2.2 Active Signaling Connection: Sending a FACility Message

A FACility message is used to exchange components when a NCACR value has already been established. "FACility," Section 4.1.2.7, describes the encoding of the FACility message. If the length of the FACility message is longer than 244 octets, the segmentation procedure defined in "BRI Message Segmentation," Section 4.1.4, is executed.

The switch encodes the FACility message with the following IEs:

- Protocol Discriminator coded as "Q.931"
- Call Reference value coded as the same value received from the terminal in the REGister message
- Message Type coded as "FACility"
- Extended Facility coded according to the Component Signaling Procedures described in "Component Signaling Procedures," Section 7.1.1

7.1.2.3 Clearing of a Signaling Connection

A RELease COMplete message is used to release a signaling connection that is no longer needed. It may be received from the terminal or sent by the switch.

7.1.2.3.1 Receipt Of A RELease COMplete Message

When the switch receives a RELease COMplete message from the terminal, it releases the NCACR value (if used) for future use. The switch accepts the following IEs in the RELease COMplete message:

- Protocol Discriminator coded as "Q.931"
- Call Reference, coded as indicated in "Call Reference," Section 4.1.3.1.2, and released for future use.
- Message Type coded as "RELease COMplete."
- Optionally, the Extended Facility, coded as indicated in "Extended Facility," Section 4.1.3.5.1, if required by the specific service invoked.

7.1.2.3.2 Sending Of A RELease COMplete Message

When the signaling connection is no longer needed by the switch, and no further component exchanges are anticipated, the switch sends a RELease COMplete message and releases the NCACR value (if used) for future use.

The RELease COMplete message will contain the following information elements:

- Protocol Discriminator coded as "Q.931"
- Call Reference value encoded as the same value received from the terminal in the REGister message.
- Message Type coded as "RELease COMplete."
- Optionally, the Extended Facility, coded as indicated in "Extended Facility," Section 4.1.3.5.1, or the Facility, coded as indicated in "Facility," Section 4.1.3.5.2, if required by the specific service invoked.

7.1.2.4 Protocol Error Treatment

7.1.2.4.1 Errors During Signaling Connection Establishment

The switch applies the procedures in this section to a REGister message received from the terminal as follows:

- Receipt of REGister message with an allocated call reference value

  If the switch receives a REGister message with a call reference that is currently in use, it will be received in a state other than the Q.931 NULL_0 state. It is an unexpected message in any other state and the existing treatment applies.

- Receipt of a REGister message without an EFIE or FIE

  If a REGister message comes into the switch without an EFIE or FIE, it discards the REGister message and responds with a RELease COMplete message with Cause 96, "mandatory information element is missing (location: public network serving the local user; diagnostic: EFIE identifier)."

- Receipt of an unrecognized service discriminator

  If the EFIE or FIE contains an unrecognized service discriminator, the switch discards the REGister message and responds with a RELease COMplete message with Cause 100, "invalid information element contents (location: public network serving the local user, diagnostic: identifier of invalid information element)."

- Receipt of an EFIE or FIE without a component

  If the switch receives an EFIE or FIE without a component, the switch discards the REGister message and responds with a RELease COMplete message with Cause 100, "invalid information element contents (location: public network serving the local user, diagnostic: identifier of invalid information element)."

7.1.2.4.2 Errors During an Active Signaling Connection

The switch applies the procedures of this section to an existing call reference established with a REGister message as follows:

- Receipt of STATus or STATus ENQuiry message

  The switch ignores a STATus or STATus ENQuiry message received from a terminal on a BRI.

- Receipt of other messages

  If the switch receives any message other than STATus, STATus ENQuiry or RELease COMplete in State 31, the switch discards the message and responds with a STATus message with ITU-TS Standard Cause 101, "message not compatible with call state," and Call State 31, "call independent service state."

7.1.2.4.3 Errors During Signaling Connection Clearing

- Missing cause IE

  If the switch receives a RELease COMplete message missing a cause IE, the switch halts any outstanding activity related to the invoked service and releases the NCACR value for future use.

- Receipt of unrecognized service discriminator

  If the EFIE or FIE contains an unrecognized service discriminator, the switch halts any outstanding activity related to the invoked service and release the NCACR value for future use.

- Receipt of an EFIE or FIE without a component

  If the switch receives an EFIE or FIE that does not contain a component, the switch halts any outstanding activity related to the invoked service and release the NCACR value for future use.

7.1.2.5 Malfunctioning Data Link

In the event of a data link malfunction as described in "Call Activity Checks," Section 4.2.1.5.4, the switch will attempt to send a RELease COMplete message to the terminal with Cause 41, "temporary failure (location: public network serving the local user)." The switch releases the call reference value (CRV), decrements the NCACR counter and ends the download session.

7.1.2.6 Non-Call-Associated Call Reference Administration

The NCACR administration procedures in this section are similar to call-associated call reference administration procedures.

7.1.2.6.1 Allocation and Release of Call References

The switch allocates a call reference when it receives a REGister message with a call reference of 1 or 2 octets with a value that has not yet been allocated by the user on the particular D-channel logical link connection. The switch releases the call reference allocated when it either sends or receives a RELease COMplete message to or from the terminal.

7.1.2.6.2 Call References Used in Messages Sent by the Switch

The call reference procedures and format used in response to a REGister message are the same as those that are currently used for a response to a SETUP message.

7.1.3 CALL-ASSOCIATED SIGNALING PROCEDURES

7.1.3.1 Signaling During Call Origination

7.1.3.1.1 Invoke Identifier Administration

When the switch receives a SETUP message from the CPE containing a Facility IE coded as an Invoke Component, the switch must retain the Invoke Identifier value to be used in all Facility IEs exchanged between the switch and the CPE. The Invoke Identifier is associated with the Call Reference Value. Multiple Invoke Identifiers may be associated with the same CRV, and different CRVs on the interface may have identical Invoke Identifiers.

For example, the switch will perform the operation received and send a Return Result component in the Facility IE of the CONNect message. The invoke identifier will be the same as the invoke identifier received in the SETUP message.

7.1.3.1.2 Errors During Call Origination

- Receipt of a Facility IE with an application request not allowed.

  If the switch receives a SETUP message that contains a Facility IE and the CPE is not allowed access to the requested application, the switch will discard the Facility IE and send either a RELease COMplete or a DISConnect message with Cause 16, "normal clearing," and a Return Error Component.

- Receipt of Facility IE with an incorrect length.

  If the switch receives a SETUP message that contains a Facility IE with a two octet length format (long form) that encodes component data element lengths of not more than 127 octets, the switch will discard the component and send a RELease COMplete message with Cause 16, "normal clearing," and a Reject component. The Reject component will contain the General problem tag and a problem value of "Badly Structured Component."

- Receipt of a Facility IE with a linked identifier.

  Upon receipt of a SETUP message with a Facility IE containing the Invoke Component, if the switch receives a linked identifier, the switch will discard the Invoke component and send the CPE a RELease COMplete message with Cause 16, "normal clearing." The clearing message will contain a Reject component with the Invoke problem tag and a problem value of "linked response unexpected."

- Receipt of a Facility IE without an invoke identifier.

  Upon receipt of a SETUP message with a Facility IE containing the Invoke Component, if the switch does not receive an invoke identifier, the switch will discard the Invoke component and send a RELease COMplete message with Cause 16, "normal clearing." The clearing message will contain a Reject component with the General problem tag and a problem value "mistyped component."

- Receipt of a Facility IE with a recognized, but unexpected component.

  If the switch receives a SETUP message containing a Facility IE with a recognized component type other than Invoke, the switch will discard the component and send a RELease COMplete message with Cause 16, "normal clearing," and a Facility IE containing a Reject component to the CPE. The Reject component will contain the General problem tag and problem value of "mistyped component."

- Receipt of a Facility IE without a valid operation value.

  Upon receipt of a SETUP message with a Facility IE containing the Invoke Component, if the switch does not receive a valid operation value, the switch will discard the Invoke component and send the CPE a RELease COMplete message with Cause 16, "normal clearing." The clearing message will contain a Reject component with the Invoke problem tag and a problem value of "unrecognized operation."

7.1.3.2 Signaling During an Active Call

7.1.3.2.1 Invoke Identifier Administration

While a call is active, the switch may send a FACility message to the CPE, containing a Facility IE coded with an Invoke component. A new Invoke Identifier is allocated to the Call Reference Value in use. If the switch expects the CPE to respond with a Return Result component, then it retains the Invoke Identifier. If, while a call is active, the switch receives a FACILITY message containing a Facility IE coded with a Return Result or Return Error component, the Invoke Identifier is expected to be one that is allocated to the current Call Reference Value.

7.1.3.2.2 Errors During An Active Call

- Receipt of a message without a Facility IE.

  If the switch receives a FACility message with an allocated call reference value that is missing the Facility IE and the call is not in the process of being cleared, the switch will discard the FACility message and respond with a STATus message containing Cause 96, "mandatory information element is missing (location: public network serving the local user; diagnostic: information element identifier)," and the current call state. If the switch receives a FACility message *without* an allocated call reference value, existing treatment will occur; that is, the switch will discard the FACility message and respond with a RELease COMplete message containing Cause 81, "invalid call reference value (location: public network serving the local user)."

- Receipt of Facility IE with an incorrect length.

  If the switch receives a FACility message with a Facility IE, containing a two-octet length format (long form) that encodes component data element lengths of not more than 127 octets, the switch will discard the component and send a FACility message with an Facility IE containing a Reject Component. The Reject component will contain the General problem tag and a problem value of "badly structured component."

- Receipt of a Facility IE without an invoke identifier.

  If the switch receives a FACility message with a Facility IE that is missing the invoke identifier, the switch will discard the FACility message and respond with a FACility message with a Facility IE containing a Reject component with a null invoke identifier. The Reject component will contain the General problem tag and problem value "mistyped component."

- Receipt of a Facility IE with an invoke identifier not currently in use.

  Upon receipt of the FACility message containing the Return Result component, the switch will check whether the invoke identifier is currently in use for the call reference value. If the invoke identifier is not currently in use for the call reference, the switch will discard the Return Result component and send a FACility message with a Reject component to the CPE. The Reject component will contain a Return Result problem tag and a problem value of "unrecognized invocation."

  Upon receipt of the FACility message containing the Return Error component, the switch will check whether the invoke identifier is currently in use for the call reference value. If the invoke identifier is not currently in use for the call reference, the switch will discard the Return Error component and send a FACility message with a Reject component to the CPE. The Reject component will contain a Return Error problem tag and a problem value of "unrecognized invocation."

- Receipt of a Facility IE without mandatory operation arguments.

  If the switch receives a FACility message with a Facility IE containing a Return Result component that does not contain mandatory operation arguments in the correct order, the switch will discard the component and send a FACILITY message with a Facility IE containing a Reject Component. The Reject component will contain the Return Result problem tag and a problem value of "mistyped result."

- Receipt of a Facility IE with an unpopulated results argument.

  If the switch receives a FACility message with a Return Result component containing the Sequence and Operation data elements but the Results argument is not populated, the switch will discard the Return Result component and send a FACility message containing a Reject component to the CPE. The Reject Component will contain the General problem tag and problem value of "mistyped component."

- Receipt of a Facility IE with an argument sequence without data elements.

  If the switch receives a FACility message with a Return Result component containing the Results arguments without the Sequence and Operation Data Elements, the switch will discard the Return Result component and send a FACility message containing a Reject component to the CPE. The Reject Component will contain the General problem tag and problem value of "mistyped component."

- Receipt of a Facility IE with an invalid operation in the data element.

  If the switch receives a FACility message containing a Return Result component and the Operation Value data element does not contain a valid operation, the switch will discard the component and send a FACility message containing a Reject component to the CPE. The Reject component will contain the General problem tag and problem value of "badly structured component."

- Receipt of a Facility IE with an unrecognized data element.

  Upon receipt of the FACility message containing the Return Error component, if the Error Value data element is not valid for the application, the switch will discard the Return Error component and send a FACility message containing the Reject component to the CPE. The Reject component will contain the Return Error problem tag and a problem value of "unrecognized error."

- Receipt of a Facility IE with an unexpected data element.

  Upon receipt of the FACility message containing the Return Error component, if the Error Value data element is valid for the application but not expected, the switch will discard the Return Error component and send a FACility message containing the Reject component. The Reject component will contain the Return Error problem tag and a problem value of "unexpected error."

- Receipt of the Facility IE with an incorrectly coded problem value.

  Upon receipt of the FACility message containing the Reject component with an incorrectly coded problem value, the switch will discard the Reject component.

7.1.3.3 Signaling During Call Clearing

7.1.3.3.1 Invoke Identifier Administration

Many requests send a Return Error component to the new RPCU.

When the switch sends a RELease COMplete or DISConnect message containing a Return Error or Reject component, it will code the Invoke Identifier to the same value as the Invoke Identifier in the corresponding component received through the SETUP message from the CPE that is being rejected. If the switch is unable to determine the Invoke Identifier of the component being rejected, the switch will use the null value.

When sending a FACility message containing a Reject component, the switch will code the Invoke Identifier to the same value as the Invoke Identifier allocated and retained at the switch and used in the corresponding component FACility message from the CPE that is being rejected. If the switch is unable to determine the Invoke Identifier of the component being rejected, the switch will use the null value.

7.1.3.4 Releasing an Invoke Identifier

The switch will release the Invoke Identifier when:

- the switch has received and accepted a FACility message with a Return Result or Return Error component;
- the switch has sent a DISConnect or RELease COMplete message with a Return Result or Return Error component;
- the switch has received (through a FACility message) or sent (through a DISConnect, RELease COMplete, or FACility message) a Reject component; or
- the switch releases the call reference value to which the invoke identifier is currently allocated.

7.1.3.5 Protocol Error Treatment

The following lists generalized protocol errors independent of call state.

- Receipt of a Facility IE with an unrecognized component.

  If the switch receives a SETUP message containing a Facility IE with a component type other than Invoke, Return Result, Return Error, or Reject, the switch will discard the component and send a RELease COMplete message with Cause 16, "normal clearing," and a Facility IE containing a Reject component. The Reject component will contain the General problem tag and problem value of "unrecognized component."

  If the switch receives a FACility message containing the Facility IE with a component type other than Invoke, Return Result, Return Error, or Reject, the switch will discard the component and send a FACility message with the Reject component to the CPE. The Reject component will contain the General problem tag and problem value of "unrecognized component."

- Receipt of a Facility IE with an unexpected component.

  If the switch receives a FACility message containing the Facility IE with a recognized but unexpected component type, the switch will discard the component and send a FACility message with the Reject component. The Reject component will contain the General problem tag and problem value of "mistyped component."

- Receipt of a Facility IE with data elements out of order.

If the switch receives a SETUP or FACility message containing the Facility IE with a component type that has data elements out of order, the switch will discard the component. The switch will respond to the SETUP message with a RELease COMplete or DISConnect message, and to the FACility message with a FACility message. Either of these responses will contain the Reject component containing a General problem tag and problem value of "mistyped component."

- Receipt of Facility IE in an invalid message.

  If the Facility IE is received in a message other than SETUP or FACILITY, the switch will ignore the Facility IE and proceed with normal call processing.

  If the switch receives a FACility message that is missing the Facility IE and the call is in the process of being cleared, the switch will discard the FACility message and continue with call clearing. The switch will not send a STATus message.

- Receipt of a Facility IE with incorrectly coded tags.

  If the switch receives a SETUP message with a Facility IE containing an Invoke component with an incorrectly coded Invoke Identifier tag or Operation Value tag, the switch will discard the component and send a RELease COMplete message with Cause 16, "normal clearing," and a Reject component. The Reject component will contain the General problem tag and problem value of "mistyped component."

  If the switch receives a FACility message with a Facility IE containing a Return Result or Return Error component with an incorrectly coded Invoke Identifier tag, Sequence tag, Error Value tag, or Operation Value tag, the switch will discard the component and send a FACility message containing a Reject component. The Reject component will contain the General problem tag and problem value of "mistyped component."

  If the switch receives a FACility message with a Facility IE containing a Reject component with an incorrectly coded Invoke Identifier tag, or Problem Value tag, the switch will discard the component.

- Receipt of a Facility IE with an invalidly coded data element.

  If the switch receives a SETUP message with a Facility IE containing an Invoke component with an invalidly coded data element, the switch will discard the component and send a RELease COMplete message with Cause 16, "normal clearing," and a Reject component. The Reject component will contain the General problem tag and problem value of "badly structured component." Examples of these invalidly coded data elements include:

  - Invoke component, Invoke Identifier, or Operation Value with no length;
  - Invoke component, Invoke Identifier, or Operation Value with an improper length; and
  - Invoke component, Invoke Identifier, or Operation Value with a length that is in long format.

  If the switch receives a FACility message with a Facility IE containing a Return Result component with an invalidly coded data element, the switch will discard the component and send a FACility message containing a Reject component. The Reject component will contain the General problem tag and problem value of "badly structured component." Examples of these invalidly coded data elements include:

- Return Result component, Invoke Identifier, Sequence, or Operation Value with no length;
- Return Result component, Invoke Identifier, Sequence, or Operation Value with an improper length; and
- Invoke Identifier or Operation Value with a length that is in long format.

If the switch receives a FACility message with a Facility IE containing a Return Error component with a invalidly coded data element, the switch will discard the component and send a FACility message containing a Reject component. The Reject component will contain the General problem tag and problem value of "badly structured component." Examples of these invalidly coded data elements include:

- Return Error component, Invoke Identifier, or Error Value with no length;
- Return Error component, Invoke Identifier, or Error Value with an improper length; and
- Return Error component, Invoke Identifier, or Error Value with a length that is in long format.
- Receipt of Facility IE without a component or with an unrecognized service discriminator.

If the switch receives a FACility message with a Facility IE that does not contain the "supplementary services" service discriminator or does not contain a component, the switch will discard the Facility IE and respond with a STATus message containing Cause 100, "invalid information element contents (location: public network serving the local user; diagnostic: identifier of invalid information element)," and the current call state.

If the switch receives a SETUP message with a Facility IE that does not contain the "supplementary services" service discriminator or does not contain a component, the switch will discard the Facility IE. The switch will respond with a RELease COMplete containing an FIE with a Return Error component containing Cause 100, "invalid information element contents (location: public network serving the local user; diagnostic: identifier of invalid information element)."

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

7.2 AUTOMATIC TERMINAL SETUP—ATS

The ATS feature (also known as Parameter Downloading) downloads certain parameters that are essential for terminal operation on a National ISDN standard BRI.

The concept of ATS came from the need to minimize the number of parameters a customer must enter into an ISDN terminal during installation. Without ATS, all parameters would have to be manually entered or locally entered through other semi-automatic means such as a local data link or pre-programmed data medium. The ATS feature enables the customer's terminal to accept the *5ESS*® switch provisioned parameters, thus ensuring the data in the terminal and switch are consistent.

Not all parameters the user has to enter into the terminal are candidates for downloading. The SPID is one example because it is the bootstrap mechanism by which the terminal identifies itself to the switch at Layer 3 for initialization and downloading purposes.

The ATS feature can be invoked from only a properly initialized terminal. The terminal requests a download from the switch, and the switch responds by sending the parameter values. The terminal ends the process by sending an acknowledgement to the switch. A terminal that has not successfully completed the initialization procedure may be linked to a default service profile allowing services such as access to 611 and 911. A request for downloading in this state is denied.

To inform a terminal that a download is required, the switch notifies it when a service order change that affects downloaded parameters has been processed. The terminal can use the notification as a trigger to automatically request a download, or the user can manually request a download through a terminal-provided means.

Downloading is accomplished by sending messages across the BRI D-channel. The protocol for these messages is derived from CMISE and ROSE (Common Management Information Service Element and Remote Operations Service Element) specifications with the parameters transported in Q.931/Q.932 messages following the ITU-TS standards for interface management services, Q.941.

There are two types of parameter downloading.

Parameter Downloading Type 1 refers to the parameters for downloading as part of the NI-2.

Terminals that support Parameter Downloading Type 1 are already in the field. In order to avoid adversely affecting the operation of these existing downloading terminals, Parameter Downloading Type 2 is defined to include the new data.

Parameter Downloading Type 2 includes all of the parameters from Parameter Downloading Type 1 plus the additional parameters needed to support ISDN virtual key capabilities as specified in Bellcore TR-NWT-001281 (Revision 1) for development in the 5E11 software release.

A terminal built to Parameter Downloading Type 1 requests only the type 1 downloading. It is designed not to receive the additional data of the type 2. A terminal built to Parameter Downloading Type 2 is able to recognize all the Type 2 data and supports both the Type 1 and Type 2 download requests. If the switch rejects a Type 2 download request for any reason, the terminal could request Type 1 downloading.

7.2.1 TERMINOLOGY

- ASN.1 - Abstract Syntax Notation One - A language for specifying the information structures of data.
- Bearer Capability - The following bearer capabilities are defined for National ISDN: speech (speech), 3.1 kHz audio (audio), 56 kbps circuit mode data (cmd56), 64 kbps circuit mode data (cmd64), and packet mode data (pmd with sub-bearers of pmdD and pmdB).
- Call Appearance (CA) - A physical means to present a call to the end-user. There is a one-to-one correspondence to a call reference if a call is present. This term is used in the Call Appearance Call Handling (CACH) Electronic Key Telephone Service (EKTS) context only.
- Call Appearance Identifier - A number that is exchanged between the switch and terminal to identify a (CA) on a terminal.
- Call Type (CT) - A term that groups the bearer capabilities as follows:
  - — Voiceband Information (VI) includes the speech and audio bearers,
  - — Circuit Mode Data (CMD) includes the cmd56 and cmd64 bearers, and
  - — Packet Mode Data (PMD) equates to the pmd bearer capability.
- CMIS - Common Management Information Services defines a set of services that can be used across the operations interface that operate on object instances as defined by an information model
- Component - see PDU.
- Default Bearer Capability - The default bearer capability is sent to the terminal as part of the Directory Number (DN) appearance ID. It establishes in the terminal a default value that is provided in the outgoing SETUP message on call origination. Terminals are expected to provide a local means to override the default with another allowed bearer capability selected by the user on a per-call basis.
- Directory Number Appearance Identifier - A DN appearance ID provides a physical mapping of a DN and a default bearer capability to a location on a terminal similar to the call appearance. This concept is unique to ATS, and provides a terminal need only.
- Downloadable CPE - An ISDN BRI CPE that supports downloading of parameters. Terminals with this functionality are expected to be available in the NI-2 time frame. Terminals that do not support parameter downloading require manual local programming of DNs and related data by the installer in order to originate and terminate calls.
- Feature Button [also called Feature Activator (FA) or Key] - A feature button provides the user interface to the CPE and, when operated, sends to the switch a button number that is interpreted as an invocation of a feature operation.
- Feature Lamp [also called Feature Indicator (FI)] - A feature lamp provides the status of a feature to the user. The lamp is administered by the switch sending a lamp number and state to the terminal.

- Interface Management - Interface management services provide network management capabilities for the subscriber installation and subscriber access by communicating management information across one ISDN interface between two peer protocol entities
- Managed Object - A managed object is an abstract representation of resources in a managed system.
- Originating DN Flag (one per terminal) - A flag that indicates the DN used for originating calls from a CACH EKTS terminal. Originating DN is the primary DN or multi-line hunt group (MLHG) listed DN, if there is no primary DN assigned.
- Permanent B-channel Packet Service (PPB) - This term defines a permanent, provisioned B-channel from the user to the protocol handler (PH), always available for X.25 calls. Q.931 signaling is not used to establish the channel.
- Protocol Data Unit (PDU) - PDUs transport the data exchanged between the switch and terminal. The format of the PDUs for this feature are defined in ASN.1 syntax in "ASN.1 Module," Section 7.2.6.2.7. The terms PDU and component are used interchangeably in this document.
- Protocol Error Record (PER) Buffer (also called Protocol Abnormality Log) - A PER buffer is provided in the Switching Module (SM) to store abnormal protocol events as they occur on the BRI.
- ROSE - The Remote Operations Service Element of the ATS feature is used in conjunction with CMISE (Common Management Information Services Element) to provide an environment for transporting download data and other information across the BRI. The ROSE services are
  - ROIV (Remote Operations Invoke),
  - RORS (Remote Operations Result),
  - RORJ (Remote Operations Reject), and
  - ROER (Remote Operations Error).
- Service Description - A service description is ASCII text (up to 20 characters) that provides a user-readable name or description of a feature that can be used for a local display by the CPE. The service description is settable by the service provider.
- Service Profile Identifier (SPID) - The SPID is a value that uniquely identifies an initializing terminal at Layer 3 on an ISDN interface.
- User Service Order Profile (USOP) - The USOP is an abstract concept of the collection of feature and service parameters that are assigned to a terminal on a BRI. Features and services can be assigned in any of several ways, such as to terminals or to DNs on a terminal.

7.2.2 ATS FEATURE DESCRIPTION

The ATS feature downloads, upon terminal request, certain parameters that are essential for terminal operation on a National ISDN standard BRI. A terminal can request a parameter download after initialization of Layer 3, after it has been notified by the switch that a service order change has been completed, or any other time during the life of the service when the user or repair technician deems necessary. Type

1 parameters, which are downloaded, include:

- CACH option per terminal
- DNs
- Bearer capabilities per DN
- Call reference busy limit per call type per DN
- DN appearance IDs per DN
- CACH EKTS CA map per DN
- Intercom CA map per intercom group per terminal
- Feature Activator (FA)/Feature Indicator (FI) map per terminal
- FA/FI service descriptions per terminal

Parameter Downloading Type 2 downloads all the parameters of Type 1 and the following:

- Activator keywords for downloaded FA/FI
- Originating DN flag (one per terminal)
- CA reservation information for Basic and CACH EKTS [CA reservation feature allows one or more CAs (that is, subaddresses) of a DN to be reserved for one of the three defined reservation statuses (that is, originations only, terminations only, or originations and priority incoming terminations) or it's not present].

The goal of this feature is to minimize the number of steps the user or installer must take to establish service. The most simple installation requires the user to plug the CPE into the interface, and then program the SPID into the CPE. After the initialization and download procedures are complete, the user may immediately originate and receive voice, circuit-switched data and packet data calls.

There are three classes of parameters that a CPE requires to provide ISDN service. They are as follows:

- **Factory-set:** The parameters needed by the CPE to establish Layer 2 and Layer 3 when it is plugged in. These parameters are programmed into the CPE at the factory. Default values of Layer 2 and Layer 3 timers and counters, fixed TEI, and fixed button and lamp numbers fall into this category.
- **Programmable:** These are parameters programmed into CPE by the user. The SPID is an example of this class of parameters. Another example is a terminal with a setup mode that allows the installer or user to define buttons as call appearance or feature, and then number them.
- **Downloadable:** These are parameters downloaded into the CPE from the switch. The ATS feature is concerned with this subset of parameters and the downloading procedures. Any parameters that are not downloaded but are required by the CPE must be either factory-set or programmable.

The ATS feature requires that the switch and CPE both support the proper protocol and procedures for successful downloading to occur. Downloadable and non-downloadable terminals designed to National ISDN requirements may be mixed on an interface.

There are two versions of this feature: Type 1 downloading and Type 2 Downloading. ATS is not a provisionable feature, and it is not supported on the Custom BRI.

ATS makes use of a subset of the non-call-associated concepts specified in TR-NWT-000864, which provides the framework for transporting procedural information and data related to supplementary services between the switch and terminal using Q.931-based procedures.

7.2.3 DOWNLOADABLE PARAMETERS

This section describes the parameters sent from the switch to the terminal. The downloaded parameters are grouped according to DN-independent and DN-dependent data.

- DN-independent parameters
  - — CACH option
  - — Paired Feature Button and Feature Lamp list
    - Feature Activator and Indicator value
    - Service description
    - Activator keyword (Type 2 only)
  - — Intercom Group Appearance list
- DN-dependent Parameters, sent for each DN on the terminal
  - — DN
  - — Originating DN flag (Type 2 only)
  - — Bearer Capability list
  - — DN Appearance ID list
    - CA ID
    - Default Bearer Capability
    - CA Reservation (Type 2 only)
  - — Call Reference Busy Limit per Call Type per Group of Call Types
  - — CA ID list for CACH EKTS terminals
    - CA ID
    - CA Reservation (Type 2 only)

In the following subsections the parameters are described in detail. The Guidelines for the Definition of Managed Objects (GDMO) template label name for each parameter is given in parentheses next to the parameter type. Complete definitions using the GDMO and ASN.1 notation are given in "Automatic Terminal Setup - ATS," Section 7.2. The descriptions of the parameters are in terms of the attribute names found on Recent Change (RC) views, and the view number is provided where possible. Parameters defined by this feature are designated by "new" the first time used in this section. (The RC attributes constitute the provisioning data in the *5ESS* switch and are provided in this document to aid in troubleshooting ISDN installations.)

7.2.3.1 DN Independent Parameters

7.2.3.1.1 CACH Option (callAppearanceCallHandlingOption)

This parameter specifies whether a terminal is CACH EKTS or not. The switch downloads this parameter to the terminal so the terminal knows whether or not it should use the CA numbers for signaling to the switch.

The form of this attribute is:

<BOOLEAN>

where 0 indicates the terminal is not CACH EKTS, and any non-zero value indicates the terminal is CACH EKTS.

7.2.3.1.2 Paired Feature Activator and Feature Indicator List (fAfIsAllDN)

Feature Activators (FAs) and Feature Indicators (FIs) are downloaded to identify to the terminal those buttons that are feature buttons, and also to associate keywords with button numbers and lamp numbers for a local inspect function.

A single assignment of a feature and action is made to a specific button/lamp pair. The *5ESS* switch cannot distinguish whether a button/lamp pair, only a button, or only a lamp exists. In general, features are designed to operate as though a button/lamp pair exists. For example, if a user activates call forwarding with feature button 3, the feature indication is returned to lamp 3.

fAfIsAllDN is a set-valued attribute that identifies FA-FI pairs for features that have the same value for all DN/CTs on a terminal. Up to 254 FA-FI pairs can be assigned to features. Each value in the set is a sequence of data items in the following format:

<featureActivatorAndIndicatorValue>

The integer (1 to 254) identifies the FA (button) number sent and the FI (lamp) number received by the terminal. (A range of 1 to 16383 is allowed by the Bellcore data model.)

<ServiceDescription>

The ServiceDescription is the service provider’s name, up to 20 ASCII characters, for the feature associated with the FA-FI. Service descriptions are assigned on a per-office basis and may be changed through RC/V during the life of the switch.

<featureActivatorAndIndicatorKeyword>

(Optional) The Activator keyword can be up to eight printable ASCII characters. As part of Parameter Downloading Type 2 (Revision 1 Data), the activator keyword is sent for the following features.

Feature	Service Description	Activator Keyword	Feature Description
DNBFC	"Conference Size 3"	CFS3	Conference Size 3
DNBFC	"Conference Size 6"	CFS6	Conference Size 6
DNBFC	"Drop Last Call"	DROP	Drop for CFS3, CFS6
DNBFC	"Call Transfer"	TRF	Call Transfer

The keyword is taken from the set of unique IDs defined in Bellcore TR-NWT-000019.

The "featureActivatorAndIndicatorValue" and "Service Description" are derived from attributes on RC/V Views 12.5 and 8.32. For a particular ROW on View 12.5, the ACTION is correlated with the SVC DESC of ACTION on the new view. A BUTTON (integer) and SVC DESC (Service Description) are downloaded for each ROW populated on View 12.5 for the specific defined CONFIG GRP on View 23.2.

7.2.3.1.3 Intercom Group Appearance List (intercomGroups)

This is a multi-valued attribute that specifies a list of intercom appearances on a CACH EKTS terminal. Intercom Groups are downloaded to provide a mechanism for the terminal to associate intercom group and address values to buttons on the terminal.

The form of this attribute is:

<X..XXXXXXXX>
This attribute (intercomGroupId) is a string of one to 8 ASCII characters (digits) that specifies the internally generated integer of the intercom group in the switch (ICM GRP of View 23.23).

<Integer(1..254)>
This integer (callAppearanceId) specifies the call appearance ID that is used in Q.931 messages between the terminal and the switch.

<Integer(0..99)>
This integer (intercomAddress) specifies the intercom address within the group.

An intercom group appearance list (IntercomGroups) is downloaded for each intercom group on the terminal.

Note: The intercom address is an optional parameter, and it will not be included if the value is not within the valid range of integers 0 - 99.

The intercomAddress is the 1-digit or 2-digit address that other members of the group dial to call this terminal (TN_POSITION of View 23.23).
The subscription parameters to support NI-2 Intercom Service are on View 23.23, ODA form 59603.

Intercom call appearances are assigned in clusters of 1 to 16 call appearances per intercom group, and up to 4 intercom groups are allowed per terminal.

CA and CA QTY of View 23.23 are defined for each intercom group on a terminal in the same manner as for CACH EKTS call appearances, that is, CA is the starting button number and CA QTY is the number of sequentially numbered call appearances.

Each ICOM type is associated with CACH EKTS, and can be assigned to a terminal, only if CKT TN is assigned. In order to be part of an ICOM group, a multi-line hunt terminal must also have CKT TN assigned. The allowed bearer capabilities for ICOM are speech and audio but they are not downloaded.

The *5ESS* switch assigns ICM GRP on View 23.23 as an alpha-numeric name of 1 to 8 characters. The *5ESS* switch internally maps that name to a unique number per ICOM group. The name is stored in the CMP and the number is stored in the SM. In order to limit the downloading task to the SM, the integer will be downloaded to the terminal.

7.2.3.2 DN Dependent Parameters

7.2.3.2.1 Directory Number (directoryNumber)

DNs are downloaded to identify to the terminal those DNs that are assigned. The value of the directoryNumber attribute is a numeric string with a length of 7 ASCII characters defining the local directory number.

<NXX><XXXX>
where

NXX is the 3-digit local office code, and

XXXX is the 4-digit line number in the local office.

The primary DN of a terminal defined on View 23.2 (attribute CKT TN) is downloaded if assigned.

This DN is shared for speech, audio, cmd56, cmd64 and pmd (pmdD and pmdB) bearer capabilities.

A terminal that is a member of an EKTS group may have more than one DN assigned. The "primary" DN is assigned on View 23.2, and all other shared (secondary) DNs are assigned on View 23.21.

Each secondary DN of an EKTS terminal defined on View 23.21 (attribute TN) is downloaded.

View 23.20 is used to add or delete a secondary DN from multiple terminals of an EKTS group. A secondary DN (attribute TN) assigned on View 23.20 is downloaded to all terminals identified on View 23.20 as having TN assigned by virtue of its appearance on multiple of View 23.21.

There are three types of directory numbers for MLHG terminals, an individual hunt DN, an individual DN marked as no-hunt, and the group DN. The following rules for downloading a DN to a MLHG member applies:

If an individual DN is assigned to a hunt group member (View 23.2, CKT TN), it is downloaded. If CKT TN is not assigned, that is, the terminal is identified only by group and member, the group DN for the hunt group is downloaded (View 3.5, LISTED TN).

If an individual secondary DN is assigned to a hunt group member of an EKTS terminal (View 23.21, TN), it is downloaded. If the CKT TN is not assigned, that is, the secondary appearance on the terminal is identified only by group and member, the group DN for the hunt group is downloaded (View 3.5, LISTED TN).

Additional DNs are assigned to a hunt group member on View 3.3. These DNs can be assigned as hunt or non-hunt DNs, and the number of such DNs that can be assigned to a terminal is essentially infinite (implemented by a linked list). Individual DNs assigned on View 3.3 are not downloaded to a hunt group terminal.

For each MLHG member on a terminal with no individual DN, a separate DN dependent message is sent to the terminal containing the View 3.5 LISTED TN.

If the D-channel packet DN is assigned on View 23.2 (attribute DPKT TN), it is downloaded.

If the B-channel packet DN is assigned on View 23.2 (attribute ODB TN), it is downloaded.

The following DNs of View 23.2 are not downloaded: PPB1 TN and PPB2 TN. Likewise, none of the BILL TN defined on View 23.2 are downloaded.

The preceding requirements deal with the case where each of the downloaded DNs are unique to a terminal. Current assignment rules permit CKT TN, ODB TN, and DPKT TN to be the same DN, or two of the three to be the same DN.

For the case where two or more of the assigned CKT TN, ODB TN, and DPKT TN are the same, only one DN-dependent message shall be sent to the terminal. The message shall include all parameters that are applicable to the particular DN, such as bearer capabilities and call types.

Please note that ODB TN and DPKT TN are not allowed to be the same as any secondary EKTS DN (attribute TN of View 23.21).

7.2.3.2.2 Originating DN Flag

The Originating DN flag indicates that this DN is the originating DN used for originating calls from a CACH EKTS terminal. There is no DN flag to be downloaded for a Basic EKTS terminal.

Originating DN is defined as one of the following:

- the primary DN of a terminal defined on View 23.2 (attribute CKT TN)
- the individual DN of a MLHG member (View 23.2, CKT TN), if assigned; otherwise, the group DN for the MLHG (View 3.5, LISTED TN).

The Originating DN flag must be downloaded for only the Originating DN (primary DN, individual DN, or group DN) of a terminal as defined previously.

It is not downloaded for a DN that is not designated as originating DN.

There is a maximum of one originating DN flag per terminal.

The Originating DN flag is a single valued Boolean (TRUE/FALSE) parameter and is optional.

The format of the Originating DN flag is:

<Boolean> FALSE: A value of "0" indicates that this is not the originating DN. A value of "0" is not downloaded.

TRUE: Any non-zero value indicates that this is the originating DN.

7.2.3.2.3 Bearer Capability List (bearerCapabilities)

A bearer capability list for each DN is downloaded to provide the terminal with an association between a DN and the BCs it supports. This association may be used to screen terminating calls offered to the terminal by the switch. The bearer capability list also allows the terminal to check that the bearer capability(ies) sent by the switch are supported by the terminal. If there is a mismatch between the terminal and the switch, the terminal notifies the switch at the end of the download.

The format of this attribute is:

<bearerCapabilities List>

The bearerCapabilities list contains all of the Bearer Capability (BC) values assigned to a DN of a terminal. The values are: speech, audio, cmd56, cmd64, pmdB and pmdD. Each BC appears only once in the list.

The following BCs are present in the bearerCapabilities List of the DN dependent message for the primary DN (CKT TN or MLHG LISTED TN) if CKT TN or MLHG and TERM of View 23.2 is assigned: if CSV = 1 or 2, speech and audio; if CSD = 1 or 2, cmd56 and cmd64; if both CSV and CSD = 1 and/or 2, speech, audio, cmd56 and cmd64.

The following BCs are present in the bearerCapabilities List if CKT TN or MLHG and TERM of View 23.2 is assigned: if CSV = 1 or 2, speech and audio; if CSD = 1 or 2, cmd56 and cmd64; if both CSV and CSD = 1 and/or 2, speech, audio, cmd56 and cmd64.

If ODB TN is assigned, pmdB is present in the bearerCapabilities List for the downloaded ODB TN DN dependent message.

If DPKT TN is assigned, pmdD is present in the bearerCapabilities List for the downloaded DPKT TN DN dependent message.

SR-NWT-001953 requires a terminal supporting X.25 on the D-channel to make a test call to itself as a part of the terminal initialization process. In order to do this, it needs to know its own X.25 DN. In the *5ESS* switch, the DN that may be used for this procedure is the DN sent with the pmdD BC.

When two or more of the following DNs are the same, CKT TN, ODB TN and DPKT TN, the BC list in the DN dependent message for this DN is the accumulation of the respective BCs.

For the case of an integrated terminal supporting VI, CMD, and PMD call types, and where CKT TN, ODB TN and DPKT TN are the same, the bearerCapabilities list would be speech,audio,cmd56,cmd64,pmdB,pmdD for CKT TN. The following BCs are downloaded for a secondary DN, that is, each TN or MLHG and TERM of View 23.21 except for those equal to the primary DN or hunt group and member (CKT TN or MLHG and TERM of 23.2): speech and audio.

7.2.3.2.4 Call Reference Busy Limit List (CallRefBsyLimCallTypeGrpList)

The call reference busy list is a multi-valued parameter that contains a list of call reference busy limits and the associated call type for a given DN.

The format of the values for this parameter is:

<CallRefBsyLim>
: This integer (1 to 16) specifies the total number of active call references the switch allows to exist concurrently for a given DN/CT.

<CallTypeGroup>
: The CallTypeGroup is one CallType that applies to the CallRefBsyLim. The allowable CallType values are VI and CMD.

The CallRefBsyLim for the VI call type is determined by the CSV LIMIT attribute on View 23.2; likewise, the CallRefBsyLim for the CMD call type is determined by the CSD LIMIT attribute on the same view.

The call reference busy limit is not applicable to the VI call type of CKT TN (or MLHG and TERM) on basic EKTS and CACH EKTS terminals.

7.2.3.2.5 Directory Number Appearance Identifier List (AppearanceInfo)

DN appearances are switch-based data used to configure the terminal through the ATS feature for non-CACH EKTS VI terminals, CMD terminals, PMD terminals, and terminals that share multiple call types. DN appearance data are provisioned by a memory administration OS from the customer's service order. A DN appearance consists of a button number and a BC. With this information, the terminal is automatically configured and the installer's task is simplified. Lacking this information, the installer or user must manually program the location of each DN appearance along with the DN and default bearer capability after a parameter download. The user can originate a call on a specific DN appearance, and the terminal has the DN and bearer capability stored and available for use in the outgoing SETUP message.

DN appearance assignment is based on the method of assigning call appearances for CACH EKTS, which uses a starting button number and a number of buttons in order to assign CAs sequentially. DN appearances are also numbered sequentially. The number of allowed DN appearances for a given VI and CMD call type's default bearer capability is limited to the call reference busy limit for the call type, CSV LIMIT or CSD LIMIT. One to four DN appearances are assignable to the PMD bearer capability for both DPKT TN and ODB TN. If a terminal has DPKT TN equal to ODB TN, the resulting DN is allowed one to four DN appearances. Twelve new parameters are defined: SP DNA and SP DNA QTY, AU DNA and AU DNA QTY, 56C DNA and 56C DNA QTY, 64C DNA and 64C DNA QTY, DPKT DNA and DPKT DNA QTY, and ODB DNA and ODB DNA QTY. Each VI DN on a basic EKTS terminal, primary and secondary(ies), may have one DN appearance for speech and one for audio.

The AppearanceInfo list is a multi-valued parameter that contains a list of call appearances (callAppearanceId) for a DN associated with the terminal. This parameter is created by this feature to map a DN to a physical button location on the terminal. The list also includes a default bearer capability (defaultBearerCapability) for each call appearance (callAppearanceId) that allows the terminal to internally provide the information required in the originating SETUP message. The format of the DN appearance ID (AppearanceInfo list) is:

<Integer(1..254)>
: This value is the terminal-controlled callAppearanceId (button number) for a particular DN on the terminal. This value is not used for call setup or for compatibility checks on terminating calls. The integer is the callAppearanceId for a particular DN of a non-CACH terminal.

<defaultBearerCapability>
: The defaultBearerCapability is one of the valid BearerCapability values assigned to the DN.

<CallAppearanceReservation>
: (Optional) The CallAppearanceReservation is one of the three defined reservation statuses (Revision 1 Data):

- TERM (0),––Terminations Only
- ORIG (1),––Originations Only
- PRIO (2),––Originations and Priority Incoming Terminations Only

For nonreserved status, there is no downloading of such data.

DN appearances for speech, audio, cmd56 and cmd64 are downloaded as follows: From RC View 23.2 (or 23.21 for VI secondary DNs), the starting callAppearanceId is determined from SP DNA, AU DNA, 56C DNA and 64C DNA respectively. The amount of consecutively numbered callAppearanceIds is determined from SP DNA QTY, AU DNA QTY, 56C DNA QTY and 64C DNA QTY respectively.

For example, if SP DNA = 3 and SP DNA QTY = 2, AU DNA = 8 and AU DNA QTY = 2, 56C DNA = 20 and 56C DNA QTY = 1, and 64C DNA = 21 and 64C DNA QTY = 3 for DNx, the AppearanceInfo list for DNx is: 3,speech;4,speech; 8,audio;9,audio; 20,cmd56; 21,cmd64;22,cmd64;23,cmd64.

DN appearances for packet mode data are downloaded as follows: From RC View 23.2, the starting callAppearanceId is determined from DPKT DNA and ODB DNA respectively. The amount of consecutively numbered callAppearanceIds is determined from DPKT DNA QTY and ODB DNA QTY respectively.

For example, if DPKT DNA = 31 and DPKT DNA QTY = 1, and ODB DNA = 36 and 64C DNA QTY = 3 for DNy, the AppearanceInfo list for DNy is: 31,PMD;36,PMD;37,PMD;38,PMD.

DNx and DNy of the previous examples may be the same DN. In this case, all DN appearances are sent in one DN-dependent message. It is also possible that CKT TN, DPKT TN and ODB TN are three different DNs or varying combinations of equal and non-equal DNs.

Each DN-dependent message sent to the terminal shall contain all appearances applicable to the DN. For the VI call type DNs on CACH EKTS terminals, no DN appearance IDs are assignable. Rather, call appearance information is downloaded as described in the next section.

7.2.3.2.6 Call Appearance Identifier List (callAppearanceIds)

This multi-valued attribute indicates assignments of call appearances to a DN with the VI call type that is part of a CACH EKTS group. The attribute values relate a particular DN call appearance to a call appearance identifier on the terminal. Call appearance IDs are downloaded to associate the DNs and call appearance values to buttons on the terminal.

The attribute values are a set of up to 16 values per DN of the following format:

<Integer(1..254)>

The integer is the callAppearanceId (button number) on the CACH EKTS terminal. (A range of 1 to 16383 is defined by Bellcore.)

<CallAppearanceReservation>

(Optional) The CallAppearanceReservation is one of the three defined reservation statuses (Revision 1 Data):

- TERM (0),––Terminations Only
- ORIG (1),––Originations Only
- PRIO (2),––Originations and Priority Incoming Terminations Only

For nonreserved status, there is no downloading of such data.

The *5ESS* switch assigns consecutively numbered call appearances to CACH EKTS service (View 23.2, EKTS = [C]ACH). On View 23.2, the starting button number for CKT TN is CA and the number of call appearance buttons is CA QTY. On View 23.21, the starting button number for TN is CA and the number of call appearance buttons is CA QTY.

Thus, a terminal with three CAs starting at button 9 for a CACH EKTS DN would receive data of the form: 9,10,11

The callAppearanceCallHandlingOption value in the DN-independent download message is a Boolean value that is set to true if (and only if) the EKTS parameter of View 23.2 is [C]ACH.

7.2.4 USER PERSPECTIVE

ATS is intended to minimize manual terminal programming at installation, which can create service problems because of mismatches between the data in the switch and terminal's user interface. The following discussion further describes the advantages of the ATS feature.

In order to receive ISDN service, the customer must negotiate with the network service provider. Part of that negotiation defines the DNs, originating DN, bearer capabilities, CA reservation information, CA locations, and feature button and lamp locations on the terminal needed to support the desired services. When the service order is completed, the service description data is installed in the switch through the memory administration OS/NE interface (text recent change).

Next, the customer or installer must perform the required local setup of the terminal. This includes programming the SPID, the DNs and bearer capabilities, and any other local setup required by the specific terminal manufacturer. Some terminals may have their button and lamp numbers fixed, and other terminals may allow the user to locally program the button and lamp numbers. An additional step may be to provide a faceplate template with all the buttons and lamps properly labeled. Finally, the terminal is connected to the BRI, whereupon it initializes and becomes available for use. The possibility for human error exists throughout the process. Steps that are likely to be error-prone include the programming of all the parameters into the terminal and the labeling of buttons and lamps.

ATS helps minimize the likelyhood of error by ensuring the data installed in the switch is the basis for the data sent to the terminal when is it downloaded. Terminals that do not automatically label their buttons and lamps after a download could have a local inspect mode to help the user verify that the downloaded information matches the faceplate labels.

Since ATS is primarily a CPE installation tool, the service provider perspective is presented first. This is followed by the end-user perspective, dealing primarily with the user's view of a service order update that causes a new download of the CPE.

7.2.5 ATS FEATURE OPERATION

Capabilities to provide ATS in the *5ESS* switch are contained in this section. The two main functions defined here are processing a download request and notifying a terminal that the processing of a service order may have affected downloadable parameters, and made a download necessary. High level message requirements are also specified.

ATS is important to minimize the amount of data that must be manually entered into an ISDN terminal and to help avoid service problems caused by data mismatch between the switch and the CPE. As a result, support of ATS in the *5ESS* switch is mandatory. Since it is not required to bill for use of this feature, ATS is available to all National ISDN BRIs and is not an assignable feature.

Support of ATS on Custom BRIs with DSL CLS of PP and MP is not required. When a terminal connected to a PP or MP interface requests a download through the REGister message, the switch will provide standard treatment for an unrecognized message and log a protocol error in the PER buffer. The ATS feature requires no additional error handling functionality beyond that provided by previous software releases.

7.2.5.1 ATS - General Requirements

The terminal or user is in the best position to determine the appropriate time to request parameter downloading to occur. As a result: Parameter downloading shall be initiated by only a request from the terminal to be downloaded. This means that Terminal 3 can not request a download for Terminal 2. For clarification, a terminal is in control of the process, but is informed by the switch to begin the process in the case of a service order update.

To simplify processing from both the terminal and switch perspective, only two types of download requests shall be supported.

- Parameter Downloading Type 1
- Parameter Downloading Type 2

Either of these two requests will result in the switch sending the parameters identified in "ASN.1 Module," Section 7.2.6.2.7, for which values exist for the terminal making the request.

7.2.5.2 ATS - Download Request

A request to download parameters originates from the terminal. This process of requesting a download has three required parts. The first part establishes a call reference, so that subsequent communication between the switch and the terminal can be associated with the download request. The second part indicates that a parameter download is the desired action. Failure to successfully provide either of these parts to the switch will result in standard error procedures being invoked by the switch, based on existing error handling procedures, most of which are consistent with TR-TSY-000268. If the second part is not successfully provided, a standard error associated with the ATS application protocol is invoked (see "REGister," Section 4.1.2.18).

The third part of the download request identifies the specific set of parameters to be downloaded. The identification, unique to the terminal, is the Service Profile Identifier (SPID) that must be entered into an initializing terminal before initialization can occur.

A download is requested when the switch receives a properly encoded REGister message as defined in "REGister," Section 4.1.2.18. The REGister message shall contain a ROIV-spvb-Action-confirmed PDU as defined in "ASN.1 Module," Section 7.2.6.2.7. On receipt of a download request, the switch shall clear an outstanding notification indication for the terminal when it is determined that a download can proceed.

A terminal built for Parameter Downloading Type 2 supports downloading Type 1 or Type 2. If the downloading Type 2 request is made, but the switch rejects it because of unusable Application Protocol Data Unit (APDU) or no such object instance, the terminal requests the download immediately again. Upon a second rejection, it is recommended that the terminal sends a downloading Type 1 request.

The following sections identify requirements for processing rules and handling error conditions related to download requests.

7.2.5.2.1 Processing Rules Related to Conditions Existing at the Switch

There are several conditions at the switch that may warrant rejecting a download request. Each condition is described in the following paragraphs. If the terminal sends between four and six download requests in a 10-minute interval, the switch shall indicate to the terminal that too many download requests have been received and release the call reference by sending a RELease COMplete message with Cause 31, "normal, unspecified." The RELease COMplete message shall contain the extended facility IE with the proper encoded PDU (ROER-processingFailure: tooFrequentRequests). This error condition shall be logged in the PER buffer.

A request beyond the allowed 3 requests in 10 minutes from a terminal is counted as a download request against that terminal, as is any other request that results in a download session.

7.2.5.2.2 Incomplete or Inconsistent Data from the Terminal

This section deals with several other conditions that cause the switch to reject the download request. The first problem that can occur with a request from a terminal is that the terminal has not yet initialized. This means there is no way for the switch to identify the data to be sent to the terminal. As a result, such requests are rejected as identified in the following paragraphs.

If a download request is received from a terminal that has not initialized, the switch shall reject the request. The response to the terminal shall indicate the terminal must be initialized before downloading can be requested, and the call reference associated with the request shall be released by sending a RELease COMplete message with Cause 31, "normal, unspecified." The RELease COMplete message shall contain the extended facility IE with the properly encoded PDU (ROER-processingFailure: terminalNotInitialized). This error condition shall be logged in the PER buffer.

If a REGister message is received from a terminal that has not initialized, the switch shall reject the request. The response to the terminal shall be a RELease COMplete message with Cause 21, "call rejected." This error condition shall be logged in the PER buffer. This procedure may be implemented outside the context of a call state machine, and no EFIE is included in the RELease COMplete.

The initialization procedure referred to previously is the procedure whereby the terminal is linked to its provisioned service profile.

Other errors that can occur are related to the SPID sent as part of the download request. There are two cases for an invalid SPID. The first is that the SPID does not exist on the interface. The second is that the SPID received in the REGister message is not consistent with the SPID used in initializing the terminal. The processing rules related to the SPID and SPID errors are given in the following paragraphs.

The switch shall accept a parameter download request only if it contains the proper SPID. It shall reject a parameter download request if the SPID received in the ROIV-spvb-Action-Confirmed PDU (part of the REGister message) does not exist on the interface, and shall provide the terminal with an error indication identifying that it is nonexistent. The call reference associated with the request shall be released by sending a RELease COMplete message with Cause 31, "normal, unspecified." The RELease COMplete message shall contain the extended facility IE with the properly encoded PDU (ROER-noSuchObjectInstance). This error condition shall be logged in the PER buffer based on the TEI.

The switch shall likewise reject a parameter download request if the SPID received in the ROIV-spvb-Action-Confirmed PDU (part of the REGister message) is not consistent with the Layer 3 initialization SPID for the terminal that sent the request, and shall provide the terminal with the error indication: access denied. The call reference associated with the request shall be released by sending a RELease COMplete message with Cause 31, "normal, unspecified." The RELease COMplete message shall contain the extended facility IE with the properly encoded PDU (ROER-accessDenied). This error condition shall be logged in the PER buffer based on the TEI.

7.2.5.2.3 Relationship of Download Requests to Call Processing

Since ATS can be used to reconfigure the terminal while the terminal is available for call handling, processing calls at the terminal during a download can be disruptive and confusing to the user. Nevertheless, the terminal is in the best position to control the interworking of its processing associated with downloading as it processes calls.

Downloading of parameters shall operate independently of call processing. The switch shall process a download request received while calls are in progress to the terminal that made the request or to any other terminal on the interface, and shall offer calls to a terminal or interface and accept calls from a terminal or interface for which one or more downloading sessions are currently in progress.

7.2.5.3 Sending of Parameters

Once a complete and valid download request has been received by the switch, the process of gathering the appropriate data and sending it to the terminal can begin. This process is intended to be essentially a dump of all the data existing for the terminal (see "ASN.1 Module," Section 7.2.6.2.7) without any response from the terminal until the transmission of data is complete. As a result, any messages related to the download received from the terminal during the gathering or transmission of data shall be ignored, consistent with procedures in "Errors During an Active Signaling Connection," Section 7.1.2.4.2, unless the message causes the call reference to be released. In that case, the process in the switch shall terminate. In order for the terminal to complete its processing and send the type of response identified in "Response from the Terminal," Section 7.2.5.3.3, the switch must clearly indicate the end of the transmission of data. General requirements for this process are listed in the following paragraphs, with additional details on data ordering and performance given in the following subsections.

The switch shall use a series of individually unconfirmed FACility messages for transmitting the data to the terminal. The FACility messages shall contain an extended facility IE with a properly encoded PDU, ROIV-spvb-dn-independent-Linked-Reply or ROIV-spvb-dn-dependent-Linked-Reply.

If the length of a FACility message exceeds 244 octets, the segmentation procedures of "BRI Message Segmentation," Section 4.1.4, are used. The *5ESS* switch implementation of interprocessor messaging limits the number of Layer 3 message octets in an information frame to 244 instead of the ITU-TS default limit of 256 (Layer 2 I-frame length of 260), which is also the value defined in TR-TSY-000793.

The switch shall provide a clear indication of the end of data sent to the terminal. The indication is a Return Result component sent in a FACility message. The FACility message shall contain an extended facility IE with a properly encoded PDU, RORS-spvb-Action-Confirmed.

7.2.5.3.1 Data to be Downloaded

The data to be downloaded is whatever data exists for the requesting terminal as described in "ASN.1 Module," Section 7.2.6.2.7. The formal ASN.1 description of the data is found in "Automatic Terminal Setup - ATS," Section 7.2.

The *5ESS* switch supports downloading of all the data described in "ASN.1 Module," Section 7.2.6.2.7, which applies to the terminal making the download request. Inclusion of parameters designated "OPTIONAL" in the ASN.1 description are specified in specific requirements in "ASN.1 Module," Section 7.2.6.2.7. The service descriptions are also required to be downloaded. The parameters and data structures used by the ATS feature are defined in ASN.1 notation in "Automatic Terminal Setup - ATS," Section 7.2.

The previous paragraph describes the success case for downloading. It is acknowledged that there are download failure conditions where the terminal may receive incomplete data or none at all.

The parameters included in a component/PDU (the argument with an Invoke, the result with a Return Result, or the parameters with a Return Error) are included in the definition of an operation.

Parameters may be specified as optional or default, and as any of the following:

- a sequence of parameters
- a set of parameters
- a specific parameter with its own tag
- nothing at all (absent)

The specification and encoding of parameters in ASN.1 syntax follows the guidelines in ITU-T Recommendations X.208 and X.209.

7.2.5.3.2 Grouping of Data

The data sent to the terminal shall be sent in a logical order to aid in the processing of data at the terminal and to reduce the amount of overhead required to transmit the data.

The parameters downloaded to the terminal shall be grouped into DN-independent data and DN-dependent data. The DN-independent data is defined in the ROIV-spvb-dn-independent-Linked-Reply of "Automatic Terminal Setup - ATS," Section 7.2. The DN-dependent data is defined in the ROIV-spvb-dn-dependent-Linked-Reply of "Automatic Terminal Setup - ATS," Section 7.2. The DN-independent data is sent first followed by the DN-dependent data.

Each group of data is sent in a unique FACility message (see "FACility," Section 4.1.2.7) or a set of SEGment messages (see "SEGment," Section 4.1.2.24).

One DN-dependent message is sent for each hunt group member using LISTED TN (see "DN Dependent Parameters," Section 7.2.3.2) for the case where there is no individual DN assigned to the member.

In order that processing of the download result by the terminal is definitive, the following rule is required:

All of the DN-independent data (per-terminal data) shall be sent in a single FACility message using the ROIV-spvb-dn-independent-Linked-Reply. If there is no DN-independent data to send, that message is not sent.

The data for each DN or hunt group member shall be sent in a single FACility message using the ROIV-spvb-dn-dependent-Linked-Reply. If there is no DN-dependent data to send, that message is not sent, and the switch immediately sends the RORS-spvb-Action-Confirmed (end-of-data) message.

It is recommended (but not required) that secondary DNs are sent in the order they appear on View 23.21.

7.2.5.3.3 Response from the Terminal

In order to aid the network service provider in handling any customer problems related to downloading of parameters, it is necessary to have some indication from the terminal as to the success or failure of the download of the parameters. This is accomplished by logging information about unsuccessful downloads and any error conditions associated with the response, or lack thereof, from the terminal. If the terminal does not respond with the results of the download within 5 seconds, the switch aborts the download session.

7.2.5.3.4 Acknowledgement of a Successful Download

After sending the "end of data" message (RORS-spvb-Action-Confirmed), the switch times for PDL-T1 seconds. In the successful case, the switch receives from the terminal a RELease COMplete that contains a ROIV-spvb-Event-Report indicating success, see "Automatic Terminal Setup - ATS," Section 7.2, for the ASN.1 coding.

When the switch receives an acknowledgement from the terminal indicating success (ROIV-spvb-downloadSuccessful-EventReport within an extended facility IE in a RELease COMplete message), the switch shall terminate the download process and release the call reference.

7.2.5.3.5 Report of Inconsistent Data

Inconsistent data detected by the terminal are reported to the switch in the RELease COMplete (ROIV-spvb-downloadError-EventReport) message. The inconsistencies the terminal can report are:

1. Call appearances are not supported.
2. Intercom groups are not supported.
3. FA/FI value is out of range.
4. Call appearance ID out of range.
5. DN appearance ID out of range.
6. Too many DNs received.
7. BC is not supported.

7.2.5.3.6 Failure of a Terminal to Respond and Errored Terminal Response

After the switch indicates to the terminal that all the data has been sent, the switch expects a report from the terminal indicating success or failure of the process. If the success or failure report is not received within a reasonable time, the switch clears the call reference and frees resources for other purposes. Timer PDL-T1 is started when the final message in the sequence is issued by the ATS application and stopped on receipt of the response from the terminal by the ATS application. If timer PDL-T1 expires, the switch assumes the download was successful, clears the call reference, and sends a RELease COMplete message to the terminal.

The switch starts timer PDL-T1 when the end-of-data indication, RORS-spvb-Action-Confirmed, is issued by the ATS application, and stops timer PDL-T1 when the ROIV-spvb-EventReport (either ROIV-spvb-downloadSuccessful-EventReport or ROIV-spvb-downloadError-EventReport received in a RELease COMplete message) is received by the ATS application. Timer PDL-T1 has a fixed interval of 5 seconds.

The switch shall also stop timer PDL-T1 on receipt of a RELease COMplete message without a PDU.

If timer PDL-T1 expires, the switch shall make an entry in the PER buffer that indicates a failure to report the results of the download process clear the call reference, send a RELease COMplete message with Cause 31, "normal, unspecified," and an extended facility IE with the PDU ROIV-spvb-timerExpiry-EventReport to the terminal.

If an invalid or unrecognizable PDU is received by the switch as an acknowledgement to a parameter download, the switch shall ignore the contents of the extended facility IE, release the call reference value, log a PER.

7.2.5.4 Notification of Service Profile Change

Occasionally an ISDN customer will request a change to the service profile through the service order process or by some other means. Some of these changes need to be reflected in the terminal. The switch must inform the downloadable terminals that a download is required in order to synchronize the switch and terminal databases.

Although every terminal may not be a downloadable terminal, users of non-downloadable terminals may be able to benefit from this type of notification being sent to their terminals by displaying some message to the user locally. Therefore, all National ISDN terminals for which service profile changes have occurred that may have affected downloadable parameters shall be notified. The switch sends the message only once to the terminal. It is then up to the terminal to provide the necessary indication to the user.

The switch has to be certain that the terminal is capable of receiving the notification. If the terminal is not available to receive the message, the switch has to wait until such time when the notification can be sent.

After an RC view has been committed, the *5ESS* switch distinguished whether any downloadable parameters defined in "ASN.1 Module," Section 7.2.6.2.7, have been changed. If so, a notification indication is set in the SM for each terminal on a standard BRI (View 23.2, DSL CLS = STD) that must be notified.

Notification indication may be keyed to data base tuple changes, not on tuple attribute changes.

The switch is required to set a notification indication for the affected terminal(s) for changes to any data defined in "ASN.1 Module," Section 7.2.6.2.7, including:

- a single terminal on View 23.2 and 23.8,
- a single terminal because of a DN or call appearance change related to EKTS service on View 23.21,

- a terminal because of an ICOM group or related call appearance change on View 23.23 or because of removal of an ICOM group on View 23.21,
- multiple terminals because of a DN or call appearance change related to EKTS service on View 23.20,
- MLHG downloadable changes from View 3.5,
- multiple terminals because of a feature button/lamp map change on View 12.5, and
- a single terminal re-assigned to a different feature button/lamp map, CONFIG GRP of View 23.2.

For the last bullet item, it is required to send a notification even if the new configuration group is identical to the old configuration group.

Multiple recent change transactions and data base updates preceding sending a notification to the terminal shall result in one and only one notification indication per terminal.

Data base changes for the following reasons do not require terminal notification: service description change, office code change and area code change. Service description changes are specifically excluded by TR-NWT-001281. Discussions with Customer Technical Support (CTS) indicate no known office code changes have been done in the field, and area code changes are not a consideration because the downloaded DN is 7 digits, not 10.

The notification indication list must be saved over all initialization levels except a full initialization with or without pump.

The switch selects a terminal from the notification indication list every 15 seconds and sends a NOTIFY message as defined in "NOTIFY," Section 4.1.2.16, on a point-to-point basis. When the notification is sent, the notification indication is cleared so that the terminal is sent one and only one notification. If the terminal has one or more downloads counted against it in the current 10-minute interval, the count is decremented by one. If there are no terminals to notify, the switch revisits the list 15 seconds later.

The NOTIFY message is sent independent of the Q.931 call state(s) of the terminal.

When the service order is entered before the terminal is installed, the switch retains the notification indication until the terminal establishes Layers 2 and 3, and then notifies the terminal accordingly unless the terminal requests a download before the switch sends the notification.

The switch will not send a notification in the following conditions:

- The switch has placed the interface in a state such that the notification cannot be sent (D-channel OOS or interface OOS).
- Layer 2 is not in the multi-frame-established state.
- Layer 2 is in the multi-frame-established state, but Layer 3 initialization has not occurred.
- A remove campon is in progress for an applicable resource (such as a D-channel or a line card) serving the terminal.

7.2.6 DATA MODEL

7.2.6.1 Data Model Overview

The protocol for ATS requires a formal model of the data communicated from the switch to the terminal. The information model is defined in terms of managed objects that represent abstractions of physical or logical entities. In the case of ATS, the entities are related to ISDN service characteristics. This section provides a high-level overview of this model. The detailed model is specified in accordance with the Guidelines for the Definition of Managed Objects (GDMO), ITU-T Recommendation X.722.

The model consists of seven object classes that contain all the data needed to be downloaded.

The Service Profile Verification-Basic Rate object class is a support object class for which one object instance exists for each terminal that has initialized (that is, for each SPID). This managed object class is the target of the Parameter Downloading Type 1 request and has an associated action that performs the process of gathering the appropriate data and sending it to the terminal. The data, in an instance of this class, consists of pointers to all the object instances that contain data for the terminal to which the Service Profile Verification-Basic Rate instance is associated.

The Service Profile Verification-Basic Rate 2 BCR object class is a support object class for which one object instance exists for each terminal that has initialized (that is, for each SPID). This managed object class is the target of the Parameter Downloading Type 2 request and has an associated action that performs the process of gathering the appropriate data and sending it to the terminal. The data, in an instance of this class, consists of the same data as in the Service Profile Verification-Basic Rate object class. This class is a subclass of the Parameter Downloading Type 1 support object and as such supports both Type 1 and Type 2 requests. It is also possible to receive requests from terminals supporting only Type 1; these use the object ID defined for the superclass as the managed object class.

The Network Element (NE) class defines those characteristics that do not vary by customer, terminal, and so on; that is, there is only one value of a parameter that applies to the entire switch. As a result, only one instance of the class exists. The data defined in this class are service descriptions for feature activators and indicators.

The Terminal Service Profile (TSP) object class includes data applicable to one or more terminals on a single BRI that share common terminal-related services, in this case, DN appearance IDs. (For the *5ESS* switch, the concept of TSP does not exist in the Bellcore sense. The *5ESS* switch User Service Order Profile (USOP) equates roughly to a TSP that applies to only one terminal.)

The EKTS object class includes data for EKTS CAs and intercom groups, originating DN information, and an indication of whether the terminal is going to use CACH procedures. Instances of this class exist for only CACH EKTS terminals.

The Terminal Configuration object class defines the mapping of feature button and feature lamp values to services. The activator and indicator per stop hunt and stop hunt make busy are shown separately for completeness; however, they are downloaded in the same manner as the other activators and indicators for all DNs. One instance exists for each different configuration required, but many TSPs may share (point to) a particular terminal configuration instance. (In the *5ESS* switch provisioning scheme, each USOP points to a configuration group defined on RC/V View 12.5 for comparison.)

The Subscriber Directory Number object class defines service characteristics related to a particular DN. The parameters that exist for this class include the DN, the Bearer Capabilities, the CA Reservation, and the Call Reference Busy Limit for each call type. There may be several subscriber DN instances associated with a TSP (USOP) and a particular instance may be associated with more than one TSP (USOP).

7.2.6.2 Model Details

7.2.6.2.1 Managed Object Class Definitions

7.2.6.2.1.1 Electronic Key Telephone Service BCR R1

```
electronicKeyTelephoneServiceBCRr1     MANAGED OBJECT CLASS
      DERIVED FROM "Recommendation X.721: 1992":top;
      CHARACTERIZED BY
            electronicKeyTelephoneServiceBCRr1Package     PACKAGE
                   BEHAVIOUR
               electronicKeyTelephoneServiceBCRr1Behaviour
                BEHAVIOUR
               DEFINED AS
              "This managed object contains the attributes
              that define the Electronic Key Telephone Service
              characteristics applicable for the TSP."
            ;;
            ATTRIBUTES
               callAppearanceCallHandlingOption GET,
               callAppearances          GET,
               elecKeyTelephoneSvcId     GET,
               intercomGroups          GET,
               originatingDN          GET
            ;;;
REGISTERED AS {spvbObject 10};
```

7.2.6.2.1.2 Network Element

```
networkElement  MANAGED OBJECT CLASS
      DERIVED FROM "Recommendation X.721: 1992":top;
      CHARACTERIZED BY networkElementPackage PACKAGE
               BEHAVIOUR
               networkElementBehaviour BEHAVIOUR
               DEFINED AS
               "This managed object contains the attributes
               that define the service descriptions for all of
               the services that make use of feature activators
               and indicators."
            ;;
          ATTRIBUTES
             "Recommendation X.721":systemId     GET,
             "Recommendation X.721":systemTitle     GET,
             featureActivatorsMasterList          GET,
             featureIndicatorsMasterList          GET
          ;;;
REGISTERED AS {spvbObject 2};
```

7.2.6.2.1.3 Service Profile Verification-Basic Rate

```
serviceProfileVerificationBasicRate     MANAGED OBJECT CLASS
      DERIVED FROM     "Recommendation X.721: 1992":top;
      CHARACTERIZED BY
            serviceProfileVerificationBasicRatePackage    PACKAGE
            BEHAVIOUR
               serviceProfileVerificationBasicRateBehavior
                  BEHAVIOUR
               DEFINED AS
            "This managed object contains attributes that point
                   to the object instances that contain all of the
            parameters to be downloaded for the terminal having
            a particular Service Profile Id.  This object class
            supports the Action that enables downloading of
            terminal characteristics to ISDN terminals upon a
            request from the terminal."
            ;;
            ATTRIBUTES
      lastRequestDateAndTime          GET,
      profileUpdateNotifHeld          GET,
      spvbDirectoryNbrList          GET,
      spvbEktsData          GET,
```

```
      spvbTermSvcProfile          GET,
      spvbSvcProfileId          GET,
      spvbTerminalConfig          GET
              ;
               ACTIONS     spvbTerminalOption;
               NOTIFICATIONS     timerExpiry;;;
         CONDITIONAL PACKAGES
             errorReportPkg PACKAGE
                   NOTIFICATIONS
            unusableAPDUs;
         REGISTERED AS {spvbPackage 1};
 PRESENT IF "protocol profile 2 is selected";

   REGISTERED AS {spvbObject 1};
```

7.2.6.2.1.4 Subscriber Directory Number BCR R1

```
subscriberDirectoryNumberBCRr1             MANAGED OBJECT CLASS
     DERIVED FROM     "Recommendation X.721: 1992":top;
     CHARACTERIZED BY
           subscriberDirectoryNumberBCRr1Package   PACKAGE
              BEHAVIOUR
                    subscriberDirectoryNumberBCRr1Behaviour BEHAVIOUR
                 DEFINED AS
                 "This managed object contains the attributes
                 applicable to each subscriber directory number
                 independent of Call Type or Terminal."
              ;;
              ATTRIBUTES
                 bearerCapabilityList               GET,
                 callAppearanceReservation          GET,
                        callRefBsyLimCallTypeGrpList          GET,
                 directoryNumber               GET
              ;;;
REGISTERED AS {spvbObject 9};
```

7.2.6.2.1.5 Terminal Configuration

```
terminalConfiguration     MANAGED OBJECT CLASS
      DERIVED FROM     "Recommendation X.721: 1992":top;
      CHARACTERIZED BY
               terminalConfigurationPackage  PACKAGE
            BEHAVIOUR
               terminalConfigurationBehaviour BEHAVIOUR
               DEFINED AS
               "This managed object contains the attributes
               that define terminal key configurations to be
                      used by one or more Terminal Service profiles."
                   ;;
                  ATTRIBUTES
               featActsAndIndsAllDN               GET,
               featActsAndIndsPerDN               GET,
               featActsAndIndsPerHuntMakeBusy     GET,
               featActsAndIndsPerStopHunt          GET,
               featureActivatorsAllDN          GET,
               featureActivatorsPerDN          GET,
               featureActsPerHuntMakeBusy          GET,
               featureActsPerStopHunt          GET,
               featureIndicatorsAllDN          GET,
               featureIndicatorsPerDN          GET,
               featureIndsPerHuntMakeBusy          GET,
               featureIndsPerStopHunt          GET,
               terminalConfigNbr               GET
            ;;;
REGISTERED AS {spvbObject 5};
```

7.2.6.2.1.6 Terminal Service Profile

```
terminalServiceProfile     MANAGED OBJECT CLASS
      DERIVED FROM     "Recommendation X.721: 1992":top;
      CHARACTERIZED BY
            terminalServiceProfilePackage PACKAGE
               BEHAVIOUR
               terminalServiceProfileBehaviour BEHAVIOUR
               DEFINED AS
               "This managed object contains the attributes
               that define the service characteristics
               applicable to a particular Terminal Service
               Profile. "
```

```
            ;;
            ATTRIBUTES
               directoryNbrAppearanceIds     GET,
               directoryNbrReferenceList     GET,
               officeEquipNbr          GET,
               termSvcProfileId          GET
               ;;;
REGISTERED AS {spvbObject 6};
```

7.2.6.2.1.7 Terminal

```
terminal   MANAGED OBJECT CLASS
      DERIVED FROM     "Recommendation X.721: 1992":top;
      CHARACTERIZED BY
            terminalPackage   PACKAGE
            BEHAVIOUR
               terminalBehaviour Behaviour BEHAVIOUR
                  DEFINED AS
               "This managed object is the sole managed object
               defined to exist in the terminal. It is named
               by the SPID of the terminal and contains
               notifications used to report download results
               and error conditions."
            ;;
            ATTRIBUTES
               svcProfileId               GET
            ;
            NOTIFICATIONS
               downloadSuccessful,
               downloadError,
               timerExpiry,
               unusableAPDU;;;
REGISTERED AS {spvbObject 7};
```

7.2.6.2.1.8 Service Profile Verification-Basic Rate 2 BCR

```
serviceProfileVerificationBasicRate2BCR     MANAGED OBJECT CLASS
      DERIVED FROM     serviceProfileVerificationBasicRate;
      CHARACTERIZED BY
            serviceProfileVerificationBasicRate2BCRPackage
         PACKAGE
               BEHAVIOUR
               serviceProfileVerificationBasicRate2BCRBehavior
               BEHAVIOUR
               DEFINED AS
            "This object class supports the Actions that enable
            downloading of characteristics to ISDN terminals upon
            a request from the terminal for downloading Type 1
            or 2. The spvbTerminalOption2 is a Type 2 request."
                ;;
            ACTIONS     spvbTerminalOption2;

   REGISTERED AS {spvbObject 8};
```

7.2.6.2.2 Attributes

```
bearerCapabilityList     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX     ASN1SpvbModule.BearerCapabilities;
      MATCHES FOR          EQUALITY;
      BEHAVIOUR
                bearerCapabilityListBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute of the Subscriber Directory Number object class
      identifies the bearer capabilities supported on each interface
      (office equipment number) on which the DN appears.  The set of
      bearer capabilities downloaded is determined based on the
      officeEquipNbr in the Terminal Service Profile object instance
      retrieved and other information retrieved that defines whether the
      packet mode data is applicable to the B or D channel.";;
REGISTERED AS {spvbAttribute 2};

-- callAppearances     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX     ASN1SpvbModule.CallAppearances;
--    BEHAVIOUR
--                callAppearancesBehaviour     BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Electronic Key
--    Telephone Service object class and identifies the assignments of
--    call appearances for each DN (for the VI call type) for Terminal
```

```
--    Service Profiles that are associated with call appearance call
--    handling EKTS terminals.  The first integer identifies a call
--    appearance number, the second identifies the call appearance
--    identifier used in signaling, and the third value is the DN to
--    which this call appearance information applies.";;
-- REGISTERED AS {spvbAttribute 3};

callAppearanceCallHandlingOption    ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.CallAppearanceCallHandlingOption;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
         callAppearanceCallHandlingOptionBehaviour     BEHAVIOUR
                    DEFINED AS
      "This attribute of the Electronic Key Telephone Service object
      class identifies whether Call Appearance Identifiers are used in
      communications between the switch and the terminal.  A value of
      true means they are used, a value of false means that they are
      not.";;
REGISTERED AS {spvbAttribute 34};

callRefBsyLimCallTypeList     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.CallRefBsyLimCallTypeList;
      BEHAVIOUR
               callRefBsyLimCallTypeListBehaviour    BEHAVIOUR
                    DEFINED AS
      "This attribute is a multi-valued attribute of the Subscriber
      Directory Number object class. This attribute specifies the total
      number of call references that the switch will allow to be active
      concurrently for a given call type for this DN.";;
REGISTERED AS {spvbAttribute 4};

directoryNbrAppearanceIds     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.DirectoryNbrAppearanceIds;
      BEHAVIOUR
               directoryNbrAppearanceIdsBehaviour    BEHAVIOUR
                    DEFINED AS
      "This attribute is a multi-valued attribute of the Terminal
      Service Profile object class.  This attribute identifies the
      terminal controlled call appearance identifier information for
      each DN associated with the Terminal Service Profile.  These call
      appearance identifiers are not used for call setup or for
      compatibility checks for incoming calls.  This information is
      simply used for associating a DN with a particular key on a
      terminal.  This attribute also identifies the default bearer
      capability associated with each terminal controlled call
      appearance.  This BC information can be used in originating calls,
      if not overridden by the user.";;
REGISTERED AS {spvbAttribute 5};

-- directoryNbrReferenceList  ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.DirectoryNbrReferenceList;
--    BEHAVIOUR
--                directoryNbrReferenceListBehaviour  BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Service Profile object class.  The function of this attribute is
--    featureActivatorsPerDN attributes of the Terminal Configuration
--    object class instance associated with this TSP.  This attribute
--    enables the determination of which DN/CT combinations the FAs and
--    FIs apply to.";;
-- REGISTERED AS {spvbAttribute 6};

directoryNumber     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.DirectoryNumber;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
               directoryNumberBehaviour  BEHAVIOUR
                    DEFINED AS
      "This attribute of the Subscriber Directory Number object class
      uniquely identifies an instance of that object class.  It
      identifies the 7 character local directory number of a
      subscriber.";;
REGISTERED AS {spvbAttribute 7};

-- elecKeyTelephoneSvcId      ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.ElecKeyTelephoneSvcId;
--    MATCHES FOR           EQUALITY;
```

```
--    BEHAVIOUR
--              elecKeyTelephoneSvcIdBehaviour      BEHAVIOUR
--                   DEFINED AS
--    "This attribute of the Electronic Key Telephone Service object
--    class uniquely identifies an instance of that object class.";;
-- REGISTERED AS {spvbAttribute 8};

-- featActsAndIndsAllDN     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX     ASN1SpvbModule.FeatActsAndIndsAllDN;
--    BEHAVIOUR
--              featActsAndIndsAllDNBehaviour     BEHAVIOUR
--                   DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    DN.  The pairs of values in this list identify the feature
--    value is the value sent across the interface to support feature
--    activations and indications.  The keyword identifies the service
--    that the activation or indication applies to and is used as a key
--    attributes of the Network Element object class.";;
-- REGISTERED AS {spvbAttribute 9};

-- featActsAndIndsPerDN     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatActsAndIndsPerDN;
--    BEHAVIOUR
--              featActsAndIndsPerDNBehaviour     BEHAVIOUR
--                   DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Configuration object class.  This attribute contains a list of all
--    of the FA-FIs that are valid for the terminal (TSP) for each DN/CT
--    combination. The values in this list identify the directory number
--    reference,  the feature identifier value, and the feature keyword.
--    The directory number reference is used to determine the actual
--    DN/CT combination that a particular FA-FI value is applicable to
--    based on the directoryNbrReferenceList in the Terminal Service
--    Profile object class.  The feature identifier value is the value
--    sent across the interface to support feature activations and
--    indications.  The keyword identifies the service that the
--    activation or indication applies to and is used as a key to pick up
--    the service identifier information from the master list attributes
--    of the Network Element object class.";;
-- REGISTERED AS {spvbAttribute 10};

-- featActsAndIndsPerHuntMakeBusy     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX     ASN1SpvbModule.FeatActsAndIndsPerHuntMakeBusy;
--    BEHAVIOUR
--              featActsAndIndsPerHuntMakeBusyBehaviour     BEHAVIOUR
--                   DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Configuration object class.  This attribute contains a list of all
--    of the FA-FIs that are valid for the terminal (TSP) for make busy
--    application sets.  The values in this list identify the feature
--    identifier value, the feature keyword, and the make busy
--    application set.  The feature identifier value is the value sent
--    across the interface to support feature activations and
--    indications.  The keyword identifies the service that the
--    activation or indication applies to and is used as a key to pick up
--    the service identifier information from the master list attributes
--    of the Network Element object class.  The make busy application set
--    provides information related to the multi-line hunt group service,
--    but this data is not downloaded.";;
-- REGISTERED AS {spvbAttribute 11};

-- featActsAndIndsPerStopHunt ATTRIBUTE
--   WITH ATTRIBUTE SYNTAX    ASN1SpvbModule.FeatActsAndIndsPerStopHunt;
--   BEHAVIOUR
--              featActsAndIndsPerStopHuntBehaviour  BEHAVIOUR
--                   DEFINED AS
--   "This attribute is a multi-valued attribute of the Terminal
--   Configuration object class.  This attribute contains a list of all
--   of the FA-FIs that are valid for the terminal (TSP) for stop hunt
--   application sets.  The values in this list identify the feature
--   identifier value, the feature keyword, and the stop hunt
--   application set.  The feature identifier value is the value sent
--   across the interface to support feature activations and
--   indications.  The keyword identifies the service that the
--   activation or indication applies to and is used as a key to pick
--   up the service identifier information from the master list
--   attributes of the Network Element object class.  The stop hunt
```

```
--   application set provides information related to the multi-line
--   hunt group service, but this data is not downloaded.";;
-- REGISTERED AS {spvbAttribute 12};

-- featureActivatorsMasterList      ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureActivatorsMasterList;
--    BEHAVIOUR
--             featureActivatorsMasterListBehaviour     BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Network Element
--    object class.  This attribute contains a list of all of the FAs
--    that are defined in the switch.  The pairs of values in this list
--    identify the service identifier and the feature keyword.  The
--    service identifier is readable text downloaded to the terminal to
--    assist the user in identifying the service associated with each
--    activator.  The keyword identifies the service that the service
--    description applies to and is used as a key to associate the
--    service identifier information with a feature identifier value.";;
-- REGISTERED AS {spvbAttribute 13};

-- featureActivatorsAllDN     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX     ASN1SpvbModule.FeatureActivatorsAllDN;
--    BEHAVIOUR
--                featureActivatorsAllDNBehaviour     BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Configuration object class.  This attribute contains a list of all
--    of the FAs that are valid for the terminal (TSP) independent of
--    the DN.  The pairs of values in this list identify the feature
--    identifier value  and the feature keyword.  The feature identifier
--    value is the value sent across the interface to support feature
--    activations.  The keyword identifies the service that the
--    activation applies to and is used as a key to pick up the service
--    identifier information from the master list attribute of the
--    Network Element object class.";;
-- REGISTERED AS {spvbAttribute 14};

-- featureActivatorsPerDN     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureActivatorsPerDN;
--    BEHAVIOUR
--                featureActivatorsPerDNBehaviour     BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Configuration object class.  This attribute contains a list of all
--    of the FAs that are valid for the terminal (TSP) for each DN/CT
--    combination.  The values in this list identify the directory number
--    reference,  the feature identifier value, and the feature keyword.
--    The directory number reference is used to determine the actual
--    DN/CT combination that a particular FA value is applicable to based
--    on the directoryNbrReferenceList in the Terminal Service Profile
--    object class.  The feature identifier value is the value sent
--    across the interface to support feature activations.  The keyword
--    identifies the service that the activation applies to and is used
--    as a key to pick up the service identifier information from the
--    master list attribute of the Network Element object class.";;
-- REGISTERED AS {spvbAttribute 15};

-- featureActsPerHuntMakeBusy ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureActsPerHuntMakeBusy;
--    BEHAVIOUR
--                featureActsPerHuntMakeBusyBehaviour BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Configuration object class.  This attribute contains a list of all
--    of the FAs that are valid for the terminal (TSP) for make busy
--    application sets.  The values in this list identify the feature
--    identifier value, the feature keyword, and the make busy
--    application set.  The feature identifier value is the value sent
--    across the interface to support feature activations.  The keyword
--    identifies the service that the activation to and is used as a key
--    to pick up the service identifier information from the master list
--    attribute of the Network Element object class.  The make busy
--    application set provides information related to the multi-line hunt
--    group service, but this data is not downloaded.";;
-- REGISTERED AS {spvbAttribute 16};

-- featureActsPerStopHunt     ATTRIBUTE
```

```
--     WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureActsPerStopHunt;
--     BEHAVIOUR
--                 featureActsPerStopHuntBehaviour     BEHAVIOUR
--                      DEFINED AS
--     "This attribute is a multi-valued attribute of the Terminal
--     Configuration object class.  This attribute contains a list of all
--     of the FAs that are valid for the terminal (TSP) for stop hunt
--     application sets.  The values in this list identify the feature
--     identifier value, the feature keyword, and the stop hunt
--     application set.  The feature identifier value is the value sent
--     across the interface to support feature activations.  The keyword
--     identifies the service that the activation applies to and is used
--     as a key to pick up the service identifier information from the
--     master list attribute of the Network Element object class.  The
--     stop hunt application set provides information related to the
--     multi-line hunt group service, but this data is not downloaded.";;
-- REGISTERED AS {spvbAttribute 17};

featureIndicatorsMasterList   ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureIndicatorsMasterList;
      BEHAVIOUR
                featureIndicatorsMasterListBehaviour  BEHAVIOUR
                     DEFINED AS
      "This attribute is a multi-valued attribute of the Network Element
      object class.  This attribute contains a list of all of the FIs
      that are defined in the switch.  The pairs of values in this list
      identify the service identifier and the feature keyword.  The
      service identifier is readable text downloaded to the terminal to
      assist the user in identifying the service associated with each
      indicator.  The keyword identifies the service that the service
      description applies to and is used as a key to associate the
      service identifier information with a feature identifier value.";;
REGISTERED AS {spvbAttribute 18};

-- featureIndicatorsAllDN     ATTRIBUTE
--     WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureIndicatorsAllDN;
--     BEHAVIOUR
--                 featureIndicatorsAllDNBehaviour     BEHAVIOUR
--                      DEFINED AS
--     "This attribute is a multi-valued attribute of the Terminal
--     Configuration object class.  This attribute contains a list of all
--     of the FIs that are valid for the terminal (TSP) independent of
--     the DN.  The pairs of values in this list identify the feature
--     identifier value  and the feature keyword.  The feature identifier
--     value is the value sent across the interface to support feature
--     indications.  The keyword identifies the service that the
--     indication applies to and is used as a key to pick up the service
--     identifier information from the master list attribute of the
--     Network Element object class.";;
-- REGISTERED AS {spvbAttribute 19};

-- featureIndicatorsPerDN     ATTRIBUTE
--     WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureIndicatorsPerDN;
--     BEHAVIOUR
--                 featureIndicatorsPerDNBehaviour     BEHAVIOUR
--                      DEFINED AS
--     "This attribute is a multi-valued attribute of the Terminal
--     Configuration object class.  This attribute contains a list of all
--     of the FIs that are valid for the terminal (TSP) for each DN/CT
--     combination.  The values in this list identify the directory number
--     reference,  the feature identifier value, and the feature keyword.
--     The directory number reference is used to determine the actual
--     DN/CT combination that a particular FI value is applicable to based
--     on the directoryNbrReferenceList in the Terminal Service Profile
--     object class.  The feature identifier value is the value sent
--     across the interface to support feature indications.  The keyword
--     identifies the service that the indication applies to and is used
--     as a key to pick up the service identifier information from the
--     master list attribute of the Network Element object class.";;
-- REGISTERED AS {spvbAttribute 20};

-- featureIndsPerHuntMakeBusy     ATTRIBUTE
--     WITH ATTRIBUTE SYNTAX     ASN1SpvbModule.FeatureIndsPerHuntMakeBusy;
--     BEHAVIOUR
--            featureIndsPerHuntMakeBusyBehaviour     BEHAVIOUR
--                      DEFINED AS
--     "This attribute is a multi-valued attribute of the Terminal
```

```
--    Configuration object class.  This attribute contains a list of all
--    of the FIs that are valid for the terminal (TSP) for make busy
--    application sets.  The values in this list identify the feature
--    identifier value, the feature keyword, and the make busy
--    application set.  The feature identifier value is the value sent
--    across the interface to support feature indications.  The keyword
--    identifies the service that the indication applies to and is used
--    as a key to pick up the service identifier information from the
--    master list attribute of the Network Element object class.  The
--    make busy application set provides information related to the
--    multi-line hunt group service, but this data is not downloaded.";;
-- REGISTERED AS {spvbAttribute 21};

-- featureIndsPerStopHunt     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.FeatureIndsPerStopHunt;
--    BEHAVIOUR
--                featureIndsPerStopHuntBehaviour     BEHAVIOUR
--                     DEFINED AS
--    "This attribute is a multi-valued attribute of the Terminal
--    Configuration object class.  This attribute contains a list of all
--    of the FIs that are valid for the terminal (TSP) for stop hunt
--    application sets.  The values in this list identify the feature
--    identifier value, the feature keyword, and the stop hunt
--    application set.  The feature identifier value is the value sent
--    across the interface to support feature indications.  The keyword
--    identifies the service that the indication applies to and is used
--    as a key to pick up the service identifier information from the
--    master list attribute of the Network Element object class.  The
--    stop hunt application set provides information related to the
--    multi-line hunt group service, but this data is not downloaded.";;
-- REGISTERED AS {spvbAttribute 22};

intercomGroups    ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.IntercomGroups;
      BEHAVIOUR
                intercomGroupsBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute is a multi-valued attribute of the Electronic Key
      Telephone Service object class.  This attribute contains a list of
      all intercom appearances on a CACH EKTS terminal.  The values in
      the list identify the intercom group within the switch, the call
      appearance identifier used for signaling, and the intercom address
      within the group.";;
REGISTERED AS {spvbAttribute 23};

-- lastRequestDateAndTime     ATTRIBUTE
--   WITH ATTRIBUTE SYNTAX    ASN1SpvbModule.LastRequestDateAndTime;
--   BEHAVIOUR
--               lastRequestDateAndTimeBehaviour      BEHAVIOUR
--                    DEFINED AS
--   "This attribute of the Service Profile Verification-Basic Rate
--   object class identifies the date and time of the last download
--   request from this particular terminal.  The last request for which
--   this is recorded is for any request, even if it was rejected or
--   aborted in the middle by the user.  This attribute is used to
--   support the maintenance of parameter downloading.";;
-- REGISTERED AS {spvbAttribute 24};

officeEquipNbr     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.OfficeEquipNbr;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
                officeEquipNbrBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute of the Terminal Service Profile object class is
      the identification of the BRI on the switch in which the TSP
      resides.  This is used to determine which set of bearer
      capabilities in the Subscriber Directory Number object class are
      applicable for each DN on this TSP.";;
REGISTERED AS {spvbAttribute 25};

-- profileUpdateNotifHeld     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.ProfileUpdateNotifHeld;
--    MATCHES FOR           EQUALITY;
--    BEHAVIOUR
--                profileUpdateNotifHeldBehaviour     BEHAVIOUR
--                     DEFINED AS
```

```
--    "This attribute of the Service Profile Verification-Basic Rate
--    object class indicates whether a notification of a service profile
--    update is waiting to be sent for this terminal.  A value of true
--    means that a notification is pending.  A value of false means that
--    no notification is being held, either because no update has
--    occurred, or because the terminal has already been notified.  This
--    value is to be readable and settable for maintenance purposes.";;
-- REGISTERED AS {spvbAttribute 26};

-- spvbDirectoryNbrList     ATTRIBUTE
--    WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.SpvbDirectoryNbrList;
--    MATCHES FOR           EQUALITY;
--    BEHAVIOUR
--              spvbDirectoryNbrListBehaviour     BEHAVIOUR
--                   DEFINED AS
--    "This attribute of the Service Profile Verification-Basic Rate
--    object class is a pointer to the Subscriber Directory Number
--    object class instance(s) associated with this terminal.";;
-- REGISTERED AS {spvbAttribute 27};

spvbEktsData      ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.ObjectInstance;
      MATCHES FOR           EQUALITY;

      BEHAVIOUR
                spvbEktsDataBehaviour       BEHAVIOUR
                     DEFINED AS
      "This attribute of the Service Profile Verification-Basic Rate
      object class is a pointer to the Electronic Key Telephone Service
      object class instance associated with this terminal, if one
      exists.";;

REGISTERED AS {spvbAttribute 28};

spvbTermSvcProfile     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.ObjectInstance;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
                spvbTermSvcProfileBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute of the Service Profile Verification-Basic Rate
      object class is a pointer to the Terminal Service Profile object
      class instance associated with this terminal.";;

REGISTERED AS {spvbAttribute 29};

spvbSvcProfileId  ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.SpvbSvcProfileId;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
                spvbSvcProfileIdBehaviour BEHAVIOUR
                     DEFINED AS
      "This attribute of the Service Profile Verification-Basic Rate
      object class uniquely identifies an instance of that object class.
      This is the value identified as the object instance in the download
      request from the terminal and is the SPID value that the terminal
      initialized with.";;
REGISTERED AS {spvbAttribute 1};

svcProfileId      ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.SvcProfileId;
      MATCHES FOR             EQUALITY;
      BEHAVIOUR
                svcProfileIdBehaviour       BEHAVIOUR
                     DEFINED AS
      "This attribute of the Terminal object class uniquely identifies
      an instance of that object class.  This value is the SPID value
      that the terminal initialized with.";;
REGISTERED AS {spvbAttribute 33};

spvbTerminalConfig     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.ObjectInstance;
      MATCHES FOR             EQUALITY;
      BEHAVIOUR
                spvbTerminalConfigBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute of the Service Profile Verification-Basic Rate
```

```
      object class is a pointer to the Terminal Configuration object
      class instance associated with this terminal.";;
REGISTERED AS {spvbAttribute 30};

terminalConfigNbr ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.TerminalConfigNbr;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
                terminalConfigNbrBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute of the Terminal Configuration object class uniquely
        identifies an instance of that object class.";;
REGISTERED AS {spvbAttribute 31};

termSvcProfileId     ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.TermSvcProfileId;
      MATCHES FOR           EQUALITY;
      BEHAVIOUR
                termSvcProfileIdBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute of the Terminal Service Profile object class
      uniquely identifies an instance of that object class.  This value
      is the SPID value minus the Terminal IDentifier (TID).";;
REGISTERED AS {spvbAttribute 32};

callAppearanceReservations    ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.CallAppearanceReservations;
      BEHAVIOUR
                callAppearanceReservationsBehaviour     BEHAVIOUR
                     DEFINED AS
      "This attribute is a multi-valued attribute of subscriber
      DN object class. It specifies the Electronic Key
      Telephone Service call appearance reservations, if any,
      that apply for this DN. These call appearance reservations are
      downloaded in parameter downloading type 2. This attribute
      consists of up to 16 call appearance numbers and an associated
      reservation status for each. The three defined statuses are
      DOR, DTM, and DTMEPI.";;
REGISTERED AS {spvbAttribute 35};

originatingDNk    ATTRIBUTE
      WITH ATTRIBUTE SYNTAX   ASN1SpvbModule.OriginatingDN;
      BEHAVIOUR
                OriginatingDNBehaviour    BEHAVIOUR
                     DEFINED AS
      "This attribute is a single-valued attribute of the EKTS
      object class. It identifies the CACH Electronic Key
      Telephone Service DN for which the terminal should
      apply automatic call appearance selection for originations.
      This information is one of the 7 character local DNs assigned
      to the TSP and is only used by the terminal.";;
REGISTERED AS {spvbAttribute 36};
```

7.2.6.2.3 Actions

```
spvbTerminalOption     ACTION
     BEHAVIOUR
          spvbTerminalOptionBehaviour      BEHAVIOUR
                     DEFINED AS
     "This action is used to download terminal configuration parameters
     to a terminal upon a request from the terminal.  The
     spvbTermSvcProfile pointer is used to access the associated
     Terminal Service Profile object instance to retrieve the
     directoryNbrAppearanceIds to be downloaded.  The officeEquipNbr and
     directoryNbrReferenceList are also retrieved to be used in
     interpreting data retrieved from other instances.  The
     spvbDirectoryNbrList pointer is used to access the corresponding
     Subscriber Directory Number instances to retrieve the
     bearerCapabilityList and the callRefBsyLimCallTypeList.  The
     officeEquipNbr from the Terminal Service Profile instance is used
     to identify the particular bearer capabilities that apply to this
     access line, and hence this terminal.  Other information known in
     the switch is used to determine if the packet bearer capability
     applies to the B channel, the D channel, or both for a particular
     DN.  The spvbTerminalConfig is used as a pointer to the
     corresponding Terminal Configuration instance to retrieve all of
     the feature activator and indicator attribute values.  The feature
     activator and indicator keyword values are used to retrieve the
```

```
     correct service description information from the Network Element
     object class.  The directoryNbrReferenceList from the Terminal
     Service Profile instance is used to determine the actual DNs to
     which the feature activators and indicators are assigned.  The
     spvbEktsData attribute is used as a pointer to access the
     associated instance of the Electronic Key Telephone Service object
     to retrieve the  CACH option, callAppearanceIds, and
     IntercomGroups information, if any.

     The information to be downloaded is organized in the following
     manner.  All data that is independent of DN is grouped together and
     sent down first if CACH is TRUE or if any other DN independent data
     exists.  If CACH is FALSE, and no other DN independent data exists,
     then no DN independent reply is sent.  The first part of this data
     is the indication of whether the terminal is supposed to support
     CACH EKTS.  Another part of this data is the feature activator and
     indicator information that is independent of DN.  This includes all
     of the FAs and FIs associated with multiline hunt.  All of these
     can be grouped together since the application set information
     associated with multiline hunt need not be sent down.  The other
     DN independent data is the intercom call appearances.  If the
     intercom group and intercom address are not available, then only
     the intercom call appearance is sent down.  The remainder of the
     data is to be grouped by DN.
     This includes call type independent data such as the
     bearerCapabilityList, the callRefBsyLimCallTypeList, and the
     DirectoryNumberAppearanceIds. Data by Call Type includes the
     EKTS call appearances, as well as FAs and FIs for the VI call type.
     For the CMD call type the data is the FAs and FIs. All of the data
     for each DN shall be sent before data for subsequent DNs.";;
   MODE CONFIRMED;
   PARAMETERS             downloadProcessError;
   WITH REPLY SYNTAX ASN1SpvbModule.DownloadResult;
REGISTERED AS {spvbAction 1};


spvbTerminalOption2     ACTION
     BEHAVIOUR
         spvbTerminalOption2Behaviour       BEHAVIOUR
                 DEFINED AS
      "This action downloads terminal configuration parameters
      to a terminal upon a request from the terminal.  The
      spvbTermSvcProfile pointer is used to access the associated
      Terminal Service Profile object instance to retrieve the
      originatingDN and directoryNbrAppearanceIds to be downloaded.
      If the originatingDN is not NULL, then the originatingDNFlag
      is set to true for the DN retrieved. The officeEquipNbr and
      directoryNbrReferenceList are also retrieved to be used in
      interpreting data retrieved from other instances.  The
      spvbDirectoryNbrList pointer is used to access the corresponding
      Subscriber Directory Number instances to retrieve the
      bearerCapabilityList, callAppearanceReservations, and
      the callRefBsyLimCallTypeList.  The officeEquipNbr from the
      Terminal Service Profile instance is used to identify the
      particular bearer capabilities that apply to this
      access line, and hence this terminal.  Other information known in
      the switch is used to determine if the packet bearer capability
      applies to the B channel, the D channel, or both for a particular
      DN. The spvbTerminalConfig is used as a pointer to the
      corresponding Terminal Configuration instance to retrieve all of
      the feature activator and indicator attribute values. The feature
      activator and indicator keyword values are used to retrieve the
      correct service description information from the Network Element
      object class.  The directoryNbrReferenceList from the Terminal
      Service Profile instance is used to determine the actual DNs to
      which the feature activators and indicators are assigned.  The
      spvbEktsData attribute is used as a pointer to access the
      associated instance of the Electronic Key Telephone Service object
      to retrieve the  CACH option, callAppearanceIds, and
      IntercomGroups information, if any.

      The information to be downloaded is organized in the following
      manner. All data that is independent of DN is grouped together and
      sent down first if CACH is TRUE or if any other DN independent data
      exists. If CACH is FALSE, and no other DN independent data exists,
      then no DN independent reply is sent.  The first part of this data
      is the indication of whether the terminal is supposed to support
```

```
      CACH EKTS.  Another part of this data is the feature activator and
      indicator information that is independent of DN. This includes all
      of the FAs and FIs associated with multiline hunt.  All of these
      can be grouped together since the application set information
      associated with multiline hunt need not be sent down.  The other
      DN independent data is the intercom call appearances.  If the
      intercom group and intercom address are not available, then only
      the intercom call appearance is sent down.  The remainder of the
      data is to be grouped by DN. This includes call type independent
      data such as the originatingDNFlag, the bearerCapabilityList, the
      callRefBsyLimCallTypeList, and the DirectoryNumberAppearanceIds.
      If the default BC information does not exist within the
      DirectoryNumberAppearanceIds, then a value equal to unknown may
      be sent with the appearance id. Data by Call Type includes
      the EKTS call appearances, as well as FAs and FIs for the VI call
      type.  All of the data for each DN shall be sent before data for
      subsequent DNs.";;
   MODE CONFIRMED;
   PARAMETERS          downloadProcessError;
   WITH REPLY SYNTAX ASN1SpvbModule.DownloadResult;
REGISTERED AS {spvbAction 2};
```

7.2.6.2.4 Notifications

```
downloadSuccessful                    NOTIFICATION
BEHAVIOUR
      downloadSuccessfulBehaviour       BEHAVIOUR
            DEFINED AS
      "This notification is sent from the terminal to the switch to
      indicate that the download was a success.  This notification has
      no event information associated with it.";;
REGISTERED AS {spvbNotification 1};

downloadError                      NOTIFICATION
BEHAVIOUR
      downloadErrorBehaviour        BEHAVIOUR
          DEFINED AS
     "This notification is sent from the terminal to the switch to
     indicate that the download process had one or more errors
     associated with it.  The terminal returns one of seven errors that
     indicates the parameters that are not supported.";;
WITH INFORMATION SYNTAX ASN1SpvbModule.DownloadNotification;
REGISTERED AS {spvbNotification 2};

timerExpiry                NOTIFICATION
BEHAVIOUR
      timerExpiryBehaviour    BEHAVIOUR
         DEFINED AS
      "This notification is sent from the terminal to the switch to
      indicate that switch has not responded in a reasonable amount of
      time and the terminal is aborting the download.  This notification
      can also be sent from the switch to the terminal when the terminal
      fails to report the results of the download within timer PDL-T1.
      This notification has no event information associated with it.";;
REGISTERED AS {spvbNotification 3};

unusableAPDU                        NOTIFICATION
BEHAVIOUR
      unusableAPDUBehaviour     BEHAVIOUR
            DEFINED AS
      "This notification is sent from the terminal to the switch to
      indicate that the switch has sent the terminal some downloaded data
      that is unrecognizable or has some other serious error such that
      the terminal cannot use it, and the terminal is aborting the
      download.  This notification has no event information associated
      with it.  This may also be used by the switch if information sent
      from the terminal has some serious error or is unrecognizable.";;
REGISTERED AS {spvbNotification 4};

generalDownloadError                    NOTIFICATION
BEHAVIOUR
      generalDownloadErrorBehaviour BEHAVIOUR
           DEFINED AS
      "This notification is sent from the switch to the terminal to
      indicate that an unspecified condition at the switch has forced the
      switch to abort the download process.  This notification has no
      event information associated with it.";;
REGISTERED AS {spvbNotification 5};
```

7.2.6.2.5 Parameters

```
downloadProcessError           PARAMETER
CONTEXT            SPECIFIC-ERROR;
WITH SYNTAX ASN1SpvbModule.ErrorInfo;
REGISTERED AS {spvbParameter 1};
```

7.2.6.2.6 Name Bindings

```
terminalConfiguration-networkElement NAME BINDING
      SUBORDINATE OBJECT CLASS terminalConfiguration;
      NAMED BY SUPERIOR OBJECT CLASS networkElement;
      WITH ATTRIBUTE terminalConfigNbr;
REGISTERED AS {spvbNameBinding 1};

serviceProfileVerificationBasicRate-networkElement NAME BINDING
      SUBORDINATE OBJECT CLASS
      serviceProfileVerificationBasicRate AND SUBCLASSES;
      NAMED BY SUPERIOR OBJECT CLASS networkElement and
SUBCLASSES;
      WITH ATTRIBUTE spvbSvcProfileId;
REGISTERED AS {spvbNameBinding 2};

terminalServiceProfile-networkElement NAME BINDING
      SUBORDINATE OBJECT CLASS terminalServiceProfile;
      NAMED BY SUPERIOR OBJECT CLASS networkElement;
      WITH ATTRIBUTE termSvcProfileId;
REGISTERED AS {spvbNameBinding 3};

subscriberDirectoryNumber-networkElement NAME BINDING
      SUBORDINATE OBJECT CLASS subscriberDirectoryNumber;
      NAMED BY SUPERIOR OBJECT CLASS networkElement;
      WITH ATTRIBUTE directoryNumber;
REGISTERED AS {spvbNameBinding 4};

electronicKeyTelephoneService-terminalServiceProfile NAME BINDING
      SUBORDINATE OBJECT CLASS electronicKeyTelephoneService;
      NAMED BY SUPERIOR OBJECT CLASS terminalServiceProfile;
      WITH ATTRIBUTE elecKeyTelephoneSvcId;
REGISTERED AS {spvbNameBinding 5};
```

7.2.6.2.7 ASN.1 Module

Parameter Downloading Type 1

The references to group related to call reference busy limit, are removed where possible. The download notification is modified to correct an inconsistency in the requirements. The default BC option of unknown is removed from the download result.

```
ASN1SpvbModule     -- {1 3 17 104 module(9) tr1281(5) model(1)  }
DEFINITIONS IMPLICIT TAGS ::=
BEGIN

-- EXPORTS everything

-- IMPORTS  ObjectInstance
-- FROM  CMIP-1 {joint-iso-ccitt ms(9) cmip(1) modules(0) protocol(3)};
-- IMPORTS doesn't work in this version of the asn1cc, so we have
-- to include the definitions directly

AttributeId ::= CHOICE  {
   --CSTR short  enumForm;
    globalForm       [0] IMPLICIT OBJECT IDENTIFIER,
    localForm       [1] IMPLICIT INTEGER
}

Attribute ::= SEQUENCE  {
      attributeId AttributeId,
      attributeValue     ANY DEFINED BY
                  attributeId
}

RelativeDistinguishedName ::= SET OF Attribute

RDNSequence ::= SEQUENCE OF RelativeDistinguishedName

DistinguishedName ::= RDNSequence

ObjectInstance ::= CHOICE  {
```

```
    distinguishedName         [2] IMPLICIT DistinguishedName,
    nonSpecificForm           [3] IMPLICIT OCTET STRING,
    localDistinguishedName    [4] IMPLICIT RDNSequence
}


-- 5ESS-specific modifications to TR-1281 definitions:
--   1. Call appearance and feature button/lamp ranges changed
--    from 0..16383 to 0..254, the current allowable range.

--    the following definitions need to be hand-coded in a header file

-- spvbObject            OBJECT IDENTIFIER ::= { 1 3 17 104 1 tr1281(5) }
-- spvbAttribute         OBJECT IDENTIFIER ::= { 1 3 17 104 2 tr1281(5) }
-- spvbAction            OBJECT IDENTIFIER ::= { 1 3 17 104 5 tr1281(4) }
-- spvbNotification      OBJECT IDENTIFIER ::= { 1 3 17 104 6 tr1281(4) }
-- spvbParameter         OBJECT IDENTIFIER ::= { 1 3 17 104 8 tr1281(3) }
-- spvbNameBinding       OBJECT IDENTIFIER ::= { 1 3 17 104 4 tr1281(5) }
-- spvbPackage           OBJECT IDENTIFIER ::= { 1 3 17 104 7 tr1281(6) }

--    the following values are used in the APDUs.
--    these definitions also need to be hand-coded in a header file

-- serviceProfileVerificationBasicRate OBJECT IDENTIFIER ::= { spvbObject 1}
-- terminal OBJECT IDENTIFIER ::= { spvbObject 7}
-- spvbSvcProfileId  OBJECT IDENTIFIER ::= { spvbAttribute 1}
-- svcProfileId  OBJECT IDENTIFIER ::= { spvbAttribute 33}
-- spvbTerminalOption    OBJECT IDENTIFIER ::= { spvbAction 1}
-- downloadSuccessful    OBJECT IDENTIFIER ::= { spvbNotification 1}
-- downloadError         OBJECT IDENTIFIER ::= { spvbNotification 2}
-- timerExpiry         OBJECT IDENTIFIER ::= { spvbNotification 3}
-- unusableAPDU         OBJECT IDENTIFIER ::= { spvbNotification 4}
-- generalDownloadError     OBJECT IDENTIFIER ::= { spvbNotification 5}
-- downloadProcessError  OBJECT IDENTIFIER ::= { spvbParameter 1}


AppearanceInfo  ::= SEQUENCE {
                callAppearanceId         CallAppearanceId,
                defaultBearerCapability  BearerCapability
        }

BearerCapability        ::= ENUMERATED
                {       speech  (0),  --Speech
                        audio   (1),  --3.1 kHz Audio
                        cmd56   (2),  --56 kbps CMD
                        cmd64   (3),  --64 kbps CMD
                        pmd     (4)   --Packet Mode Data
                }

-- BearerCapabilities      ::= SET OF SEQUENCE
--        {       officeEquipNbr    OfficeEquipNbr,
--               bearerCapability  SET OF BearerCapability
--        }

CallAppearanceId        ::= INTEGER (1..254)

CallAppearanceCallHandlingOption  ::= BOOLEAN

-- CallAppearances ::= SET OF SEQUENCE {
--                callAppearanceNbr  INTEGER (1..16),
--                callAppearanceId   CallAppearanceId,
--                directoryNumber   DirectoryNumber
--        }

CallRefBsyLim   ::= INTEGER  (1..16)

CallRefBsyLimCallTypeList ::= SET OF SEQUENCE
{
     callRefBsyLim   INTEGER,
     callTypeGroup   CallTypeGroup
}

CallTypeGroup   ::= SET OF CallType

CallType        ::=  ENUMERATED {
                vi      (0),  --Voice
                cmd     (1)  --Circuit Mode Data
```

```
        }

-- DirectoryNbrAppearanceIds       ::= SET OF SEQUENCE {
--                directoryNumber    DirectoryNumber,
--                COMPONENTS OF AppearanceInfo
--         }

-- DirectoryNbrReferenceList       ::= SET OF SEQUENCE {
--                referenceNumber INTEGER (1..128),
--                directoryNumber DirectoryNumber,
--                callType        CallType
--         }

DirectoryNumber ::= NumericString (SIZE (7))

-- ElecKeyTelephoneSvcId   ::= PrintableString (SIZE (8))

FeatureActivatorValue   ::= INTEGER (1..254)

FeatureActivatorKeyword ::= PrintableString (SIZE (1..7))

FeatureActivator ::=  SEQUENCE {
                featureActivatorValue   FeatureActivatorValue,
                featureActivatorKeyword FeatureActivatorKeyword }

-- FeatureActivatorsMasterList ::=  SET OF SEQUENCE {
                featureActivatorKeyword FeatureActivatorKeyword,
                fAServiceDescription    ServiceDescription }

FeatureActivatorSpvbData ::=  SEQUENCE {
                featureActivatorValue   FeatureActivatorValue,
                fAServiceDescription    ServiceDescription }

FeatureIndicatorValue   ::= INTEGER (1..254)

FeatureIndicatorKeyword ::= PrintableString (SIZE (1..7))

FeatureIndicator        ::= SEQUENCE {
                featureIndicatorValue   FeatureIndicatorValue,
                featureIndicatorKeyword FeatureIndicatorKeyword }

FeatureIndicatorsMasterList ::=  SET OF SEQUENCE {
                featureIndicatorKeyword FeatureIndicatorKeyword,
                fIServiceDescription    ServiceDescription }

FeatureIndicatorSpvbData ::=  SEQUENCE {
                featureIndicatorValue   FeatureIndicatorValue,
                fIServiceDescription    ServiceDescription}

-- FeatActAndInd           ::= SEQUENCE {
--      featureActivatorAndIndicatorValue   INTEGER (1..254),
--      featureActivatorAndIndicatorKeyword PrintableString (SIZE (1..7) ) }

   FeatActAndIndSpvbData   ::= SEQUENCE {
       featureActivatorAndIndicatorValue   INTEGER (1..254),
       fAandFiServiceDescription           ServiceDescription }

-- FeatActsAndIndsAllDN  ::= SET OF FeatActAndInd

-- FeatActsAndIndsPerDN  ::= SET OF SEQUENCE {
--                        referenceNumber  INTEGER (1..128),
--                        COMPONENTS OF FeatActAndInd
--         }

-- FeatActsAndIndsPerHuntMakeBusy      ::= SET OF SEQUENCE {
--                        COMPONENTS OF FeatActAndInd,
--                        makeBusyApplicationSet MakeBusyApplicationSet
--         }

-- FeatActsAndIndsPerStopHunt  ::= SET OF SEQUENCE {
--                        COMPONENTS OF FeatActAndInd,
--                        stopHuntApplicationSet StopHuntApplicationSet
--         }

-- FeatureActivatorsAllDN  ::= SET OF FeatureActivator

-- FeatureActivatorsPerDN  ::= SET OF SEQUENCE {
```

```
--                         referenceNumber ReferenceNumber,
--                         COMPONENTS OF FeatureActivator
--          }

-- FeatureActsPerHuntMakeBusy      ::= SET OF SEQUENCE {
--                         COMPONENTS OF FeatureActivator,
--                         makeBusyApplicationSet MakeBusyApplicationSet
--          }

-- FeatureActsPerStopHunt  ::= SET OF SEQUENCE {
--                         COMPONENTS OF FeatureActivator,
--                         stopHuntApplicationSet StopHuntApplicationSet
--          }

-- FeatureIndicatorsAllDN  ::= SET OF FeatureIndicator

-- FeatureIndicatorsPerDN  ::= SET OF SEQUENCE {
--                         referenceNumber    INTEGER (1..128)
--                         COMPONENTS OF FeatureIndicator
--          }

-- FeatureIndsPerHuntMakeBusy      ::= SET OF SEQUENCE {
--                         COMPONENTS OF FeatureIndicator,
--                         makeBusyApplicationSet MakeBusyApplicationSet
--          }

-- FeatureIndsPerStopHunt  ::= SET OF SEQUENCE {
--                         COMPONENTS OF FeatureIndicator,
--                         stopHuntApplicationSet StopHuntApplicationSet
--          }

IntercomGroups  ::= SET SIZE (1..16) OF SEQUENCE {
                intercomGroupId [0] PrintableString (SIZE (1..8)) OPTIONAL,
                callAppearanceId [1] CallAppearanceId,
                intercomAddress [2] INTEGER (0..99 or blank) OPTIONAL
        }

-- LastRequestDateAndTime  ::= GeneralizedTime

MakeBusyApplicationSet  ::= INTEGER (0..99)

OfficeEquipNbr          ::= PrintableString (SIZE (12))

-- ProfileUpdateNotifHeld  ::= BOOLEAN

ServiceDescription ::= PrintableString (SIZE (1..20))


SpvbBearerCapability        ::= ENUMERATED
                {       speech  (0),  --Speech
                        audio   (1),  --3.1 kHz Audio
                        cmd56   (2),  --56 kbps CMD
                        cmd64   (3),  --64 kbps CMD
                        pmdB     (4),   --Packet Mode Data on the B Channel
                        pmdD     (5)   --Packet Mode Data on the D Channel
                }

-- SpvbDirectoryNbrList ::= SET OF ObjectInstance

-- SpvbEktsData::= ObjectInstance

-- SpvbTerminalConfig::= ObjectInstance

-- SpvbTermSvcProfile::= ObjectInstance

SpvbSvcProfileId        ::= PrintableString (SIZE (3..20))

SvcProfileId        ::= PrintableString (SIZE (3..20))

-- StopHuntApplicationSet  ::= INTEGER (0..99)

-- TerminalConfigNbr       ::= PrintableString (SIZE (7))

-- TermSvcProfileId        ::= PrintableString (SIZE (3..18))

CmdCallTypePerDN ::= SEQUENCE  {
        cmdFAandFIs       [8]  SET OF FeatActAndIndSpvbData  OPTIONAL,
```

```
        cmdFAs            [9]  SET OF FeatureActivatorSpvbData OPTIONAL,
        cmdFIs            [10] SET OF FeatureIndicatorSpvbData OPTIONAL }


ViCallTypePerDN ::= SEQUENCE  {
        viFAandFIs        [11] SET OF FeatActAndIndSpvbData  OPTIONAL,
        viFAs             [12] SET OF FeatureActivatorSpvbData OPTIONAL,
        viFIs             [13] SET OF FeatureIndicatorSpvbData OPTIONAL,
        callAppearanceIds   [14] SET OF CallAppearanceId  OPTIONAL }


-- The following is the DownloadResult. The parameters for
-- all DNs will be sent in one of the linked-replies.  Parameters for
-- each DN will be sent in individual linked-replies.

DownloadResult ::=  CHOICE
  {
    -- One form of the Linked-Reply, including:  Call Appearance Call Handling
    -- Option, feature activators and indicators for all DN, per HuntMakeBusy,
    -- and per StopHunt, as well as intercom groups.  This linked reply is sent
    -- first if CACH is true or if any other data exists.  If CACH is false and no
    -- other data exists this form is not sent.

    valuesPerTSP        [0]  IMPLICIT SEQUENCE
    {
         callAppearanceCallHandlingOption   [16] CallAppearanceCallHandlingOption,
        fAfIsAllDN              [2] SET OF FeatActAndIndSpvbData OPTIONAL,
        fAsAllDNandHunt         [3] SET OF FeatureActivatorSpvbData OPTIONAL,
        fIsAllDNandHunt         [4] SET OF FeatureIndicatorSpvbData OPTIONAL,
        intercomGroups          [5] IntercomGroups OPTIONAL
    },

    -- Another form of the Linked-Reply that
    -- contains the parameters for a DN.
    -- Note that for each DN only one Linked-Reply shall be sent, except for
    -- MLHG members with only a group DN.

    valuesPerDN  [1] IMPLICIT SEQUENCE
    {   directoryNbr           DirectoryNumber,
        bearerCapabilities [6] SET OF SpvbBearerCapability,
        dNAppearanceIds    [7] SET OF AppearanceInfo OPTIONAL,
        cRBLCallTypeList    [15]   CallRefBsyLimCallTypeGrpList  OPTIONAL,

        -- optional data for CallTypes per DN follows:
        COMPONENTS OF CmdCallTypePerDN,
        COMPONENTS OF ViCallTypePerDN
    }
  }

-- The following is the event report information.
--
-- (1) downloadSuccessful  this event type has no event information
-- (2) downloadError       this has the event information described in
--                         DownloadNotification

DownloadNotification ::= SEQUENCE
{
      cAsNotSupported      [0] BOOLEAN OPTIONAL,
        iCGsNotSupported     [1] BOOLEAN OPTIONAL,
        fAOrFIOutOfRange     [2] BOOLEAN OPTIONAL,
        cAIDOutOfRange       [3] BOOLEAN OPTIONAL,
        dNAppIDOutOfRange    [4] BOOLEAN OPTIONAL,
        excessDNsSent        [5] BOOLEAN OPTIONAL,
        bCNotSupported       [6] BOOLEAN OPTIONAL
}

ErrorInfo ::=    ENUMERATED {
    svcNotAvailableSvcProUpdate    (0),
                -- the switch is unable to download
                -- because it is currently updating
                -- the service profile for the access line
    terminalNotInitialized       (1),
                -- the terminal requests download
                -- before it has initialized at Layer 3
    processingOtherDownload       (2),
                -- the switch rejects the download
                -- request because it is currently
```

```
                -- processing another request from
                -- the terminal
    tooFrequentRequests             (3)
                -- The switch rejects the download
                -- request because the terminal has
                -- requested more than three downloads
                -- in less then ten minutes
                }

END
```

Parameter Downloading Type 2

The following additions reflect the new additional data for Parameter Downloading Type 2.

```
serviceProfileVerificationBasicRate2BCR OBJECT IDENTIFIER ::= {spvbObject8}
spvbTerminalOption2  OBJECT IDENTIFIER ::= {spvbAction 2}

AppearanceInfo2  ::= SEQUENCE
{
      callAppearanceId              INTEGER,
     defaultBearerCapability     BearerCapability,
     callAppearanceReservation   CallAppearanceReservation OPTIONAL
}

CallAppearanceInfo ::= CHOICE
{
      callAppearnceIds        [14] SET OF INTEGER OPTIONAL,
      callAppIdAndReservations  [18] SET OF CallAppIdAndReservation OPTIONAL
}

CallAppIdAndReservation ::= SEQUENCE
{
      callAppearanceId        INTEGER,
      callAppearanceReservation     CallAppearanceReservation OPTIONAL
}

CallAppearanceReservation ::= ENUMERATED
{
      dor   (0),   --denied origination
      dtm   (1),   --denied termination
      dtmepi     (2)     --denied termination except priority incoming
}

--      DirectoryNbrAppearanceIds    ::= SET OF SEQUENCE
-- {
--     directoryNumber    DirectoryNumber,
--     COMPONENTS OF AppearanceInfo2
-- }

--      FeatureActivatorSpvbData2 ::=  SEQUENCE
-- {
--      featureActivatorValue   INTEGER,
--     fAServiceDescription    PrintableString,
--     featureActivatorKeyword     PrintableString   OPTIONAL
-- }

--      FeatureIndicatorSpvbData2 ::=  SEQUENCE
-- {
--        featureIndicatorValue   INTEGER,
--        fIServiceDescription    PrintableString
-- }

FeatActAndIndSpvbData2  ::= SEQUENCE
{
     featureActivatorAndIndicatorValue INTEGER,
     fAandFiServiceDescription         PrintableString,
     featureActivatorAndIndicatorKeyword PrintableString OPTIONAL
}

--     CmdCallTypePerDN ::= SEQUENCE
-- {
--     cmdFAandFIs       [8]  SET OF FeatActAndIndSpvbData2  OPTIONAL,
--     cmdFAs            [9]  SET OF FeatureActivatorSpvbData2 OPTIONAL,
--     cmdFIs            [10] SET OF FeatureIndicatorSpvbData2 OPTIONAL
```

```
-- }

--       ViCallTypePerDN ::= SEQUENCE
-- {
--      viFAandFIs        [11] SET OF FeatActAndIndSpvbData2  OPTIONAL,
--      viFAs             [12] SET OF FeatureActivatorSpvbData2 OPTIONAL,
--      viFIs             [13] SET OF FeatureIndicatorSpvbData2 OPTIONAL,
--      callAppearanceInfo     CallAppearanceInfo
-- }


-- The following is the DownloadResult. The parameters for
-- all DNs will be sent in one of the linked-replies.  Parameters for
-- each DN will be sent in individual linked-replies.

DownloadResult2 ::=  CHOICE
{
    -- One form of the Linked-Reply, including:  Call Appearance Call Handling
    -- Option, feature activators and indicators for all DN, per HuntMakeBusy,
    -- and per StopHunt, as well as intercom groups.  This linked reply is sent
    -- first if CACH is true or if any other data exists.  If CACH is false and no
    -- other data exists this form is not sent.  The TSP acronym stands
    -- for Terminal Service Profile.

     valuesPerTSP2       [0]  IMPLICIT SEQUENCE
     {
            callAppearanceCallHandlingOption   [16] BOOLEAN,
           fAfIsAllDN2              [2] SET OF FeatActAndIndSpvbData2 OPTIONAL,
--      fAsAllDNandHunt2         [3] SET OF FeatureActivatorSpvbData2 OPTIONAL,
--      fIsAllDNandHunt         [4] SET OF FeatureIndicatorSpvbData OPTIONAL,
            intercomGroups           [5] IntercomGroups OPTIONAL
     },

    -- Another form of the Linked-Reply that
    -- contains the parameters for a DN.
    -- Note that for each DN only one Linked-Reply shall be sent, except for
    -- MLHG members with only a group DN.

     valuesPerDN2  [1] IMPLICIT SEQUENCE
     {
           directoryNbr           DirectoryNumber,
           originatingDNFlag  [17] OriginatingDNFlag OPTIONAL,
           bearerCapabilities [6] SET OF SpvbBearerCapability,
           dNAppearanceIds2   [7] SET OF AppearanceInfo2 OPTIONAL,
           cRBLCallTypeList   [15]  CallRefBsyLimCallTypeList OPTIONAL,

               -- optional data for CallTypes per DN follows:
                -- COMPONENTS OF CmdCallTypePerDN,
          -- COMPONENTS OF ViCallTypePerDN,
          callAppearanceInfo     CallAppearanceInfo
         }
  }
```

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

7.3 NETWORK ELEMENT SERVICES SIGNALING—NESS

7.3.1 NESS FEATURE DESCRIPTION

The Network Element Services Signaling (NESS) feature provides a generic data transport mechanism between ISDN CPE (that is, a Lucent Technologies Service Circuit Node) and Service Control Points (SCPs) or Adjuncts. This transport occurs independent of any call being processed by the switch. The *5ESS*® switch, acting as an Advanced Intelligent Network (AIN) 0.1 Service Switching Point (SSP), does protocol translation and limited processing of data it receives from either network element. Included in the data is an "envelope" whose contents are not examined by the SSP. The CPE and SCP agree on its format and contents.

This generic transport feature is a component of Lucent Technologies' Advanced Network Services (ANS) Advanced Services Platform (ASP). The concept of NESS came from the need to transport non-call related information between ISDN-CPE and an SCP or Adjunct without switch knowledge of the format or content of the data. It is left to the applications on the network elements off the switch to provide and make use of the data.

NESS is an implementation of only unidirectional Non-Call Associated Signaling (NCAS). It does not include query/response NCAS signaling at this time. This feature follows the requirements in GR-1129-CORE and GR-1299-CORE for unidirectional NCAS. Three new ASN.1-encoded operations are introduced: envelopNCAData, nCAData, and envelopNCAData5. The ISDN CPE uses common element procedures as specified in TR-NWT-000864 to communicate with the SSP regarding these operations. The SSP and SCP communicate using AIN 0.1 SS7 TCAP protocol.

NESS conforms to available Bellcore AIN 0.2 requirements (GR1129-CORE, GR1298-CORE, GR1299-CORE). This helps ensure that ANS network elements can communicate with those of other vendors.

The following needs gave rise to this feature:

a. Centralization of subscriber databases at SCPs

   Centralization simplifies service provider operations by eliminating duplication of common subscriber data at each SCN. A method is then needed by which SCNs can easily access the data in real time.

   For example, for a service such as "Who's Calling?" that makes use of a database of names, the database can be located centrally on one or more SCPs, and SCNs in the local area can query the database using NESS to retrieve the name to announce to the subscriber.

b. Centralization of SCN resource status at SCPs

   If the SCP is to intelligently make use of the SCN for service delivery, it may be useful to know the status of the SCN itself (that is, is it alive and well), or the status of SCN resources.

7.3.2 NESS SIGNALING PROCEDURES

For Network Element Services Signaling (NESS) service control, a terminal (N-ISDN CPE) and an SCP or Adjunct communicate through unidirectional messages that are provided with routing and basic protocol checking/conversion services by the switch. Protocol Conversion is done by the switch between the Q.932 format and Signaling System 7 (TCAP) format. Data is carried between ISDN CPE and SCP/Adjunct within an "EnvelopeContent" argument of these messages. This data is not inspected by the switch, and the format of the data is unknown to the switch. It is left to the terminating entity to decipher the data contained within the data envelope.

The Non Call Associated Signaling operations that are used by NESS are specified in Section 6 of Bellcore GR-1129-CORE.

The unidirectional NESS messaging is not call processing related, that is, it is independent of a call. Because the messages are unidirectional by definition, the switch does not provide the capability to wait for a response message.

The components that are used in communicating between the switch and the terminal are carried within the Facility Information Element (FIE) in the REGister and RELease COMplete messages.

Because of the software architecture of the NESS unidirectional feature, only a single Call Reference value may exist per terminal at any one time. It is therefore not necessary for the switch to keep a count of call reference values associated with terminals.

7.3.2.1 ISDN-CPE Initiated Signaling: Receipt Of A REGister Message

A terminal initiates NESS unidirectional messaging by sending a NESS REGister message to the switch over a N-ISDN BRI. "REGister," Section 4.1.2.18, describes the encoding of the REGister message.

The switch accepts the following information elements (IEs) in the REGister message:

- Protocol Discriminator coded as "Q.931"
- Call Reference coded as indicated in "Call Reference," Section 4.1.3.1.2
- Message Type coded as "REGister"
- Facility coded as described in "Facility," Section 4.1.3.5.2

After validating the received components, the switch performs translation to TCAP message format and forwards that message to the SCP/Adjunct that is specified by the CalledPartyID argument received.

Note that "CalledPartyID" and "CallingPartyID" operation arguments in AINDigit format are being used instead of "CalledDN" and "CallingDN." This is done to make message translation more efficient since AIN 0.1 Requirements (see GR-1299-CORE) use the same format.

7.3.2.2 SCP/Adjunct Initiated NESS Messaging: Delivery Of A REGister Message

An SCP/Adjunct may initiate a NESS unidirectional message targeted for delivery to a specific Directory Number associated with N-ISDN CPE. Using the NESS feature, the *5ESS* switch hosting the specified terminal provides protocol checking, protocol conversion, and routing services in order to deliver valid messages to the appropriate terminal. Messages are delivered through a REGister message sent to the terminal. "REGister," Section 4.1.2.18, describes the encoding of the REGister message.

7.3.2.3 Clearing Of A NESS Unidirectional Signaling Connection

7.3.2.3.1 ISDN-CPE Initiated Messaging

A RELease COMplete message is sent by the switch to the originating terminal immediately after processing the contents of an incoming NESS REGister message and forwarding the appropriate contents to TCAP.

The switch encodes the RELease COMplete message with the following IEs:

- Protocol Discriminator coded as "Q.931"
- Call Reference coded as indicated in "Call Reference," Section 4.1.3.1.2, is released for future use
- Message Type coded as "RELease COMplete"
- Cause value coded appropriately (see "Cause," Section 4.1.3.2.9)
- Facility coded as described in "Facility," Section 4.1.3.5.2, FIE is omitted if a protocol error was encountered.

7.3.2.3.2 SCP/ADJUNCT Initiated Messaging

A RELease COMplete message is sent by the switch to the destination terminal immediately after forwarding the appropriate contents of an incoming TCAP NESS unidirectional message to that same terminal in a REGister message. No response is expected from the terminal. No response is sent to the SCP/Adjunct.

The switch encodes the RELease COMplete message with the following IEs (note that a Facility IE is NOT included in this case):

- Protocol Discriminator coded as "Q.931"
- Call Reference coded as indicated in "Call Reference," Section 4.1.3.1.2, is released for future use
- Message Type coded as "RELease COMplete"
- Cause value coded appropriately (see "Cause," Section 4.1.3.2.9)

National ISDN Basic Rate Interface Specification

CONTENTS PAGE

LIST OF FIGURES

7.4 ISDN-PERSONAL COMMUNICATIONS SERVICES (PCS) INTERWORKING

7.4.1 ISDN-PCS INTERWORKING FEATURE OVERVIEW

ISDN/PCS Interworking will be offered to National ISDN BRI lines that reside on an Advanced Intelligent Network (AIN) capable switch and will provide four basic capabilities that are fundamental to a PCS user as well as provide several important features that will enhance the service that a PCS user receives.

7.4.1.1 Basic Capabilities

The **first** capability allows a PCS user to register with the network. Registration allows the PCS user to specify where the PCS user, identified by that user's Mobile Identification Number (MIN), currently is placed relative to the network. This process links the MIN to a serving area defined by a PCS provider and is represented in the network as a group of "interface DNs" that identify the serving area.

Note: For every BRI that links the switch and Radio Port Control Unit or Intelligent Base Station, there will be two interface DNs (one per B-channel). This interface DN is the primary DN that is assigned to a User Service Order Profile (USOP).

The SCP Visitor Location Register (VLR) in the service control point (SCP) keeps track of the most current location that the PCS user has registered from and as a result stores this most current interface DN. The registration process uses unidirectional Network Element Services Signaling.

The **second** capability allows a PCS user to complete a call into the network. When a PCS user originates a call, the following steps are followed:

1. The PCS provider interacts with the serving SCP to validate the call request, through Network Element Services Signaling.
2. On receiving a positive response to the validation request, the PCS provider follows normal ISDN origination procedures with the MIN associated with the calling PCS user as calling number information. [The switch is not to discard this user provided number (MIN)].
3. The serving switch interacts with its serving SCP, which results in the MIN being screened so that it can be used for AMA and calling number delivery purposes.
4. The serving switch routes the call using normal call origination procedures.

The **third** capability allows a PCS user to receive calls from the network. When a call is delivered to a PCS user, the following steps are followed:

1. When the caller has completed dialing a PCS user's MIN, the switch serving the caller determines how to handle the call. If the dialed MIN is not routable (has no geographic significance), the serving switch needs to interact with its serving SCP to determine where to route the call. If the dialed MIN is routable (has geographic significance), the serving switch will route the call to the appropriate switch and that switch will then interact with its serving SCP to determine where to route the call.
2. The serving SCP (mentioned in Step 1) will query the called user's home SCP [the Home Location Register (HLR)] to determine which network data base will have the most recent registration of the called PCS user. This network database, the VLR, will interact with the PCS provider and will be able to determine the location of the called PCS user and identify the proper interface DN that is

needed to be able to reach the called PCS user. This interface DN will be passed to the serving SCP that initiated the first query.

3. The serving SCP provides this interface DN to the switch that initiated the query, and that switch routes the call to the switch serving the indicated interface DN (the terminating switch).

4. The terminating switch offers the call to the interface associated with that interface DN using normal ISDN call delivery procedures.

The **fourth** capability allows a PCS call to move from one RPCU to another RPCU without any loss to the call provided the RPCUs are in the same registration area or in different overlapping registration areas. This is referred to an Automatic Link Transfer (ALT) and it is assumed that both RPCUs are served by the same switch.

ALT is necessary for the PCS provider to compensate for a variation in signal strength and quality as the PCS user moves away from a radio port. When a PCS user's handset determines that the signal strength and quality would be better if the handset were served by a different radio port, the handset will request to change serving radio ports. If the PCS provider cannot handle interRPCU ALT itself, the ALT feature will provide the change. The PCS provider requests ALT at the interface serving the better radio port and identifies the interface DN associated with the worse radio port. The network will direct a call from the better interface to the worse interface, tells the worse interface that an ALT is requested, obtains acceptance from the worse interface, bridges the ALT call with the existing call, and transfers control of the call to the better interface.

7.4.1.2 Features

There are an unlimited number of PCS features that can be created using the service logic in the serving SCP (for example, PCS Profile Manipulation, PCS Call Forwarding, or PCS Call Screening). Some of the SCP based features rely on switch based features in order to operate. Listed in the following subsections are SCP based features that are dependent on switched based features in order to operate. These features can be offered to PCS users with the ISDN/PCS Interworking feature. (It is assumed that the RPCU and SCP will work together with the switch to support the features listed.)

7.4.1.3 PCS Call Waiting

PCS Call Waiting will be provided through the NI-2 Additional Call Offering feature and the NI-1 Call Hold feature. PCS Call Waiting will allow the PCS user to:

1. receive notification of a waiting call while the user is currently involved in a call
2. hole the existing call and accept the waiting call
3. alternate between the held call and the active call
4. clear the existing call and accept a waiting call

7.4.1.3.1 PCS Three Way Calling

PCS Three Way Calling will be provided through the NI-2 Flexible Calling feature. This feature will allow the PCS user to:

- hold an existing call and originate another call (3-way)
- retrieve the held call into the conference with the connected call (3-way)

- drop the last party added to the conference, in which case the switch converts the conference into a regular two party call

7.4.1.3.2 PCS Calling Line Identification

PCS Calling Line Identification will be provided through the NI-2 Calling Number Identification Services feature. PCS CLID will provide two services: one associated with call origination and the other with call delivery.

The first service, PCS Calling Number Privacy, allows the PCS user to indicate to the network whether the user wishes to have his/her MIN displayed to the called party. The PCS user can designate that the privacy applies to all calls or on a per-call basis.

The second service, PCS Calling Number Delivery, provides for the delivery of the calling party number to call PCS handset (if available and allowed by the calling user).

7.4.2 ISDN-PCS INTERWORKING SIGNALING PROCEDURES

Existing National ISDN-2 BRI signaling along with Network Element Services Signaling (NESS) procedures mentioned in "NESS Feature Description," Section 7.3.1, are sufficient to provide the majority of the BRI signaling needed for the ISDN-PCS Interworking feature. Automatic Link Transfer, mentioned in "Basic Capabilities," Section 7.4.1.1, requires new BRI signaling procedures. These new signaling procedures are illustrated in the first call flow, Figure 7.4-1. In addition, new BRI signaling is needed to support an ALT when there is a feature (for example, Call Waiting) in operation at the old radio equipment. This new BRI signaling is illustrated in the second call flow, Figure 7.4-2.

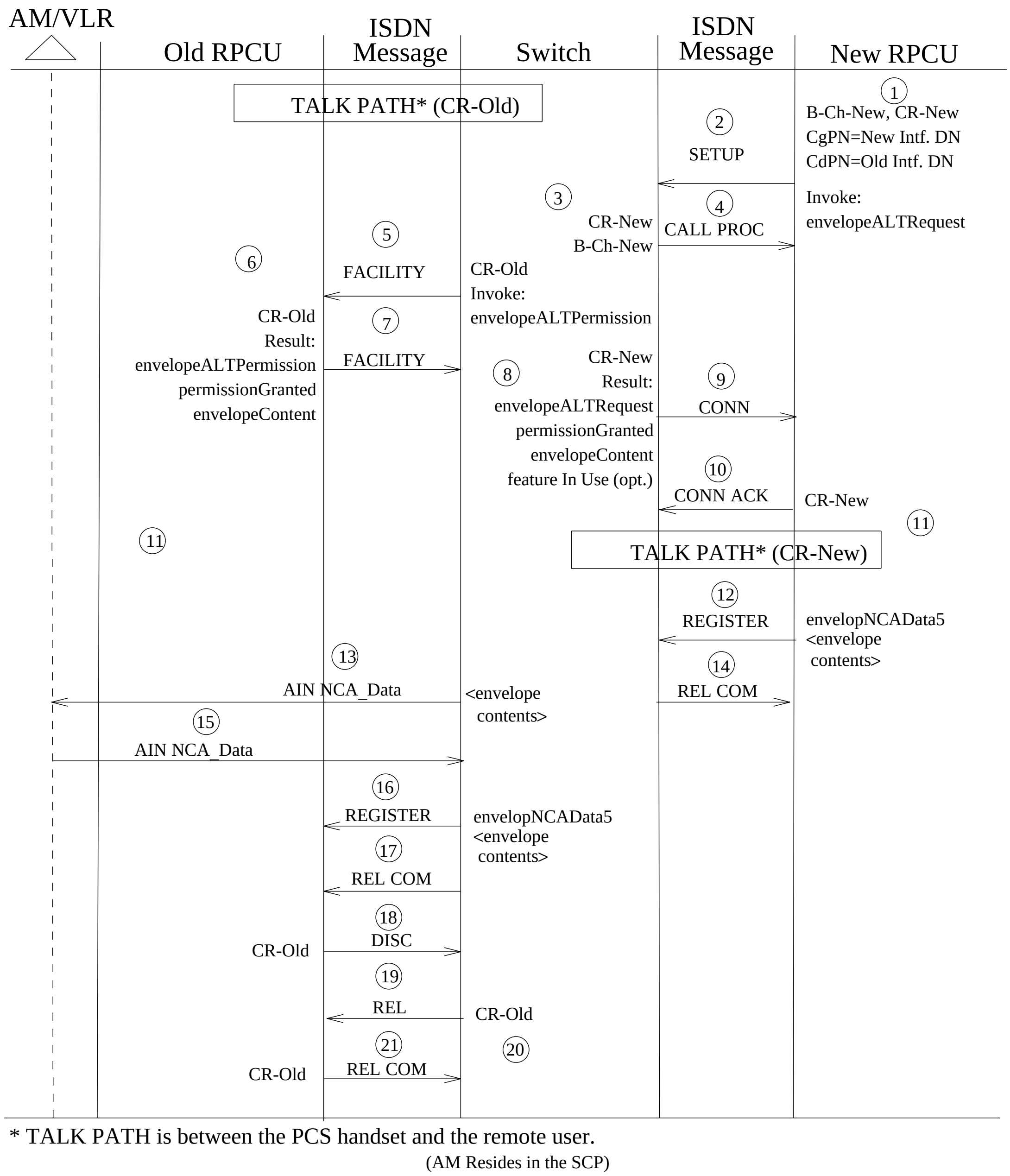


Figure 7.4-1 — Call Flow Automatic Link Transfer

Steps 1-10 and Steps 18-21 represent call associated signaling and pertain to either call reference new [the call reference associated with the new radio port control unit (RPCU) involved in ALT] or call reference old (call reference associated with the old RPCU involved in the ALT). Steps 12-17 represent unidirectional non-call associated signaling or Network Element Services Signaling (NESS).

1. The new RPCU detects a request for an ALT from the handset. (This communication between the handset and new RPCU is not switch impacting.) It is assumed that this ALT request includes the PCS interface DN of the old RPCU. The new RPCU determines that the ALT will be an interRPCU ALT.

2. The new RPCU sends a SETUP message with a Facility Information Element (FIE) than has an invoke component with an operation of EnvelopeALTRequest. In addition, the SETUP has the old PCS interface DN (as called number information element), and (optionally) the new PCS interface DN (as calling number information element), plus other information specific to a call origination (for example, call reference and, optionally, a B-channel designation).

3. The switch recognizes the ALT request as taking precedence over the Off-Hook Delay trigger (normally encountered on PCS call origination). Digit analysis, based on the office dialing plan, of the called DN (old PCS interface DN) determines that this ALT request is directed toward an RPCU served by the same switch.

4. The switch returns a CALL PROCeeding message to indicate that the switch has accepted the ALT call and to finalize B-channel allocation for the call [referred to as call reference new (CR-new)].

   Note: A CALL PROCeeding message is not sent before the switch is aware that there will be a call.

5. The switch sets a timer (T-ALTperm) and sends to the old RPCU a FACility message containing a FIE with an invoke component with an operation of EnvelopeALTPermission. The call reference for the FACility message will be call reference old (CR-old).

6. Assume the old RPCU gives permission for ALT to take place. (A situation where the old RPCU may not grant ALT permission could be when the RPCU is in overload condition. In this case the old RPCU sends a FACILITY message to indicate that permission is denied; the FACility message sent from the old RPCU would include a FIE with either a task refused error in a return error component or a problem code in a reject component. The switch would have to pass this information on to the new RPCU by sending a DISConnect message with a FIE with either a return error component or a reject component).

7. The old RPCU sends a FACility message to the switch that has a FIE with a return result component indication permissionGranted and an operation of EnvelopeALTPermission. In addition, the FACility message includes CR-old as the call reference and includes call specific information needed by the new RPCU (in other words encryption information, profile information). This specific information is passed in the envelopeContent; the switch cannot enforce the old RPCU's inclusion of this information.

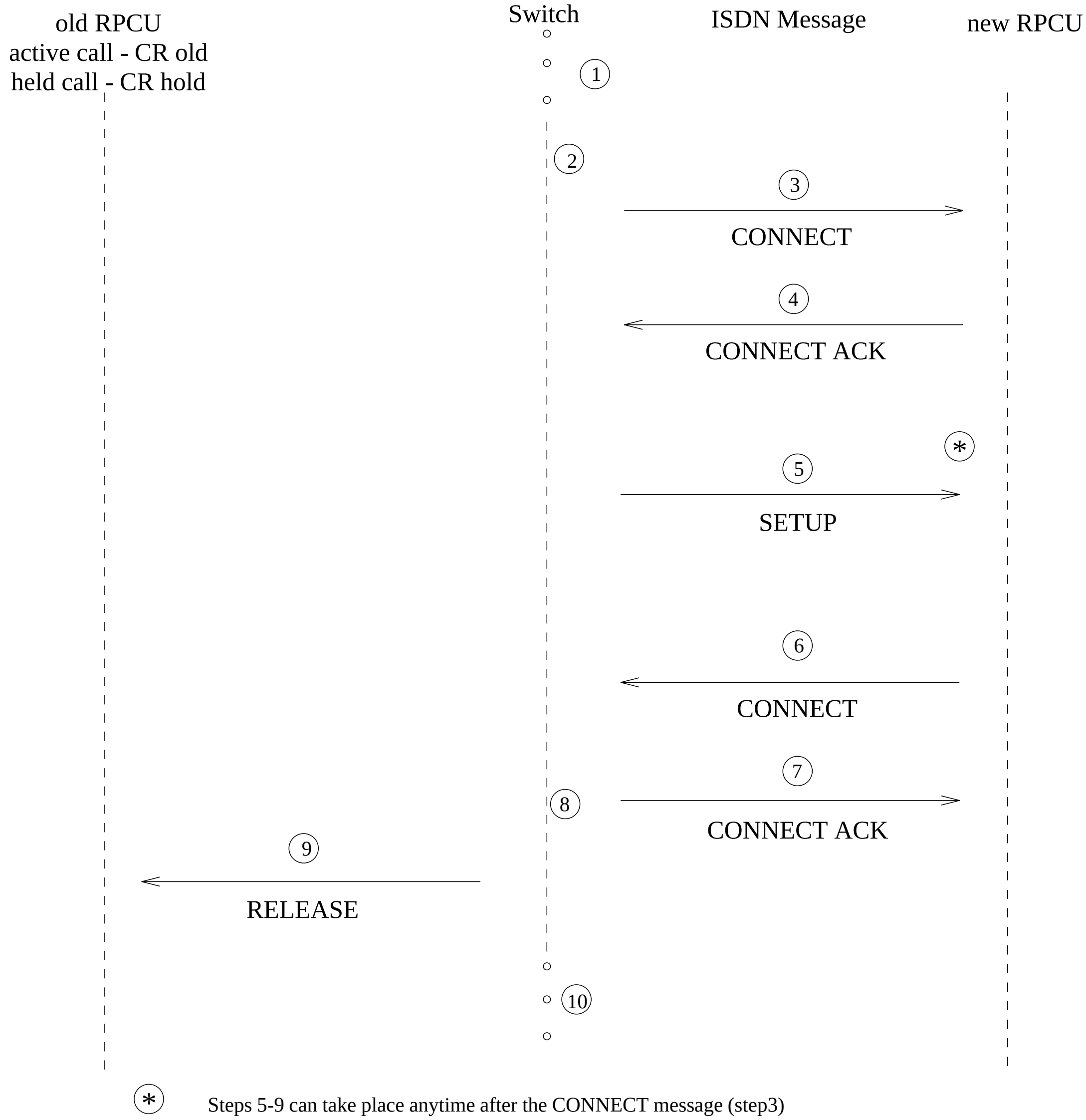
8. After the switch receives the FACility message including the permission for ALT, the switch sets up a 3-way connection (a bridge) between the remote party (the party that the PCS user is talking to at the time ALT occurs), old RPCU, and the new RPCU and sets a timer (ALTDISC). This 3-way connection must be arranged so that when the old RPCU disconnects, there will still be a 2-way connection between the remote party and the new RPCU. (The old RPCU should be viewed as the controller of the 3-way).

9. The switch sends the new RPCU an CONNect message (with CR-new) with a FIE with a return result component indicating permissionGranted and an operation of envelopeALTRequest. In addition, the CONNect message will pass the call specific information that was in the FACility message sent by the old RPCU (Step 7). The call specific information is in the EnvelopeContent.

10. The new RPCU returns an CONNect ACKnowledge message (with CR-new) to the switch.
11. The old RPCU, new RPCU and handset need to communicate so that the handset knows that arrangements in the switching network have been completed. It is assumed that the handset will inform the new RPCU that it is ready to change over to the new RPCU and will begin using the connection through the new RPCU. (This communication does not involve the switch.)
12. Once the handset informs the new RPCU that it is now using it as its connection to the switch, the new RPCU will send a REGISTER message (using NESS). The REGISTER message will contain information to indicate that an ALT has taken place and information that will allow the VLR/AM to update its current location of where the PCS handset is now (for example, radio call identifier, old PCS interface DN, new PCS interface DN, or MIN). This information is put in the envelopContent of the REGISTER message and the switch will not screen any of the envelopContent information. The RPCU determines what information is put in the REGISTER message.
13. The switch puts the appropriate information from the REGISTER message in an AIN TCAP NCA_Data message and sends the NCA_Data message to the VLR/AM.
14. The switch completes the NESS interaction by sending a RELease COMplete message to the new RPCU. (This releases the call reference that was used for the NESS. This is the same call reference that was used in the REGISTER message, Step 12.)
15. The VLR/AM updates the stored location of the handset (MIN associated with new PCS interface DN) and sends an AIN TCAP NCA_Data message to the switch. This NCA_Data message must include information that allows the switch to determine the proper old RPCU involved in the ALT and information that will allow the old RPCU to identify which ALT has been completed (for example, new PCS interface DN, old PCS interface DN, MIN, or radio call identifier). This information is put in the envelopContent and the switch will not screen any of the envelopContent information. The VLR determines what information is put in the NCA_Data message.
16. The switch takes the appropriate information from the NCA_Data message and puts it into a REGISTER message and sends the message to the old RPCU.
17. The switch completes the NESS interaction by sending a RELease COMplete message. This is the same call reference that was used in the REGISTER message in Step 16.
18. The old RPCU sends the switch a DISConnect message with CR-old as the call reference. The message indicates that the old RPCU wants to be removed from the call.

    Note: ALT Bridging is in effect from the time the switch receives permission from the old RPCU (Step 7) until the old RPCU send a DISConnect to the switch (Step 18). ALT is considered successful once the switch receives the DISConnect from the old RPCU. (This assumes that the switch has already sent the new RPCU the CONNect message in Step 9.)

19. The switch disconnects the B-channel associated with CR-old and responds with a RELease message.
20. The switch removes the 3-way conference circuit and retains the two-way connection between the remote party and the new RPCU.
21. The old RPCU releases the B-channel associated with CR-old, releases CR-old, and sends a RELease COMplete message to the switch. The switch will release the B-channel and CR-old on receipt of the RELease COMplete message.



(AM Resides in the SCP)

Figure 7.4-2 — Call Flow - Automatic Link Transfer with Call on Hold

1. Steps 1-7 are identical to the ALT call flow.

2. The switch determines that a particular feature is in use at the old RPCU (for example, CW).
3. The switch sends the new RPCU a CONNect message (with CR-new) with a FIE with a return result component indicating permissionGranted, which feature is in use (for example, CW) and an operation of envelopeALTRequest. The call specific information that was in the FACility message sent by the old RPCU (Step 7 in the ALT call flow) will be passed in the envelopContent.
4. The new RPCU returns an CONNect ACKnowledge (with CR-new) to the switch.
5. The switch sends the new RPCU a SETUP message with a signal value of alerting off, a no B-channel allocated indication, and a called number of the new interface DN, and a call reference of CR-hold.
6. The new RPCU responds to the switch with a CONNect (CR-hold).
7. The switch sends the new RPCU a CONNect ACKnowledge (CR-hold).
8. The switch associates the held call (CR-hold) with the new RPCU.
9. The switch sends the old RPCU a RELease message (CR-hold) with Cause 16, "normal clearing (location: public network serving local user)." (This will release the held call at the old RPCU.)
10. The rest of the call flow is identical to Steps 11-21 of the ALT call flow.

ABBREVIATIONS AND ACRONYMS

AC	Automatic Callback
ACE	Automatic Call Exclusion
ACO	Additional Call Offering
AI	Activation Indication
Ai	Action Indicator
AIB	Alarm Indication Bit
AP	Applications Processor
AR	Activate Request or Automatic Recall
ARS	Automatic Route Selection
ASP	Advanced Services Platform or Assignment Source Point
BC	Bearer Capability
BCLID	Bulk Calling Line Identification
BER	Bit Error Ratio
BN	Billing Number or Button Number
BRI	Basic Rate Interface
CA	Call Appearances
CACH	Call Appearance Call Handling
CAQ	Call Appearance Quantity
CAR	Computer Access Restriction
CCITT	International Telegraph and Telephone Consultative Committee
CcrcN	Corrupted CRC Notified
CcrcR	Corrupted CRC Requested
CCSA	Common Control Switching Arrangement
CdPN	Called Party Number
CdPS	Calling Party Subaddress
CES	Connection Endpoint Suffix
CgPN	Calling Party Number
CgPS	Called Party Subaddress
CIC	Carrier Identification Code
CLAMN	Called Line Address Modified Notification
CND	Calling Number Delivery
CNIS	Calling Number Identification Services
COT	Customer Originated Trace
CPE	Customer Premises Equipment
CPN	Calling Party Number

CRBL	Call Reference Busy Limit
CRC	Cyclic Redundancy Check
CRV	Call Reference Value
CSD	Circuit-Switched Data
CSV	Circuit-Switched Voice
CUG	Closed User Group
DCE	Data Circuit-Terminating Equipment
DDD	Direct Distance Dialing
DI	Deactivation Indication
DISC	Disconnect
DLCI	Data Link Connection Identifier
DM	Disconnected Mode
DN	Directory Number
DNT	Dialed Number Trigger
DOI	Disruptive NT Operation Indication
DR	Deactivate Request or Distinctive Ringing
DSL	Digital Subscriber Line
DTE	Data Terminal Equipment
DTMF	Dual Tone Multifrequency
DTSE	Detected Access Transmission System Error
EC	Echo Canceler
ECH	Echo Canceler with Hybrid
EDS	Electronic Directory Service
EI	Error Indication
EID	End Point Identifier
EKTS	Electronic Key Telephone Service (or Set)
EMC	Electromagnetic Compatibility
EOC	Embedded Operations Channel
EPSCS	Enhanced Private Switched Communications Service
ER	Emergency Ringback
ERWT	Expensive Route Warning Tone
ETS	Electronic Tandem Switching
Ext	Extension bit
FA	Feature Activation
FC	Flexible Calling
FCS	Frame Checking Sequence

FECV	Far-End Code Violation
FIT	Fully Initializing Terminal
FRMR	Frame Reject
FX	Foreign Exchange
HLC	High-Layer Compatibility
Hn	Go to State Hn
I-CNIS	ISDN Calling Number Identification Services
IBNAM	Implemented but no Active Messages
IC	Interexchange Carrier
ICI	ISDN Call Identification
ICLID	Individual Calling Line Identification
IDDD	International Direct Distance Dialing
IDP	Individualized Dialing Plan
IE	Information Element
IEC	Interexchange Carrier
ILMT	Insertion Loss Measurement Test
IR	Information Request
ISDN	Integrated Services Digital Network
ITU	International Telecommunications Union
Jn	Go to State Jn
LAPB	Link Access Procedure-Balanced
LAPD	Link Access Procedures for the D-Channel
LB	Loopback Requests
LB1N	B1–Channel Loopback
LB2N	B2–Channel Loopback
LCL	Longitudinal Conversion Loss
LDS	Long Distance Service
LLC	Low-Layer Compatibility
LP	Loss of Power
LRS	Loss of Received Signal
LT	Line Termination
LUTI	Loop-Under-Test Indication
M	Mandatory
MBK	Make-Busy Key
MCE	Manual Call Exclusion
MDNL	Multiple DNs per Line

MDR	Message Detail Recording
MHS	Message Handling Systems
MLHG	Multiline Hunt Group
MSB	Most Significant Bit
MSS	Message Service System
MWI	Message Waiting Indicator
NAI	Network Alarm Indication
NARTAC	North American Regional Technical Assistance Center
NBL	Notification Busy Limit
NCRV	Null Call Reference Value
NIC	Network Independent Clock
NIT	Noninitializing Terminal
NPCU	Normal Mode, One Power Consumption Unit
NPN	Network-Provided Number
NSAP	Network Address Service Access Point
NT	Network Termination
NTM	NT Test Mode
NT1	Network Termination Type 1
O	Optional
OCLID	Outgoing Called Line Identification
OCN	Original Called Number
ODB	On-Demand B-Channel
OS	Operations Support
OSA	Operator System Access
P/F	Poll/Final
PAM	Pulse Amplitude Modulation
PBG	Packet-Switched Data Business Group
PCU	Power Consumption Unit
PER	Protocol Error Record
PFA	Private Facilities Access
PIC	Polyethylene Insulated Cable
PPb	Power Primary Bad
PPD	Permanent Packet D-Channel
PRBS	Pseudo-Random Binary Source
PS	Power Status
PSb	Power Secondary Bad

PSD	Packet-Switched Data or Power Spectral Density
PVC	Permanent Virtual Circuits
PVN	Private Virtual Network
QM	Quiet Mode
RAO	Revenue Accounting Office
REJ	Reject
Ri	Reference Number
RN	Redirecting Number
RND	Redirecting Number Delivery
RNR	Receive Not Ready
ROLR	Receive Objective Loudness Rating
RPCU	Restricted Mode, One Power Consumption Unit
RPOA	Recognized Private Operating Agency
RR	Receive Ready
RSET	Reset
RUEOC	Reception of a Valid, but Unrecognized, EOC Message
Rx	Reception
SABME	Set Asynchronous Balanced Mode Extended
SAI	S/T Interface Activity Indicator
SAPI	Service Access Point Identifier
SBAC	Standard ISDN Basic Access TE Cords
SCA	Selective Call Acceptance
SCD	Selective Carrier Denial
SCF	Selective Call Forwarding
SCR	Selective Call Rejection
SDA	Selective Distinctive Alert
SDL	Specification Description Language
SFG	Simulated Facilities Group
SLE	Screen List Editing
SLP	Single Link Procedure
SNI	Subchannel Not Implemented
SPCS	Stored Program Control System
SPID	Service Profile Identifier
ST	Self-Test
STF	Self-Test Fail
STI	Self-Test Indication

STP	Self-Test Pass
SW	Synchronization Word
TE	Terminal Endpoint
TEI	Terminal Endpoint Identifier
TID	Terminal Identifier
TNS	Transit Network Service
TOLR	Transmit Objective Loudness Rating
TR	Technical Reference
TSP	Terminal Service Profile
Tx	Transmission
UA	Unnumbered Acknowledgment
UI	Unit Interval or Unnumbered Information
UO	Null
UOA	U-Interface-Only-Activation
USID	User Service Identifier
USOP	User Service Order Profile
USPID	User Service Profile Identifier
UTI	U-only Turn-on Indication
UTR	U-only Turn-on Request
XID	Exchange Identification