Lucent Technologies
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WaveStar® TDM 10G (STM-64)

Release 5.0.01

Applications and Planning Guide

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Notice

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About this information product

Purpose

This Applications and Planning Guide (APG) provides the following information about WaveStar® TDM 10G (STM-64):

- Features
- Applications
- Product description
- Operations and maintenance
- System engineering
- Product support
- Technical and reliability specifications

Reason for reissue

This is the first issue of this manual for Release 5.0.01.

Safety labels

Safety labels are not used in this guide.

Intended audience

The WaveStar® TDM 10G (STM-64) Applications and Planning Guide is primarily intended for network planners and engineers. In addition, others who need specific information about the features, applications, operation, and engineering of WaveStar® TDM 10G may find the information in this manual useful.

How to use this information product

Each chapter of this manual treats a specific aspect of the system and can be regarded as an independent description. This ensures that the reader can inform himself according to his special needs. This also means that the manual provides more information than needed by many of the readers. Before you start reading the manual, it is therefore necessary to assess which aspects or chapters will cover the individual area of interest.

The following table briefly describes the type of information found in each chapter.

Chapter	Title	Description
Preface	About This Document	This chapter • describes the guide's purpose, intended audience, and organization • lists related documentation • explains how to comment on this document
1	Introduction	This chapter • presents network application solutions • provides a high-level product overview • describes the product family • lists features
2	Features	Describes the features
3	Network Topologies	Describes some of the main network topologies possible with WaveStar® TDM 10G
4	Product Description	This chapter • provides a functional overview of the system • describes the hardware and configurations available for the product
5	Operations, Administration, Maintenance, and Provisioning	Describes OAM&P features (such as alarms, operation interfaces, security, and performance monitoring)

Chapter	Title	Description
6	System Planning and Engineering	Provides planning information necessary to deploy the system
7	Ordering	This chapter • provides information about the planning tool • discusses the use of a sparing graph
8	Product Support	This chapter • describes engineering and installation services • explains documentation and technical support • lists training courses
9	Quality and Reliability	This chapter • provides the Lucent Technologies quality policy • lists the reliability specifications
10	Technical Specifications	Lists the technical specifications
11	Circuit Pack Descriptions	Provides descriptions of the individual circuit packs on block diagram level
Appendix A	SDH Overview	Describes the standard for optical signal rates and formats
Appendix B	Port Unit Data Sheets	Describes the optical/electrical parameters of the port units (transmission circuit packs) used in WaveStar® TDM 10G
	Abbreviations and Acronyms	Expands common telecommunication abbreviations and acronyms
	Glossary	Defines telecommunication terms
	Index	Lists specific subjects and their corresponding page numbers

Conventions used

The following conventions are used throughout this manual:

Numbering

The chapters of this document are numbered consecutively. The page numbering restarts at "1" in each chapter. To facilitate identifying pages in different chapters, the page numbers are prefixed with the chapter number. For example, page 2-3 is the third page in chapter 2.

Cross references

Cross reference conventions are identical with those used for numbering, i.e. the first number in a reference to a particular page refers to the corresponding chapter.

Keyword blocks

This document contains so-called keyword blocks to facilitate the location of specific text passages. The keyword blocks are placed to the left of the main text and indicate the contents of a paragraph or group of paragraphs.

Abbreviations

Abbreviations used in this document can be found in the "Glossary" unless it can be assumed that the reader is familiar with the abbreviation.

Related documentation

This section briefly describes the documents that are included in the WaveStar® TDM 10G documentation set.

- Installation Manual
  The "WaveStar® TDM 10G (STM-64) Installation Manual" is a step-by-step guide to system installation and setup. It also includes information needed for pre-installation site planning and post-installation acceptance testing.
- Applications and Planning Guide
  The "WaveStar® TDM 10G (STM-64) Applications and Planning Guide" is for use by network planners, analysts and managers. It is also for use by the Lucent Account Team. It presents a detailed overview of the system, describes its applications, gives planning requirements, engineering rules, ordering information, and technical specifications.
- User Operations Guide
  The "WaveStar® TDM 10G (STM-64) User Operations Guide" provides step-by-step information for use in daily system operations. The manual demonstrates how to perform system provisioning, operations, and administrative tasks by use of WaveStar® CIT.

- Alarm Messages and Trouble Clearing Guide
  The “WaveStar® TDM 10G (STM-64) Alarm Messages and Trouble Clearing Guide” gives detailed information on each possible alarm message. Furthermore, it provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement..
- TL1 Reference Manual
  The “WaveStar® TDM 10G (STM-64) TL1 Reference Manual” serves as a reference for all TL1 commands which can be used to operate the network element. The manual also gives an introduction to the concept of the TL1 commands and instructs how to use them.
- SNMS Provisioning Guide
  The “WaveStar® TDM 10G (STM-64) SNMS Provisioning Guide” gives instructions on how to perform system provisioning, operations, and administrative tasks by use of WaveStar® SNMS.

The following table lists the documents included in the WaveStar® TDM 10G documentation set.

Document Number	Title
365-371-554	WaveStar® TDM 10G (STM-64) Applications and Planning Guide
365-371-556	WaveStar® TDM 10G (STM-64) User Operations Guide
365-371-555	WaveStar® TDM 10G (STM-64) Alarm Messages and Trouble Clearing Guide
365-371-558	WaveStar® TDM 10G (STM-64) Installation Manual
365-371-557	WaveStar® TDM 10G (STM-64) TL1 Reference Manual
365-371-559	WaveStar® TDM 10G (STM-64) SNMS Provisioning Guide

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1 Introduction

Overview

Purpose This chapter introduces the WaveStar® TDM 10G (STM-64).

Contents

WaveStar® TDM 10G (STM-64) Network Solutions

Overview

The WaveStar® TDM 10G Time Division Multiplexer (TDM) is a global platform design supporting both the SONET product version as well as the SDH product version.

This Application, Planning and Ordering Guide applies to the SDH version only which is referred to as the WaveStar® TDM 10G (STM-64). For information on the SONET version please ask for the WaveStar® TDM 10G (OC-192) Application, Planning and Ordering Guide.

The WaveStar® TDM 10G (STM-64) supports high-capacity, self-healing transport by means of an SDH-standard STM-64 line rate signal in an SDH-standard 2-fiber MS-SPRing protected ring. The feature set in Release 4 has common points with existing SDH transport products as well as an advanced set of market-proven features.

Key Features

Key features of the WaveStar® TDM 10G (STM-64) include:

- STM-64 and STM-16 2-fiber MS-SPRing transmission
- 1+1 Multiplex Section Protection (MSP)
- STM-1 (el), STM-1(o), STM-4 and STM-16 interfaces
- SX and LX Gigabit Ethernet interfaces
- 100% (64 x STM-1) add/drop capability to/from the STM-64 aggregate interfaces using any combination of available tributary interfaces
- flexible, non-blocking VC-4 (and VC-3, VC-4-4c, VC-4-16c) granularity cross connect
- TL1 operations interface
- TCP/IP and FTP over IP connectivity
- FTAM—FTP gateway (FT-TD)
- Provisionable SS bits
- manageable by WaveStar® SNMS element and subnetwork manager and WaveStar® CIT craft terminal.
- Partition Repair
- Gigabit Ethernet SX and LX with Link Pass Through
- Optical channel trace identifier provisioning
- STM-16 selective MS-SPRING NUT/NPPA.

Applications

WaveStar® TDM 10G is equipped with up to two STM-64 lines. It accesses the STM-64 signals with an unrestricted Time Slot Assignment (TSA) capability. If no MS-SPRing is required, Time Slot Interchange (TSI) within the STM-64 ring signal is also possible. Low-speed hairpin applications are supported to directly interconnect any tributary interfaces. Multiple ring applications are supported to directly interconnect added/dropped tributaries between STM-64 and STM-16 rings. The ability to support and efficiently interconnect multiple STM-16 rings and an STM-64 ring using a single Network Element provides the basis for advanced networking capabilities and potential cost savings to a large amount.

The start-up configuration consists of a single shelf. The design is in compliance with ETSI specifications.

Differentiators

The main differentiators of the product are:

- High drop capacity
- Distributed cross-connect capabilities
- No single point of failure in the network element (DNI, Dual Node Interworking)
- Extended range of low speed interfaces and data interfaces
- Integrated design (supports multiple ring applications in the network element)
- Compact design (one-shelf solution)
- Flexibility in applications and protection capabilities
- Easy installation & maintenance.

These features make the WaveStar® TDM 10G (STM-64) one of the most cost-effective, future-proof and flexible network elements available on the market today.

Configurations

Because of the modular design of the WaveStar® TDM 10G (STM-64), the system can be configured as:

- An Add/Drop Multiplexer (ADM) system working at STM-64 level in rings or linear chains
- A Terminal system working at STM-64 level in linear applications.

Management

Like most of the network elements of the Lucent Technologies SDH product portfolio, the WaveStar® TDM 10G (STM-64) is managed by Lucent Technologies WaveStar® SNMS, a user-friendly subnetwork and element level management system. On a network level, the network management system WaveStar® NMS can be used to manage, among others, the WaveStar® TDM 10G (STM-64) network elements. A local craft terminal, the WaveStar® CIT, is available for on-site, but also for remote operations and maintenance activities.

Interworking

The WaveStar® TDM 10G (STM-64) is a next-generation SDH transport system. The system can be deployed together with other Lucent Technologies SDH products, e.g. WaveStar® ADM-16/1, WaveStar® BandWidth Manager, WaveStar® DACS, and WaveStar® LXC-16/1 systems today and in the future. This makes the WaveStar® TDM 10G (STM-64) one of the main building blocks of today's and future SDH networks.

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The WaveStar® Product Family

Overview

Lucent Technologies offers the industry's widest range of high-quality transport systems and related services designed to provide total network solutions. Included in this offering is the WaveStar® family of products. The WaveStar® product family offers telecommunications service providers advanced services and revenue-generating capabilities.

Family Members

The WaveStar® family includes products designed to bring your networks forward into the next century.

The following table lists WaveStar® products that are currently available or under development.

WaveStar® Product	SONET	SDH
WaveStar® BandWidth Manager	Yes	Yes
WaveStar® 2.5G	Yes	No
WaveStar® TM1	No	Yes
WaveStar® AM1, AM1+	No	Yes
WaveStar® ADM 4/1	No	Yes
WaveStar® ADM 16/1	No	Yes
WaveStar® LXC-16/1	No	Yes
WaveStar® TDM 10G	Yes	Yes
WaveStar® TDM 40G Express	Yes	Yes
WaveStar® Optical Line System (OLS) 40G	Yes	No
WaveStar® Optical Line System (OLS) 80G	No	Yes
WaveStar® Optical Line System (OLS) 400G	Yes	Yes
WaveStar® LambdaRouter	Yes	Yes
WaveStar® DACS 4/4/1	No	Yes
WaveStar® Digital Video System (DVS)	Yes	No
WaveStar® External Orderwire (EOW)	Yes	Yes
WaveStar® Subnetwork Management System (SNMS)	Yes	Yes
WaveStar® Network Management System (NMS)	Yes	Yes

Family Features

The WaveStar® product family offers customers

- SDH and/or SONET-based services
- Scalable cross-connect, multiplex and transport services

- Network consolidation and reliability
- Interoperability with other vendors' products
- Coordination of network element and element management services

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WaveStar® TDM 10G Description

Overview

In its basic configuration, the WaveStar® TDM 10G is a single shelf that interfaces electrical and optical STM-1, optical STM-4 and STM-16 lines with an SDH-standard 2-fiber MS-SPRing protected ring in the add/drop multiplexer configuration or with an STM-64 line in the terminal multiplexer configuration. It has 16 tributary slots that support flexible optical and electrical port unit mixing. If additional capacity for tributary port units is required, the system can be expanded by one or more an extension shelfs. The shelves are in accordance with Rec. ETS 300 119-4 and can be mounted in an ETSI rack.

Transmission Interfaces

WaveStar® TDM 10G contains the following general types of port units:

- Optical Interfaces
- Electrical Interfaces

Optical Interfaces

STM-64 port units are available in the 1550-nm wavelength (intermediate reach and long reach as well as very long reach by use of optical amplifiers, additionally DWDM and passive WDM are supported with direct compatible interfaces).

STM-16 port units are available in two wavelengths:

- 1310 nm wavelength (very short reach, long reach)
- 1550 nm wavelength (long reach).

Additionally, DWDM is supported with direct compatible interfaces for OLS80G and OLS400G.

Each STM-16 port unit contains one bidirectional port. Two STM-16 port units are necessary for one STM-16 MS-SPRing.

STM-4 port units are available in two wavelengths:

- 1310 nm wavelength (very short reach and short reach)
- 1550 nm wavelength (long reach).

The STM-4 port units feature two bidirectional ports per circuit pack.

STM-1 port units are available for 1310 nm wavelength (short reach and long reach) single-mode fiber applications. The STM-1 long reach port units feature four bidirectional ports per circuit pack, the STM-1 short reach port units offer up to eight ports per circuit pack.

Gigabit Ethernet Interface

Gigabit Ethernet port unit with 2 bidirectional ports per circuit pack. Two types of circuit packs are available, one for short haul application with SX ports (850 nm) and one for long haul application with LX ports (1310 nm).

Electrical Interfaces

The electrical STM-1 port units are capable of transmitting and receiving signals at the 155 Mbit/s rate. Each port unit contains four independent bidirectional ports.

Control and Synchronization

WaveStar® TDM 10G uses a single control system and a dual synchronization system.

Switch Capacity

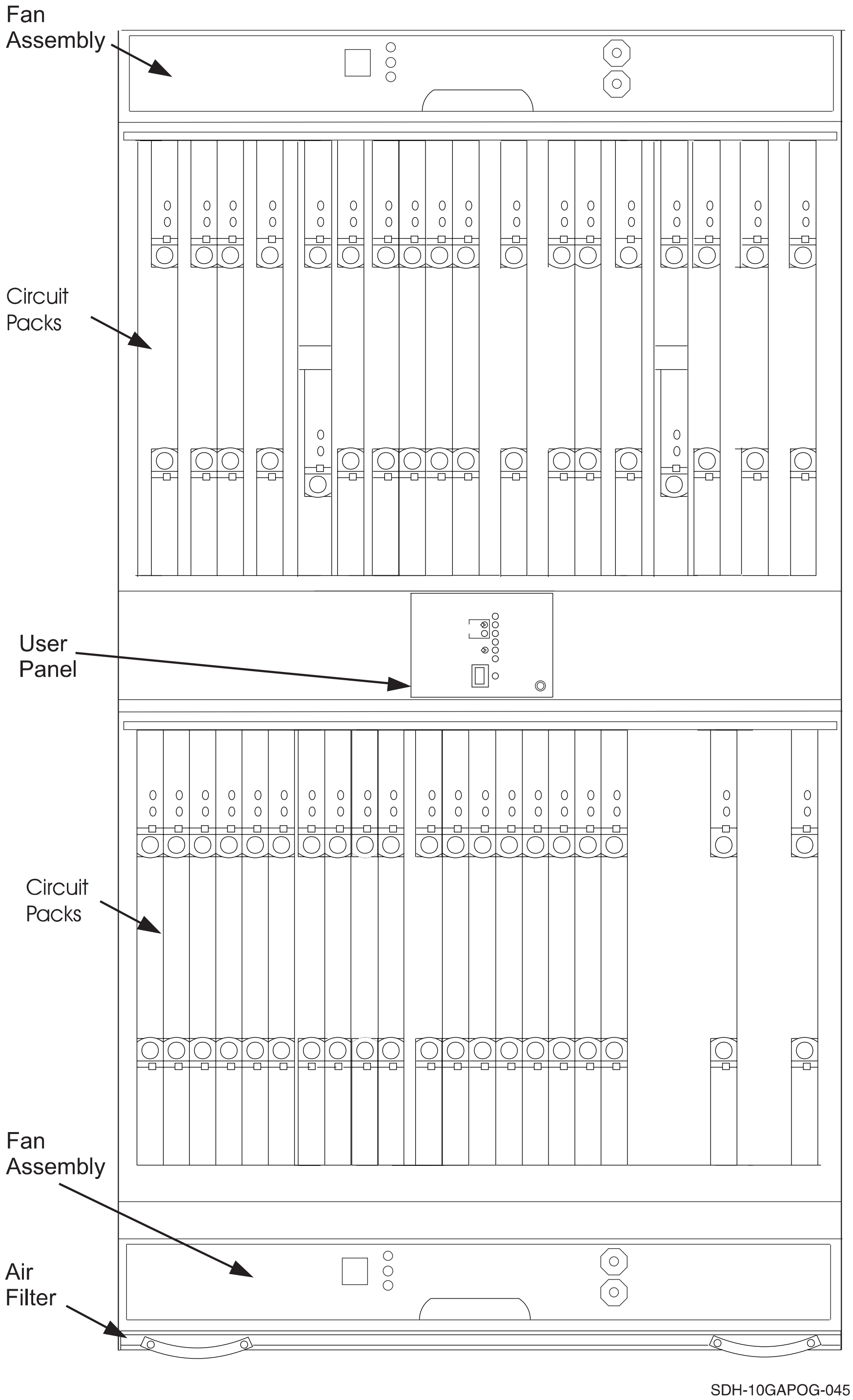
The 192x192 switch fabric (SWITCH/STS576) of the WaveStar® TDM 10G supports simultaneous cross-connections from each of up to 128 input STM-1 equivalents to all of the up to 128 output STM-1 equivalents. The cross-connections are fully non-blocking and can have unlimited broadcasting within a shelf.

The 256x256 switch fabric (SWITCH/STS768) allows 200% add drop functionality when PPA is used. It provides in comparison with the SWITCH/STS576 circuit pack an additional capacity of 64 STM-1 equivalents between the high-speed shelf and the low-speed shelves.

WaveStar® TDM 10G Main Shelf

The following figure illustrates the WaveStar® TDM 10G (STM-64) main shelf.

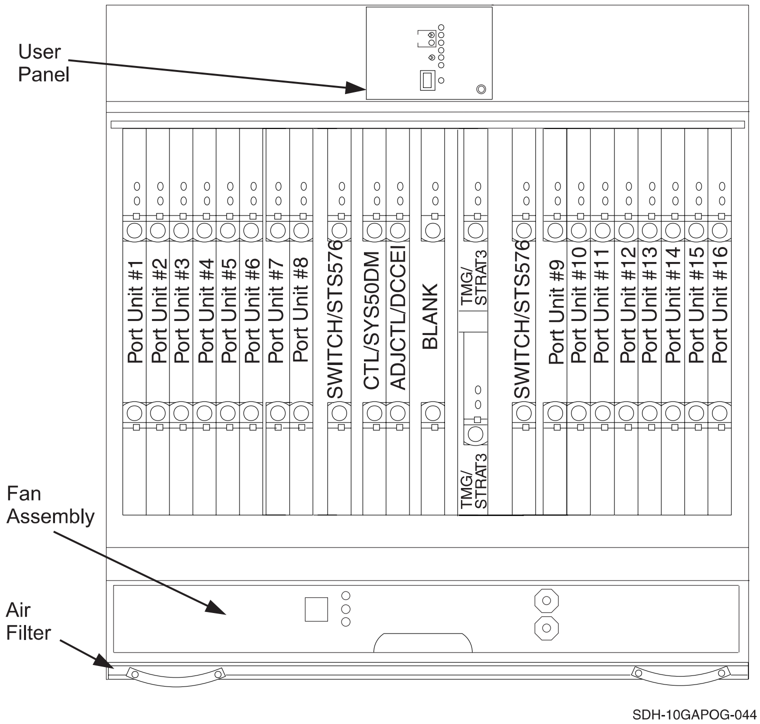
Figure 1-1 WaveStar® TDM 10G Main Shelf



WaveStar® TDM 10G Extension Shelf

The following figure illustrates the WaveStar® TDM 10G (STM-64) extension shelf.

Figure 1-2 WaveStar® TDM 10G Extension Shelf



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2 Features

Overview

Purpose

This chapter briefly describes the features of the WaveStar® TDM 10G (STM-64). The features have been grouped into the following areas:

- Line Transmission Interfaces
- Add/Drop Transmission Interfaces
- Administration and Provisioning
- Synchronization and Timing
- Maintenance.

Standards Compliance

Lucent Technologies SDH products comply with the relevant SDH ETSI and ITU-T standards. Important functions defined in SDH Standards such as the Data Communications Channel (DCC), the associated 7-layer OSI protocol stack, the SDH multiplexing structure and the Operations, Administration, Maintenance, and Provisioning (OAM&P) functions are implemented in Lucent Technologies product families.

Lucent Technologies is heavily involved in various study groups with ITU-T and ETSI work creating and maintaining the latest worldwide SDH standards. The WaveStar® TDM 10G (STM-64) complies with all relevant and latest ETSI and ITU-T standards.

Contents

Aggregate Transmission Interfaces

Introduction

WaveStar® TDM 10G (STM-64) supports an SDH line rate of STM-64 (10 Gbit/s). The add/drop multipexer configuration uses two STM-64 port units to interface wth a (MS-SPRing protected) ring. The terminal multiplexer uses one STM-64 port unit (or two STM-64 port units with 1+1 MSP) to interface with a point-to-point structure. Port units are available for 1550 nm transmission. WaveStar® TDM 10G (STM-64) does not support SONET service. The WaveStar® TDM 10G (OC-192) supports SONET OC-192 service.

1550 nm IR/SR

The WaveStar® TDM 10G OC192/1.5IR1 / OC192/1.5IRS1 port units support standard SDH signals over spans of up to 60 km or 40 km, respectively. The distance can be increased by using the Forward Error Correction (FEC) option.

2-fiber MS-SPRing is supported for the STM-64 interfaces.

1+1 MSP including preemptible protection access (low priority traffic) is supported for the STM-64 interface in the terminal multiplexer configuration.

1550 nm LR/VLR (with internal Optical Amplifier)

In order to bridge long distances without using Line Regenerators, optical amplifiers can be connected to the corresponding STM-64 optical interfaces.

They are suitable for long distance applications:

- as per ITU-T G.691, L-64.2a/3 (with optical booster amplifier): spans of up to 80 km can be bridged
- as per ITU-T G.691, V-64.2a/3 (with optical booster and pre-amplifier + Dispersion Compensation Module): spans of up to 120 km can be bridged.

Increased System Reach (with external OA)

Distances beyond 120 km can be bridged by using external optical amplifiers from the Ditech STAR series together with a WaveStar® TDM 10G STM-64 optical interface. An STM-64 interface circuit pack out of the DWDM compatible interfaces is used to best fit in this application. Dispersion Compensation Modules (DCM) accommodate to the fibre dispersion. With this configuration, span lengths up to 150 km or 38 dB link budget and link lengths of up to 5 x 125 km can be achieved. G.652 fibre characteristic is assumed for all given transmission link budgets and spans.

Forward Error Correction (FEC)

Forward Error Correction (FEC) makes it possible to lower the bit error ratio of an optical line signal by adding redundant information.

This redundant information can then be used to correct bit errors that inevitably occur when an optical line signal is transmitted over longer distances via an optical fiber.

Two types of FEC are supported:

- In-band FEC (also referred to as “multibit FEC”)
- Out-of-band FEC (also referred to as “strong FEC”)

Universal Optical Connectors

With the exception of the coloured interfaces for OLS 400G and the STM1o-8-port units (these units use the LC connector) all optical interfaces are factory-equipped with 0-dB SC-type connectors and are also capable of operating with FC-type and ST-type connectors. These connectors are attached to a universal buildout block on the port unit faceplate. The connectors are available in kits that provide several values of optical attenuation.

Optical Performance Parameters

The following optical perfomance parameters of the STM-64 interface can be retrieved:

- Normalized Laser Bias Current
- Optical Transmit Power
- Optical Power Received.

Automatic Laser Shutdown

In the event of Loss Of Signal (LOS) caused by a cable break or loose connectors, the ALS (Automatic Laser Shutdown) has the task of switching off the powered laser sources. The operating personnel are thus in no danger of being exposed to laser radiation emitted at unterminated ends of fibre-optic cables. This feature is enabled by default.

The following circuit packs, where applicable in connection with optical amplifiers (OBA10G, OBPA10G), support the ALS functionality:

- OC192/STM64/1.5IR1 (LEY69)
- OC192/STM64/1.5IRS1 (LEY97)
- OC192/STM64/WDM9310 .... (LEY228).

□

Tributary Transmission Interfaces

Overview

WaveStar® TDM 10G port units (transmission interface circuit packs) for STM-1(e), STM-1(o), STM-4, STM-16 and Gigabit Ethernet can be installed in port unit slots 1 through 16 in any combination consistent with the shelf capacity in the Main Shelf and in the Extension Shelf.

Electrical STM-1 Port Units

The electrical STM-1 port unit provides four electrical STM-1 ports. The system supports 1:N equipment protection (where N≤16) for the electrical STM-1 port units.

NOTE: It is not possible to pre-provision STM-1/E units. The unit should be inserted and initialized prior to provisioning.

STM-1 and STM-4 Port Units

The OC3/STM1/1.3SR4 and OC3/STM1/1.3LR4 port units provide four STM-1 ports.

The OC3/STM-1/1.3SR8 provides eight STM-1 ports.

The OC-12/STM4/1.3SR2, OC-12/STM4/1.3LR2 and OC-12/STM4/1.5LR2 port units provide two STM-4 ports. Each port supports G.957-compliant SDH signals over single-mode fibers.

1+1 MSP is supported for the STM-1 and STM-4 interfaces.

STM-16 Port Units

The OC48/STM16 port units provide one STM-16 port each. Each port supports G.957-compliant SDH signals over single-mode fibers. The OC48/STM16/1.3SR1 interface spans distances of up to 2 km. OC48/STM16/1.3LR1 interface spans distances of up to 51 km. The OC48/STM16/1.5LR1 interface is capable of supporting spans of up to 80 km. The optical properties of the DWDM port units are those of the corresponding Optical Translator Units (OTU).

1+1 MSP and 2-fiber MS-SPRing is supported for the STM-16 interfaces.

Optical performance parameters of the STM-16 interface can be retrieved.

Gigabit Ethernet

The following Gigabit Ethernet features are available:

Port Units

The GE1/SX2 port unit provides two Gigabit Ethernet (GbE) ports. Each port supports IEEE 802.3-compliant Ethernet signals over multi mode fibers. All connections to the 1000BASE-SX Ethernet interface on the GE1/SX2 port unit require Dual SC Connectors.

The GE1/LX2 port unit also provides two Gigabit Ethernet (GbE) ports. Each port supports IEEE 802.3–compliant Ethernet signals over single mode or multi mode fibers. All connections to the 1000 BASE-LX Ethernet interface on the GE1/LX2 port unit require Dual SC Connectors.

LCAS/VBA

The NE supports the technique of Link Capacity Adjustment Scheme (LCAS), previously known as Variable Bandwidth Allocation (VBA), for Gigabit Ethernet transport. LCAS defines a synchronization protocol between two termination points of a virtual concatenated path that allows in-service dynamic sizing of the VCn-xv bandwidth available for Ethernet over SDH transmission. This bandwidth change can occur either in response to a failure condition on one member or a change in bandwidth requirement at a NE (provisioning action). In case of a failure, the bandwidth will be restored automatically after the failure clears. The size of the VC4-xv is increased or decreased in steps of one VC4.

The provisioning is performed by connecting/disconnecting paths to/from the Ethernet tributary card.

Ethernet Performance Monitoring

It is possible to monitor byte and packet related performance parameters on any LAN port and any WAN port. The following counters are supported for each port:

- Outgoing number of Mbytes
- Outgoing number of Mframes
- Dropped frames – errors
- Incoming number of Mbytes
- Incoming number of Mframes.

Full VLAN List Support

The system supports 4093 VLANs per GbE circuit pack in IEEE VLAN tagging mode. The VLANs must be unique per port.

VLAN ID Transparency

The system supports operation promiscuous/buffereing repeater mode forwarding all Ethernet packets between one external LAN port and one internal WAN port without address filtering, address learning, spanning tree algorithm nor VLAN support. This mode can be selected per GbE port.

Auto-Negotiation Bypass

Normally, if an equipment with the auto-negotiation function enabled is connected to a link partner with the auto-negotiation function disabled, then the auto-negotiating equipment will declare an auto-negotiation error and will consider the link as down. Therefore, a two-way communication cannot be established.

"Auto-negotiation bypass" solves that problem. The functionality is as follows: if the system detects that the link partner is available but does not support auto-negotiation, then it bypasses the auto-negotiation and establishes the interface with a fixed configuration: Full-Duplex and Flow Control enabled. Moreover, no auto-negotiation error is detected.

Interface Mixing

The basic configuration of the WaveStar® TDM 10G (Main Shelf) supports up to 16 tributary port units in addition to the STM-64 port unit(s) used for the aggregate side. These can be any combination of STM-1(e), STM-1(o), STM-4, STM-16 and GbE port units. The number of possible port units can be increased by using an Extension Shelf together with the Main Shelf. The Extension Shelf can house up to 16 additional port units. The shelf layout which shows the location of the port units can be found in chapter 4.

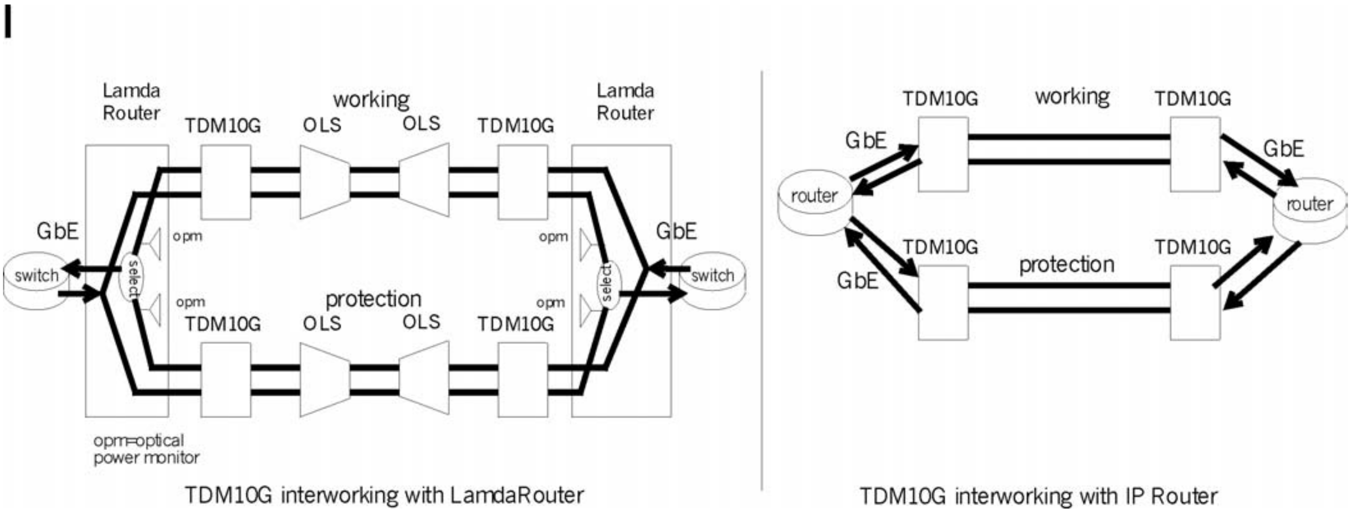
The numbers of tributary port units of a single type are:

Port Unit	Number of Units in Main Shelf	Number of Ports per Unit	Total Number of Ports	Port Protection
STM-1(e)	16	4	64	Unprotected or protected (1:N)
STM-1(o) LH	16	4	64	For protection of more than 8 units Extension Shelf necessary.
STM-1(o) SH	16	8	128	128 unprotected (partly filled); or 64 protected
STM-4	16	2	32	32 unprotected (partly filled), or 16 protected.
STM-16	8	1	8	8 unprotected (partly filled), or 4 protected.
GbE	8	2	16	16 unprotected (partly filled), or 8 protected.

Link Pass Through

If an Ethernet port is in Link Pass Through (LPT) mode, its GbE transmitter is disabled in case of failures in the upstream network: remote GbE fiber failure, SDH/SONET network failure or equipment failures. The downstream equipment, a LambdaRouter or an IP router, will observe the absence of GbE input signal and use it as a fast trigger to perform its native protection scheme. The two main applications for LPT are in networks with LambdaRouter or in networks with IP routers. In both cases LPT is used to enable or improve network protection schemes on the equipment external to the TDM10G systems.

Figure 2-1 Network application for LPT

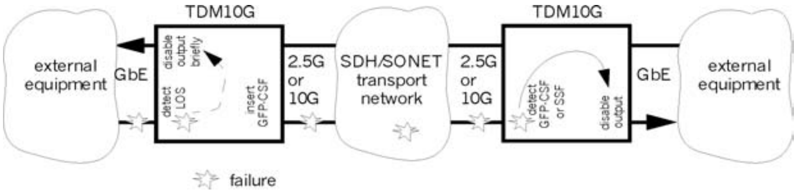


The LambdaRouter uses an optical power monitor to switch between working and protection input paths. Without LPT the TDM10G GbE outputs are never disabled, thus protection switching can not be done by LambdaRouter. In applications with IP-routers the IP router may have 2 or more parallel paths for IP over GbE transport. The LPT feature on TDM10G is used here to improve the detection speed of link failures and trigger the native IP layer protection or restoration scheme used by the IP router. Without LPT the IP router would wait for persistent absence of keep alive or hello PDUs before it can decide to trigger protection or restoration. In other words: LPT is not a protection feature itself, much more a way to make TDM systems in between routers behave as a 'fiber': no light in on the GbE port then no light out on the GbE port on the remote end.

LPT operation

LPT is supported on bi-directional links with a fixed LAN-WAN port relation. In those cases where the GbE receiver inputs do not have a LOS condition, the link can support uni-directional traffic. A GbE failure or an associated SDH path failure is forwarded by shutting off the GbE optical output. This makes the SDH network look like 'dark fiber'. Also, for a short period the local GbE output is disabled. At the remote end, when a GFP CSF indication is received on the WAN port or a Server Signal Fail (SSF) condition exists on the WAN port, the GbE output of the associated LAN port is disabled.

Figure 2-2 LPT operation



The reason for the temporary local GbE output disabling is that the GbE PCS layer disables frame transmission during GbE LOS on its GbE input; even if no fiber or node failure exists in that signal path direction. Thus the output must be briefly disabled to make sure that the external equipment switches over to the standby path. After detecting GbE input LOS, the local GbE output will be disabled, coincident with sending GFP_CSF to the remote end. The local GbE output will be re-enabled after T1 seconds or as soon as LOS disappears. T1 is 3 seconds. See figure below for timing sequence. Reception of GFP_CSF or SSF from the remote node overrules local GbE disable rules. The local GbE output is not permanently disabled during LOS because a deadlock condition would occur if the implementation of the external equipment is similar to TDM10G: both would permanently disable their outputs after a LOS condition; another reason is to prevent a permanent LOS of signal alarm condition at the external equipment.

Figure 2-3 LPT timing sequence

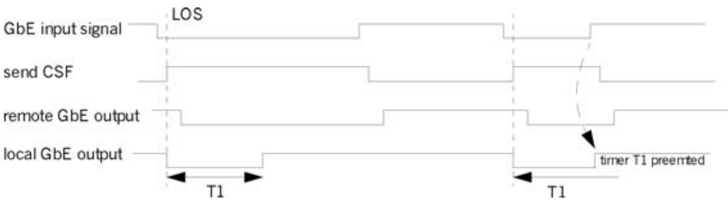
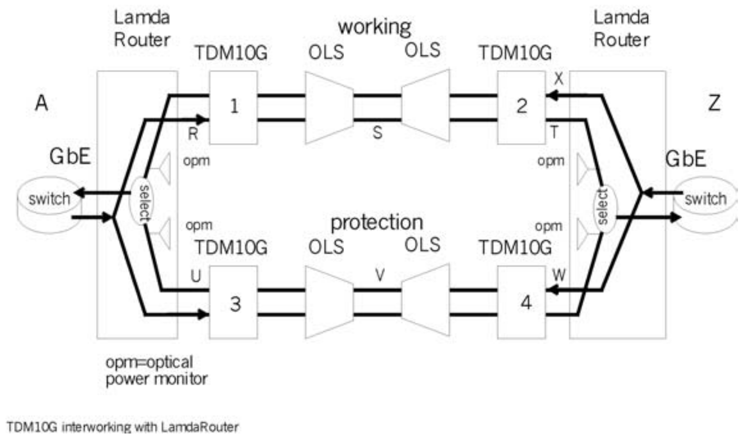


Figure 2-4 Protection scenarios, single or multiple failure conditions



A double fault at points R and V in figure above will lead to traffic failure, see table below for other path selections.

Failure	Remote action	Local action	A towards Z	Z towards A
S	output 2 disabled	none	via 3 and 4	same path as before failure
R	output 2 disabled	output 1 briefly disabled	via 3 and 4	via 4 and 3
T	none	none	via 3 and 4	same path as before failure
S & V	outputs 2 and 3 disabled	none	via 3 and 4	via 2 and 1
R & X	outputs 2 and 1 disabled	outputs 2 and 1 disabled	via 3 and 4	via 4 and 3
T & V	output 3 disabled	none	via 3 and 4	via 2 and 1
R & V	outputs 2 and 3 disabled	output 1 briefly disabled	via 3 and 4	-FAILED-

Due to implementation reasons of the GbE units in the TDM10G systems, these units no longer support autonegotiation when configured in LPT mode. Therefore autonegotiation must be disabled in the external equipment.

Instead external equipment must be configured as listed below:

- Full Duplex Gigabit Ethernet
- Flow Control setting is advised to be enabled

□

Data interfaces

Gigabit Ethernet interface

WaveStar® TDM 10G supports an optical 1-Gbit/s (1000BASE-SX) Ethernet interface, called GE1/SX4. This interface is in accordance with IEEE 802.3-2000 Clause 38. To optimize communication the Ethernet interface supports flow control and auto-negotiation, as defined in Section 37 of IEEE 802.3. This feature, among others, enables IEEE-802.3 compliant devices with different technologies to communicate their enhanced mode of operation in order to inter-operate and to take maximum advantage of their abilities.

The GE1/SX4 interface provides enhanced flexibility for Gigabit Ethernet packet routing, for example virtual concatenation, multipoint MAC bridge, VLAN trunking and Spanning Tree Protocol (STP) with Generic VLAN Registration Protocol (GVRP).

Each GE1/SX4 circuit pack offers four bidirectional 1000BASE-SX Ethernet LAN ports with LC connectors.

□

Ethernet features

Overview

The Gigabit Ethernet interface provides an enhanced feature set for flexible Ethernet over SONET/SDH transport.

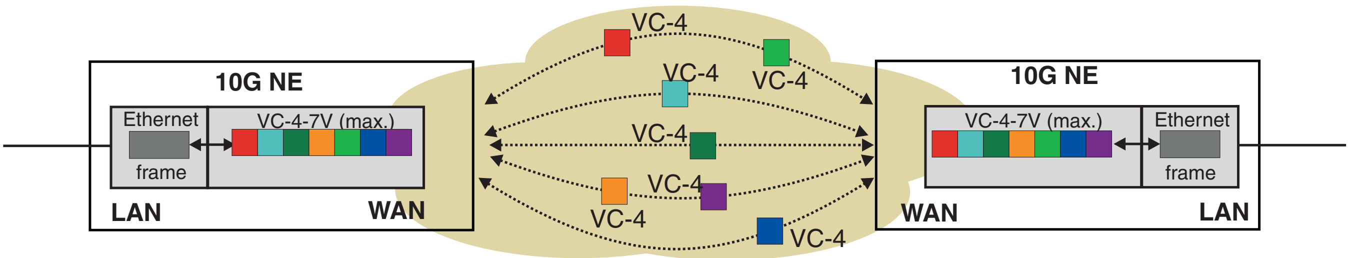
This section describes in brief some related features of WaveStar® TDM 10G:

- Virtual concatenation
- Link Capacity Adjustment Scheme
- Virtual LAN
- Repeater mode
- VLAN tagging
- Multipoint mode
- VLAN trunking
- Spanning Tree Protocol
- Rapid spanning tree protocol, planned for the next WaveStar® TDM 10G release
- Generic VLAN Registration Protocol

Virtual concatenation

The GE1/SX4 interface supported by WaveStar® TDM 10G allows you to transport Gigabit Ethernet (GbE) signals over SONET/SDH networks by encapsulating Ethernet packets in virtually concatenated Synchronous Payload Envelopes (SPEs, SONET) or Virtual Containers (VCs, SDH).

The following figure shows the principle of virtual concatenation in a point-to-point Gigabit Ethernet (GbE) application example. Protection of the VC-4-kv traffic is possible via UPSR/SNCP, via 1+1 line APS / 1+1 MSP and in ring topologies via BLSR/MS-SPRing protection schemes.



The H4 POH byte is used for the sequence and multi-frame indication specific for virtual concatenation.

Due to different propagation delay of the virtual containers a differential delay will occur between the individual virtual containers.

This differential delay has to be compensated and the individual virtual containers have to be re-aligned for access to the contiguous payload area. The WaveStar® TDM 10G re-alignment process covers at least a differential delay of 32 ms.

Link Capacity Adjustment Scheme

Link Capacity Adjustment Scheme (LCAS) is an extension to virtual concatenation that allows dynamic changes in the number of VC-4 channels per connection. In case channels are added or removed by management actions this will happen without loosing any customer traffic. LCAS allows a bandwidth service with scalable throughput in normal operation mode. In case of failure the connection will not be dropped completely only the affected VC-4s. The remaining channels will continue carrying the customer traffic. The implemented LCAS provides automatic decrease of bandwidth in case of link failure and reestablishment after link recovery.

The following unidirectional and bidirectional virtual concatenations are supported:

- VC-4-Kv, where K = 1 up to 7 in steps of 1.

The GE1/SX4 circuit pack allows to transport Gigabit Ethernet signals efficiently over SONET or SDH networks by encapsulating Ethernet packets in virtually concatenated VC-4, using the LCAS. This protection-by-load-sharing feature allows for efficient use of protection bandwidth, that can be added/removed hitlessly for Ethernet applications.

Virtual LAN

Virtual Local Area Networks (VLANs) can be used to establish broadcast domains within the network as routers do, but they cannot forward traffic from one VLAN to another. Routing is still required for inter-VLAN traffic. Optimal VLAN deployment is predicated on keeping as much traffic from traversing the router as possible.

VLAN supports the following advantages:

- Easy provisioning of VLANs
- Consistency of the VLAN membership information across the network
- Optimization of VLAN broadcast domains in order to save bandwidth
- Isolated service for different customers.

The operator configures VLANs on LAN ports, and GVRP takes care of configuring VLANs on Wide Area Network (WAN) ports in the most optimized way.

Repeater mode

The simplest form of Ethernet transport is to transparently forward all frames on the WAN that are transmitted by the end user via the LAN; this mode is called repeater mode (also referred to as promiscuous mode or no-tag mode). In this mode minimal provisioning is necessary.

VLAN tagging

In the VLAN tagging mode Ethernet frames are processed according IEEE802.1D and according to IEEE802.1Q. All frames on the network links have a single VLAN tag. This tag is either the tag that was created by the end-user equipment or it is inserted by the TransLAN switch on the incoming customer port (Port VLAN ID, PVID). On outgoing customer ports the earlier inserted VLAN tag is removed if a PVID is provided on that port. This is the same VLAN ID as on the associated incoming ports. This tagging scheme supports VLAN trunking: traffic from multiple different customers is multiplexed over one physical interface towards an IP router. Customer identification and isolation is done via the VLAN tag.

Its main functions are as follows:

- Media Access Control (MAC) address learning prevents that frames are forwarded over the WAN link while the destination is local. In practice however the end user would have a router or bridge connected to the LAN port that would already prevent such unnecessary frame forwarding.
- VLAN filtering could help in preventing forwarding unwanted or unnecessary VLANs of the WAN link; as above, in practice an external router or bridge would handle this.
- Priority queueing allows the operator to support service differentiation: high priority tagged frames are always forwarded before low priority tagged frames. In case of a low capacity WAN link low priority tagged frames are more likely to be dropped during congestion.

Multipoint mode

Multipoint applications provide flexible Ethernet network topologies: an end user has more than 2 sites that need to be connected. It is also possible to support multiple end users on the same Ethernet network, sharing the available bandwidth on the WAN ports over the SONET/SDH network.

A virtual switch is a logical grouping of Ethernet ports and Virtual Concatenation Group (VCG) ports that share interconnect and a common set of properties. The virtual switch is automatically instantiated as soon as the VLAN tagging mode is set to IEEE802.1Q multipoint mode. All 4 LAN ports and all 4 WAN ports of the GE1/SX4 circuit pack are part of the single virtual switch.

Regarding multipoint Ethernet service a more general terminology is needed to cover the functions of LAN and WAN ports. The new application focused terms are:

- customer LAN ports (formerly LAN ports)
- network WAN ports (formerly WAN ports)
- network LAN ports
- customer WAN ports.

By default, network ports participate in STP and GVRP, and customer ports have a PVID and a Valid VLAN list assigned. LAN ports default to customer port role and WAN ports to network role. All default values can be overridden.

VLAN trunking

Trunking applications are those applications where traffic of multiple end users is handed-off via a single physical Ethernet interface to a router or switch for further processing. This scenario is also called "back-hauling", since all traffic is transported to a central location, e.g. a point-of-presence (PoP) of a service provider. Trunking applications can be classified into two topology types, trunking in the hub-node and distributed aggregation in the access network.

Further reading

For further information please refer to the chapter "Traffic provisioning concepts" of the WaveStar® TDM 10G User Operations Guide.

Spanning Tree Protocol

The Spanning Tree Protocol (STP) is a standard Ethernet method for eliminating loops and providing alternate routes for service protection. Standard STP depends to information sharing among Ethernet switches/bridges to reconfigure the spanning tree in the event of a failure. The STP algorithm calculates the best loop-free path throughout the network. STP defines a tree that spans all switches in the network; it e.g. uses the capacity available bandwidth on a link (path cost) to find the optimum tree. It forces redundant links into a standby (blocked) state. If a link fails or if a STP path cost changes the STP algorithm reconfigures the Spanning Tree topology and may reestablish previously blocked links. The STP also determines one switch that will be the root switch; all leaves in the Spanning Tree extend from the root switch.

Rapid spanning tree protocol

Rapid Spanning Tree Protocol (rSTP) reduces the time that the STP protocol needs to reconfigure after network failures. Instead of several tens of seconds, rSTP can reconfigure in less than a second. The actual reconfiguration time depends on several parameters, the two most prominent are the network size and complexity. IEEE802.1w describes the standard implementation for rSTP.

This feature is planned for the next WaveStar® TDM 10G release.

Generic VLAN Registration Protocol

Generic VLAN Registration Protocol (GVRP) is an additional protocol that simplifies VLAN assignment on network ports and ensures consistency among switches in a network. Further it prevents unnecessary broadcasting of Ethernet frames by forwarding VLAN frames only to those parts of the network that have customer ports with that VLAN ID.

The operator configures VLANs on customer ports, and GVRP will take care of configuring VLANs on network ports - in the most optimized way. Note that GVRP and Spanning Tree Protocol interact with each other. After a stable Spanning Tree is determined (at initialization or after a reconfiguration due to a failure) the GVRP protocol will recompute the best VLAN assignments on all network ports, given the new Spanning Tree topology.

The provisioned VLANs on customer ports are called static VLAN entries; the VLANs assigned by GVRP are called dynamic VLAN entries. The dynamic VLAN entries need not be stored in NE's database. GVRP can be enabled (default) or disabled per virtual switch. Up to 64 VLANs can be supported through GVRP; an alarm will be raised if more then 64 VLANs are provisioned on an Ethernet network. The limitation stems from processor performance limitations. In a future release up to 4093 VLANs per "network" port will be supported if GVRP is disabled WaveStar® TDM 10G.

Further reading

For further information please refer to the chapter "Traffic provisioning concepts" of the WaveStar® TDM 10G User Operations Guide. For further information about the hardware implementation please refer to .

□

Administration and Provisioning

Unidirectional VC-3/VC-4 Cross-Connections

Unidirectional cross-connections on VC-3 (AU-3 based) or VC-4 (AU-4 based) level can be made for all supported SDH signal rates between tributaries on any two port units with appropriate mappings. The corresponding signal in the other direction of either tributary at either port unit can be independently cross-connected or terminated with no cross-connection. In the latter case, the system inserts an appropriate idle/unequipped signal at the output.

Bidirectional VC-3/VC-4 Cross-Connections

A bidirectional cross-connection on VC-3 (AU-3 based) or VC-4 (AU-4 based) level is created by connecting both directions of traffic between tributaries on any two port units with appropriate mappings. The path payload and path overhead are cross-connected transparently as a unit.

Unidirectional and Bidirectional VC-4-4c/VC-4-16c Cross-Connections

The WaveStar® TDM 10G can create unidirectional and bidirectional cross-connections for VC-4-4c/VC-4-16c payloads between ports.

DNI Cross-Connections

The WaveStar® TDM 10G provides a service selector for each STM-N tributary provisioned for Dual Node Interworking (DNI). The service selector selects the better of two received path-level signals in accordance with a given hierarchy of conditions. This release supports DNI with the Drop and Continue method. DNI is supported for each of the available cross-connection rates.

Bridged Cross-Connections (Broadcast)

An existing cross-connection is bridged by adding a one-way cross-connection from the existing input port to a second output port, resulting in a 1x2 broadcast. The WaveStar® TDM 10G supports bridging for each of the supported SDH cross-connection rates. You can bridge any existing cross-connection to a second output port without impairing the existing signal. Conversely, either half of a bridged signal can be taken down without impairing the remaining cross-connected signal.

> **Important!** The forwarding rate of multicast or broadcast frames is restricted to 1.1/N Gbit/s; where N is the amount of ports in the multicast group. Frame loss is to be expected at rates above 1.1/N Gbit/s.

Rolling Cross-Connections

The system supports facility rolling for all allowed cross-connection rates. Rolling means that for an existing cross-connection a new source can easily be selected, i.e. the cross-connection can be “rolled” to this new source.

Fully Non-Blocking Cross-Connect

The system is strictly non-blocking for all supported cross-connection arrangements (point-to-point, multi-cast allowable port type connections, etc.) among all transmission interfaces within the cross-connection capacity of the system. Thus, within the system cross-connect capacity, a desired cross-connection can always be made, regardless of the state of other cross-connections. New cross-connections and/or disconnections do not cause any bit errors on existing cross-connections.

Subnetwork Connection Protection (SNCP)

Subnetwork Connection Protection (SNCP) can be configured for STM-64, STM-16, STM-4 and STM-1 interfaces for all allowed cross-connection rates. The SNCP is based on non-intrusive monitoring of the sub-network connection (SNC/N). Add/drop of SNCP traffic is possible from/to all ports.

There are some limitations in case a big switch configuration is used. See “Sub-Network Connection Protection (SNCP)” (3-23)

Equipment Protection

To enhance the reliability of the system, equipment protection can be used. The WaveStar® TDM 10G provides redundancy of all important system functions:

- Timing Generator circuit pack (TMG)
- Cross-connect circuit pack (SWITCH/STS576, SWITCH/STS768)
- STM-1 electrical interface circuit packs (1:N equipment protection, N=max. 16)
- Power feed is maintained duplicated throughout the system.

Equipment Inventory

The WaveStar® TDM 10G automatically maintains an inventory of the following information:

- Type, version and serial number of each installed circuit pack
- Software release
- Enabled features

You can obtain this information by an inventory request command.

Equipping Check

The network element provides an equipping check to alarm invalid configuration or to prevent the operator from inserting wrong circuit packs.

Security The WaveStar® TDM 10G uses logins, passwords, authentication, and access levels to protect against unauthorized access. It also keeps a log.

OSI LAN Interface WaveStar® TDM 10G also communicates with remote logins, operations systems and management systems by means of the standard 7-layer OSI protocol over a LAN.

DCC Interfaces The system supports operations via the standard 7-layer OSI protocol over Data Communications Channel (DCC). DCC_R and DCC_M channels are available in STM-1o, STM-4, STM-16 and STM-64 signals. DCC channel protection switching is supported in conjunction with protection switching of the respective optical interface.

Local and Remote Software Downloads WaveStar® TDM 10G can download software from the WaveStar® Customer Interface Terminal (CIT), or from the WaveStar® SNMS subnetwork and element manager. Software downloading does not affect transmission or operations. Activating the newly downloaded software may affect operations but does not affect transmission.

J1/J0 Path Trace Access Including TIM processing SDH VC-N path trace (J1 Byte) TIM processing and SDH section trace (J0 Byte) read/write access (includes TIM processing). The system can generate and monitor an STM-N RSOH Trace (J0), as well as retrieving VC4 path trace messages (when cross-connection of those rates is supported) at any SDH ports. It supports ETS 300 417 compliant TIM processing.

WaveStar® CIT Operations, administration, maintenance, and provisioning (OAM&P) activities are performed using either the WaveStar® CIT or the operations system interface. The WaveStar® CIT is a customer-supplied Windows NT PC running the WaveStar® Graphical User Interface (GUI) software. You can plug it into the WaveStar® TDM 10G user panel or use it at a remote location to access the WaveStar® TDM 10G by means of a WAN. You can use the WaveStar® CIT to run a full featured GUI. The GUI provides access to the entire WaveStar® TDM 10G functionality and contains extensive menus and context-sensitive help.

2F MS-SPRing NUT This feature offers the user the possibility to exclude timeslots from the MS-SPRing protection.

The basic MS-SPRing feature offers ring protection on all VCs of an optical line. In that case the full protection bandwidth is used (all timeslots are subject to being bridged and switched).

A better availability can be achieved by deciding not to access a portion of the protection bandwidth in case of a protection switch, i.e. making some of the protection timeslots unaccessible for protection purposes, i.e. making the traffic in these selected timeslots non-preemptible. Traffic contained in such timeslots is called Non-preemptible Unprotected Traffic (NUT).

The feature allows also a mix of MS-SPRing and SNCP protected circuits in an STM-64 ring, with bandwidth optimisation.

NOTE: If a node is present in a ring, which is not capable of processing NUT (i.e. BWM), then NUT must be avoided on any timeslot!

Benefits

The feature provides the following benefits:

- Flexible network and network survivability configuration
- Extends range of traffic availabilities to be offered to carrier's customer
- Bandwidth optimisation
- Selective securisation of existing low priority traffic (temporarily or long term).

Enhancement

The non-preemtible protection access feature is implemented on STM-16 protection groups also.

IP Access

The WaveStar® TDM 10G supports three types of IP Access. In one case, the WaveStar® network element (NE) can serve as a TL1 Translation Device (T-TD) by being a gateway NE that allows an WaveStar® SNMS and/or WaveStar® CIT to communicate to other NEs on an OSI network through an IP access network. In the second instance, the WaveStar® NE can functionally encapsulate IP packets within OSI packets to be transmitted through the OSI network to the proper NE. This capability is called IP tunneling. In the third instance the WaveStar® TDM 10G is configured as an FTTD-FTP/FTAM gateway.

TL1 Translation

The WaveStar® TDM 10G can copy the application information within an IP packet into an OSI packet. Thus, all IP protocol information is lost. This translation is performed at the application layer. For each application, a specific gateway is needed. Separate gateways can be provided by a single WaveStar® NE.

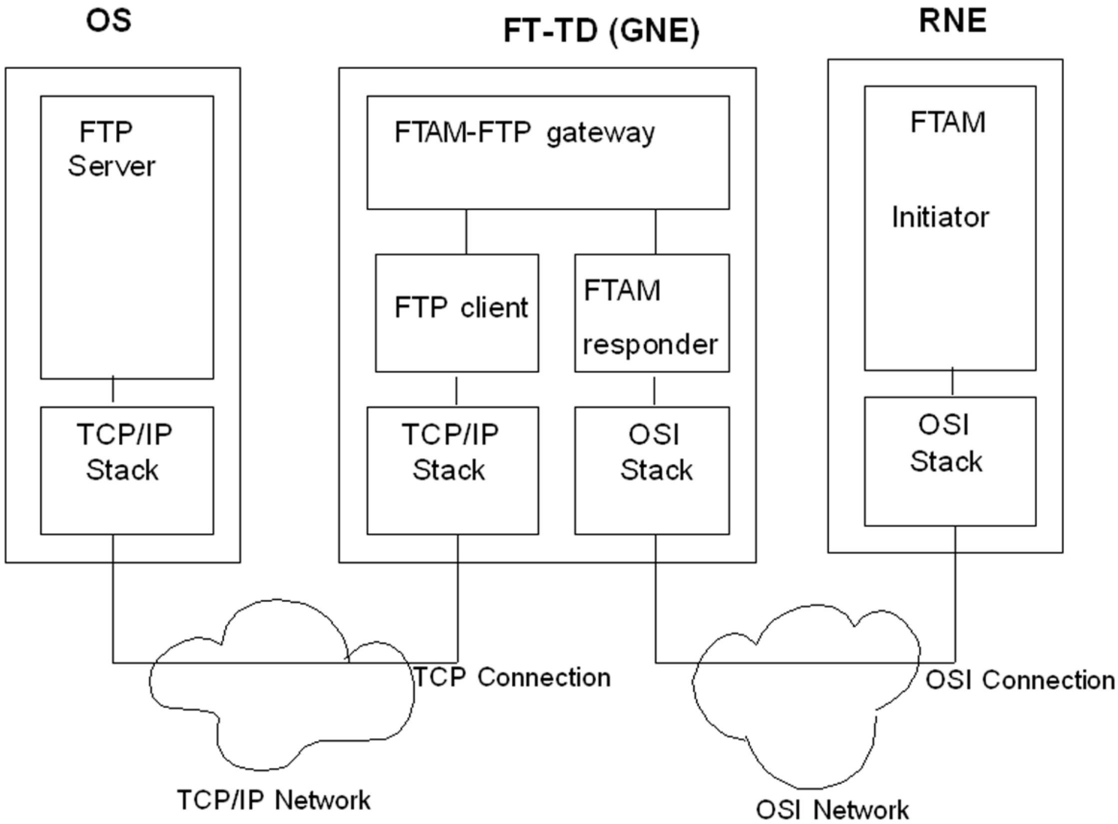
IP Tunneling

IP tunneling allows for file transfer through an IP access network. IP tunneling is used to perform end-to-end FTP through the OSI portion of the IP access network. In this instance the WaveStar® NE serves as a gateway NE that encapsulates an IP packet within an OSI packet. When the final destination of the file is reached, the IP packet is removed from within the OSI packet and processed by the TCP/IP stack. Thus, IP tunneling allows an WaveStar® SNMS and/or WaveStar® CIT to reach NEs in an OSI based DCN network with FTP over IP. In this case, the end points of the IP tunnel are the actual terminating points for the IP traffic.

FTAM—FTP gateway (FT-TD)

WaveStar® TDM 10G (STM-64) supports the FTAM-FTP gateway functionality, allowing file transfers across a mixed OSI and TCP/IP network. The FTAM-FTP gateway is used in a mixed OSI and IP network, where the access DCN is IP and the NEs being managed are in a OSI network. The FTAM-FTP gateway translates FTAM (File Transfer and Management) over OSI presentation to FTP over TCP-IP. The FTAM-FTP gateway is also referenced as FT-TD (File Transfer Translation Device).

Figure 2-5 FTTD-FTP/FTAM gateway (FT-TD)



Partition Repair

The Partition Repair feature is needed to allow management DCNs for large multi-ring networks to be designed such that single points of failure are avoided. The use of Partition Repair is restricted to those cases where the current mechanisms cannot avoid a single point of failure, even though a physical backup route is available.

Partition Repair provides a way to enhance the robustness of the DCN by providing the capability to repair intra-area routing using connections via nodes outside the area. This is done by creating a path outside the area, between two level 2 nodes (which are provisioned to be partition capable level 2 nodes) that belong to distinct partitions of the same IS-IS area. Level 1 IS-IS PDUs and CLNP PDUs are encapsulated and transferred over the level 2 path.

Note that network element types that do not support the Partition Repair feature, like ISM, LR16, FT2000 and LXC, can exist in the “repaired” areas; however, they cannot be part of the level 2 repair path (they are not able to be part of the level 1 tunnel through the level 2 domain).

An Network Element, or NE, is a physical box that contains a physical piece of equipment. A Network Element can contain one or more Nodes. A Node is a logical part of the DCN. It is the basic building block of the DCN. Both Intermediate Systems and End Systems are considered Nodes. Each Node is identified by exactly one NSAP. An NSAP, or Network Service Access Point, is the address of a Node. Each Node has exactly one NSAP that is unique in the entire network (usually, the NSAP is even globally unique). Routing and forwarding in each Node of a network is done using the target NSAP.

The terminology that is used in combination with the Partition Repair functionality requires some explanation. A node can be Partition Repair Capable, Partition Repair Compatible, and Partition Repair Designated. These terms are described below:

- A node is Partition Repair Capable if it is provisioned as such. Only possible end points of Partition Repair tunnels need be provisioned as Partition Repair Capable. Such possible end points must be attached level 2 nodes. (A level 2 node is called attached if it is able to forward packets to a different area, even if the level 2 node itself is not on an area boundary).
- A node is Partition Repair Compatible if a Partition Repair path can pass through the node. No provisioning is needed or required to make a node Partition Repair Compatible. Older NE types, like ISM, LR16, FT2000 and LXC, are ***not*** Partition Repair Compatible.
- A node is Partition Repair Designated if all other nodes in its area that are still connected to it via a level 1 path elect it as such. The election is done by choosing one node from the set of still-connected Partition Repair Capable nodes. If a Partition Repair Designated node of a certain area learns (by listening to level 2 communication) that there is another Partition Repair Designated node in the same area, both of these nodes conclude that their area is partitioned. They will then establish a Partition Repair path between each other. The Partition Repair path is a virtual level 1 connection between the two Partition Repair Designated nodes that runs through the level 2 domain. Level 1 packets are tunnelled through this virtual connection; this removes the area partitioning.

□

Synchronization and Timing

Overview

Several synchronization configurations can be used. The WaveStar® TDM 10G (STM-64) can be provisioned for:

- Free-running operation (SEC)
- Hold-over mode (SEC)
- Locked mode, where external station clocks or SDH signals can be used as timing reference.

Timing Unit Protection

In the Main Shelf, there are 2 Timing Unit circuit packs for each, the aggregate and the tributary side, to provide 1+1 non-revertive protection of the timing sources. If an Extension Shelf is used, this contains two Timing Unit circuit packs which also protect each other in a 1+1 equipment protection scheme.

Timing Reference Selection

Automatic timing reference switching is supported on signal failure of the active timing reference. If all provisioned timing references fail, the system will automatically switch over to the hold-over mode.

Synchonization Status Message

A Timing Marker or Synchronization Status Message (SSM, the S1 byte of the SOH) can be used to transfer the signal quality level throughout a network. This will guarantee that all network elements will always be synchronized to the highest quality clock available.

On the WaveStar® TDM 10G system, the ETSI SSM algorithm or Timing Marker is supported according to ETSI ETS 300 417–6. SSM is supported on all incoming and outgoing optical STM-N (N=1(o), 4, 16, 64) interfaces and on the external timing inputs and outputs (2.048 Mbit/s signals).

Reference selection based on the ETSI SSM algorithm can be disabled. In that case reference selection is based on signal status and priority only. Also the timing marker value forwarded to all STM-N ports is DUS.

External Netclock Outputs

The NE provides external timing output signals derived from the system clock or from the incoming aggregate signals. These output ports support 2048-kHz or 2.048-Mbit/s (framed/unframed) signals as per ITU-T Recommendations G.812 and G.703.

For clock regeneration applications an external timing loop can be provisioned between the external timing output and one or both external netclock inputs. The loop delay can be provisioned.

Synchronization Provisioning

The user has the possibility to provision manual timing reference switching, set priorities for timing sources, choose timing sources that are added to the sources list, lock out of individual timing sources, etc. using the customer terminal or the element manager.

Provisionable SS Bits

This feature allows users to provision the value of the bits 5 and 6, the SS bits, that are transmitted in the first H1 pointer byte of an VC-c signal. Present SONET (Telcordia) and SDH (ITU-T) standards require that these bits be ignored by the receiving equipment, however, some older embedded SONET and SDH equipment may not ignore these bits.

Provisioning the SS bits to “00” (overwrite enabled) can allow interworking with older embedded SONET equipment. Provisioning the SS bits to “10” (overwrite disabled) can allow interworking with older embedded SDH equipment. The SS bits are provisionable on a per shelf basis.

□

Maintenance

Two-Tiered Maintenance

The WaveStar® TDM 10G (STM-64) system maintenance procedures are built on two levels of system information and control. The first maintenance tier consists of the user panel display (LED's) and pushbuttons (all on the front of the shelf on the user panel), and the circuit pack faceplate light-emitting diodes (LEDs). These allow most of the typical maintenance tasks to be performed without the WaveStar® Customer Interface Terminal (CIT) or the WaveStar® SNMS element and subnetwork manager.

NE Level

Detailed information and system control is obtained by using the WaveStar® CIT (Customer Interface Terminal) which supports provisioning, maintenance, configuration on a local basis. A similar facility is remotely (via a Q-LAN connection or via the DCC channels) available on the WaveStar® SNMS, which provides a centralized maintenance view and supports maintenance activities from a central location.

Performance Monitoring

The WaveStar® TDM 10G monitors performance parameters on-board the transmission interfaces, so monitoring can be full-time for each signal without requiring any additional cross-connect capacity.

Transmission Maintenance Signals

Regenerator section, multiplex section, and high order path maintenance signals are supported as per ITU-T Rec. G.783. The OJ3 byte is an overhead optical channel overhead byte. This OJ3 byte is part of Lucent's proprietary overhead. The OJ3 byte can be provisioned at the transmit side only.

Circuit Provisioning Audits

The WaveStar® TDM 10G automatically maintains a record of the provisioned state of each transmit and receive port on each port unit (transmission circuit pack).

Operations Interworking

The WaveStar® TDM 10G's optical interfaces support operations interworking with

- WaveStar® ADM-16/1
- WaveStar® Bandwidth Manager
- WaveStar® OLS 400G directly via STM-64 interface (40 colors) or via OTU
- WaveStar® OLS 80G directly via STM-16 interface (16 colors) or via OTU
- WaveStar® LXC-16/1
- Intelligent Synchronous Multiplexer (ISM-1).

The interworking provides routing of messages across the DCC in support of user access, OS access, and element management.

The WaveStar® TDM 10G's electrical STM-1 interfaces support operations interworking with WaveStar® DACS 4/4/1 and ISM-1.

Full TL1 Command/Message Set

The WaveStar® TDM 10G supports the full TL1 command and message set. The WaveStar® CIT and the SNMS convert user inputs at the GUI into the corresponding TL1 commands and convert TL1 responses and messages into the GUI displays.

TL 1 Cut-Through Interface

The WaveStar® TDM 10G (STM-64) system provides a TL1 cut-through interface via WaveStar® CIT and WaveStar® SNMS. Thus, users can interact with the NE using the TL1 language directly. SNMS provides TL1 cut-through as a function within the GUI and also supports a special TL1 login. The TL1 cut-through is useful because it enables users to build custom macros of multiple TL1 commands coupled with a broadcast capability to send the TL1 commands to multiple NEs. Furthermore, TL1 cut-through is necessary for some infrequently used commands that are not supported by the SNMS GUI.

Loopback

The system supports two kinds of loopback for testing and maintenance purposes:

- Cross-Connect Loopback
  This loopback is available for each supported signal type. The VC is looped without being changed from its input port to its corresponding output port via the switch fabric. AIS is injected in the outgoing (cross-connected) direction.
- Facility Loopback (inloop, outloop)
  - Inloop:
    Loop back of the entire signal at the input port from receive interface to the corresponding transmit interface. Bipolar violations remain unchanged.
  - Outloop:
    Loop back the entire signal at the output port of the transmit interface to the corresponding input port of the receive interface.

Orderwire and User Channel

Access to the orderwire bytes X19 (for E1) and E2 and to the user channel byte X20 (for F1) is provided for the STM-64 interfaces. Thus, an external orderwire equipment can be connected to the system. Each channel is open for the customer to use as desired. The content of the signal on the channel is not monitored or alarmed. Up to 6 channels can be active simultaneously in one NE.

Local and Remote Inventory

The WaveStar® TDM 10G system provides automatic version recognition of the entire hardware and software installed in the system. Circuit pack types, versions and circuit pack codes (‘comcodes’) are accessible via the local CIT or via the SNMS Element Manager. This greatly simplifies troubleshooting, dispatch decisions, and inventory audits.

Pack Exchangeability

This feature allows the physical exchange of line and tributary circuit packs, which have a different apparatus code (LEY), but are functionally equivalent/compatible. It restores the provisioned connections, without being forced to de-provision and subsequently re-provision the card and all its traffic. It alleviates the logistic and operational work load, and minimizes the impact of service interruptions.

Upgrade SWITCH/STS576 to SWITCH/STS768

For dublicating the switch capacity the 256x256 switch fabric (SWITCH/STS768) is required in the high-speed part of the Main Shelf. It provides an additional capacity of 64 STM-1 equivalents. Besides the larger switch, also the corresponding PPROC/STS192 circuit packs have to be replaced by the PPROC/STS384 circuit packs (c.f. chapter 4).

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3 Network Topologies

Overview

Purpose

This chapter describes network topologies in which the WaveStar® TDM 10G (STM-64) add/drop multiplexer is used to increase reliability, lower costs and provide growth paths.

Contents

2-Fiber MS-SPRing

What is a 2-Fiber MS-SPRing?

A 2-fiber multiplex section shared protection ring (MS-SPRing) is a self-healing ring configuration in which traffic is bidirectional between each pair of adjacent nodes and is protected by redundant bandwidth on the bidirectional lines that interconnect the nodes in the ring. Because traffic flow is bidirectional between nodes, traffic can be added at one node and dropped at the next without traveling around the entire ring. This leaves the spans between other nodes available for additional traffic. Therefore, with many traffic patterns a bidirectional ring can carry much more traffic than the same facilities could carry if configured for a unidirectional ring. Additionally, the protection capacity can be used to provide unprotected transport for extra traffic when no failures are present.

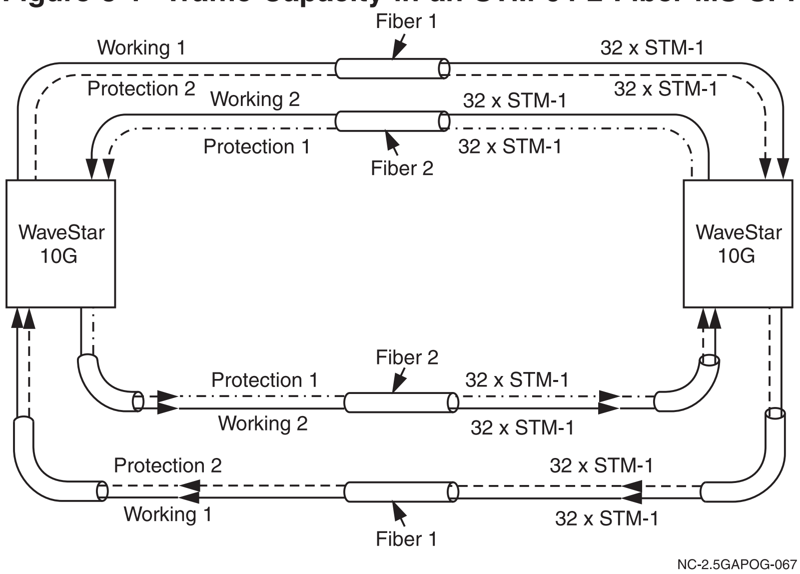
MS-SPRing in WaveStar® TDM 10G (STM-64)

WaveStar® TDM 10G (STM-64) provides the possibility to configure MS-SPRing for one STM-64 ring and for up to four STM-16 rings per shelf.

Traffic Capacity

The following figure shows working and protection traffic capacities in a WaveStar® TDM 10G STM-64 2-fiber MS-SPRing.

Figure 3-1 Traffic Capacity in an STM-64 2-Fiber MS-SPRing



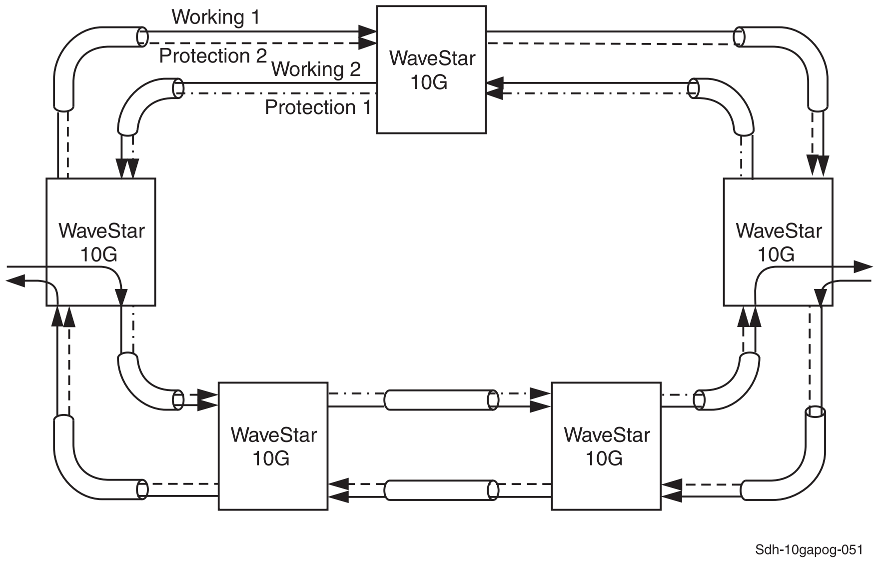
Self-healing Rings

WaveStar® TDM 10G 2-fiber MS-SPRings are self healing in that transport is automatically restored after node or fiber failures. In the case of an STM-64 MS-SPRing, each line carries 32 STM-1 equivalent timeslots of working capacity plus 32 STM-1 equivalent timeslots of protection capacity. For STM-16 MS-SPRing, the working capacity is 8 STM-1 equivalents, the protection capacity 8 STM-1. In the event of a fiber or node failure, service is restored by switching traffic from the working capacity of the failed line to the protection capacity in the opposite direction around the ring. (See Figure 3-2, "Normal Traffic Flow in an 2-Fiber MS-SPRing" (3-4) and Figure 3-3, "Loopback Protection Switch in a 2-Fiber MS-SPRing" (3-5).)

2-Fiber MS-SPRing Traffic Flow

The following figure shows normal (non-protection-switched) traffic flow in a WaveStar® TDM 10G 2-fiber MS-SPRing.

Figure 3-2 Normal Traffic Flow in an 2-Fiber MS-SPRing



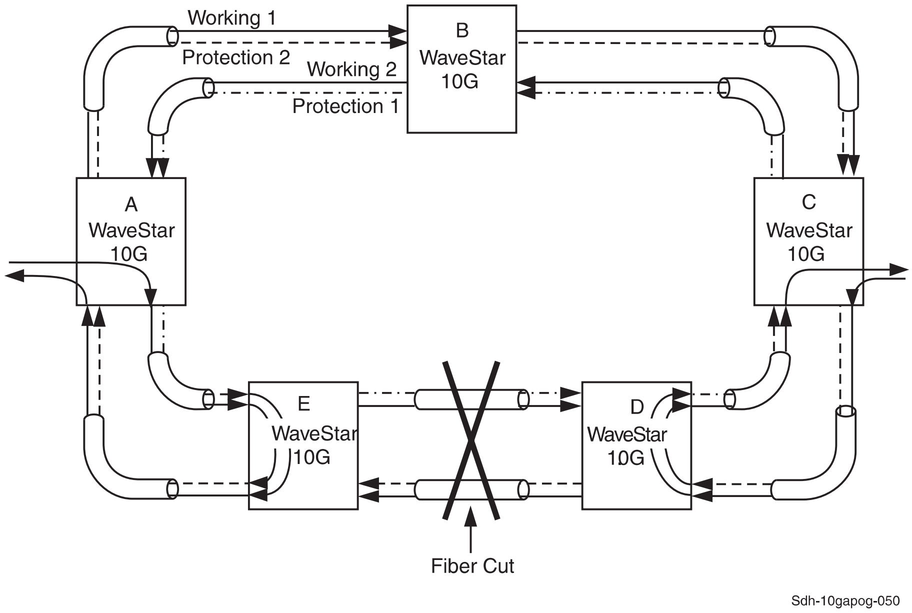
Protection Switching

When a line-level event triggers a protection switch, the affected nodes switch traffic on to protection capacity and transport it to its destination by looping it back the long way around the ring. (See Figure 3-3, "Loopback Protection Switch in a 2-Fiber MS-SPRing" (3-5).) Service is reestablished on the protection capacity in ≤ 50 milliseconds after detection of the failure (for catastrophic failures in rings without existing protection switches or extra traffic).

Fiber Cut Example

The following figure illustrates a 2-fiber MS-SPRing protection switch that results from a fiber cut.

Figure 3-3 Loopback Protection Switch in a 2-Fiber MS-SPRing



Protection Traffic Flow

In Figure 3-3, “Loopback Protection Switch in a 2-Fiber MS-SPRing” (3-5), traffic going from Node A to Node C that normally passed through Node E and Node D on “working 2” capacity, is switched onto the “protection 2” capacity of the line leaving Node E in the opposite direction. The traffic loops back around the ring via Node B, C, and D (where the loopback switch is active) to Node C. Similarly, traffic going from Node C to Node A that normally passed through Node D and Node E on “working 1” capacity is switched on to the “protection 1” capacity of the line leaving Node D in the opposite direction.

The same approach is used for a node failure. For example, if Node D were to fail, Nodes C and E would perform loopback protection switches to provide an alternate route for ring traffic.

□

Ethernet applications

Overview

Data services based on IP are becoming more and more important. With Ethernet being the native LAN interface for IP traffic, offering Ethernet interface based WAN transport services becomes an important element for competitive service offerings.

This section explains the Ethernet services and underlying applications supported by WaveStar® TDM 10G:

- Ethernet service types
- Inter-PoP (Point-of-Presence) services
- Corporate LAN interconnections

Ethernet service types

An Ethernet end-to-end transport service is the service that a service provider or operator delivers to an end-user, in which multiple access points of that customer are interconnected via physical Ethernet interfaces. The end-user Ethernet frames are transported transparently to the proper destination. A second type of Ethernet transport service is not really end-to-end, but is a back-hauling service whereby the end-user traffic is collected via a physical ethernet access interface and handed-off at a central location to a service node (most likely an IP edge router). In this case Ethernet provides a transport function for services at the IP layer.

These service types are grouped in three applications based on Ethernet network topology:

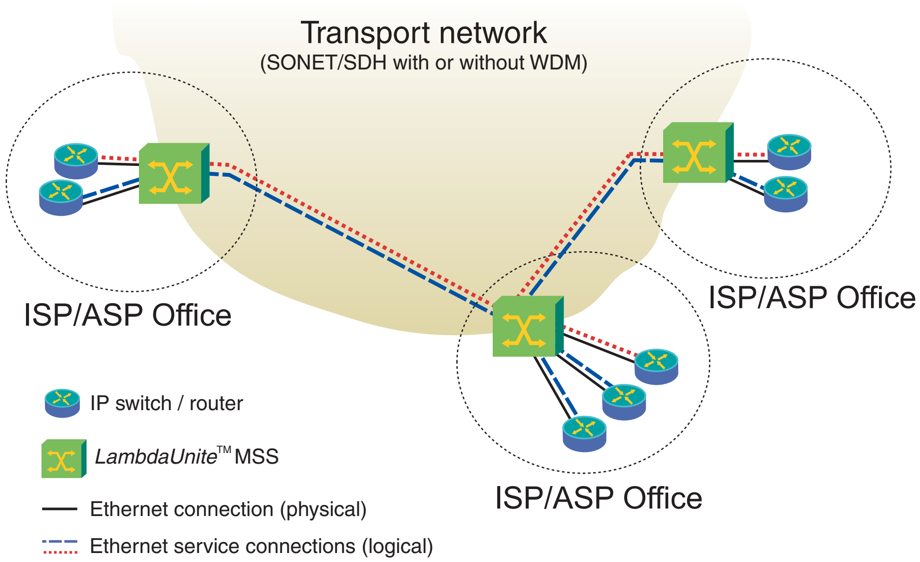
- point-to-point applications, see the first example of “Corporate LAN interconnections”
- multi-point applications, see the first example of “Inter-PoP services”
- trunking applications, see the second example of “Corporate LAN interconnections”.

For further information please refer to “Ethernet features” (2-13) and to the chapter “Traffic provisioning concepts” of the WaveStar® TDM 10G User Operations Guide.

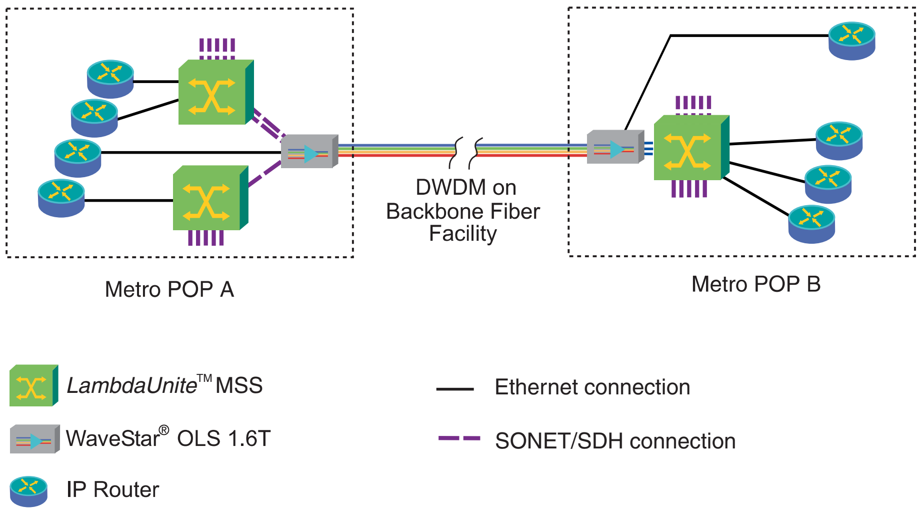
Inter-PoP services

Internet Service Providers (ISPs) and Application Service Providers (ASPs) need high but flexible bandwidth connections between their IP routers and their bandwidth wholesaler. An efficient solution for these connections are direct paths between the main routing locations (inter-PoP services) in the form of dedicated SONET/SDH and/or WDM signals, simply employing Ethernet interfaces in SONET/SDH add-drop-multiplexers.

This Hybrid Transport based on SONET/SDH with WaveStar® TDM 10G systems can provide high speed and simply leased line Ethernet connections between ISP/ASP offices over long distances, see the multi-point application example given in the following figure.



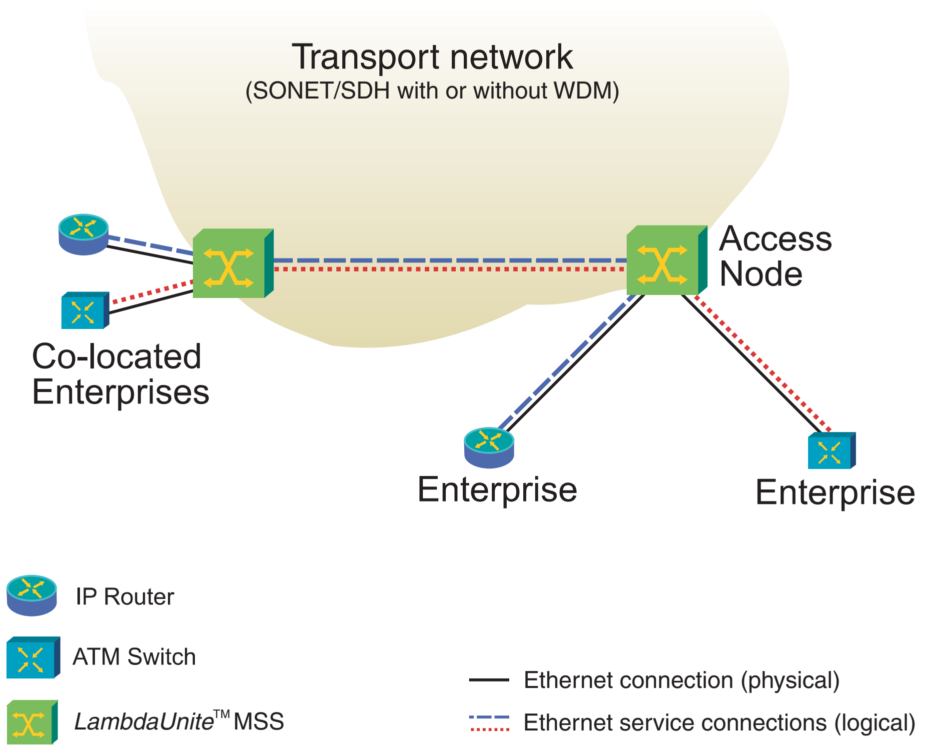
A specific option for high bandwidth between distant Metro POPs is to transport Gigabit Ethernet (GbE) traffic with Hybrid Transport over WaveStar® TDM 10G and WaveStar® OLS 1.6T (OLS 800G), based on SONET/SDH and Dense Wavelength Division Multiplexing (DWDM) solutions, as shown in the example given in the following figure.



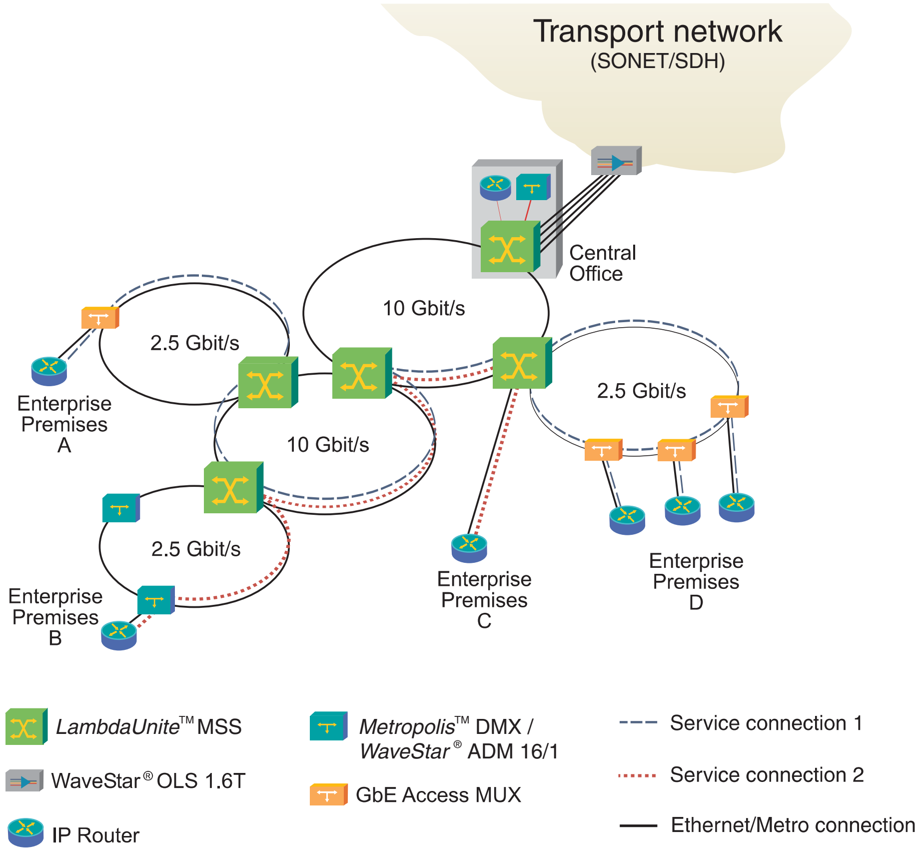
Corporate LAN interconnections

With the growing need to communicate across long distances, many enterprises find themselves faced with a severe problem: although they have Ethernet available in their Local Area Networks (LAN) in each of their geographically separated offices, a standard and cost-efficient way to connect them is missing.

Hybrid Transport with an Ethernet connection via WaveStar® TDM 10G systems over the public transport network (often referred to as Wide Area Network – WAN) provides a solution to this problem, connecting the different enterprise locations like in a single LAN. A schematic example for such a point-to-point corporate LAN interconnection with two WaveStar® TDM 10G systems is shown in the following figure.



The Lucent portfolio allows service providers to offer LAN interconnection services to their customers with throughput rates of up to 1 Gbit/s or 10 Gbit/s WANPHY. These high bandwidth service connections require a high capacity metro network, as shown in the following figure. In this example two corporate LAN interconnections are depicted, between enterprise premises A and D, and between B and C, employing WaveStar® TDM 10G as multi-ring terminals and in the central office, connecting the metro network over a WaveStar® OLS 1.6T (OLS 800G) system to the optical backbone transport network. In this figure also VLAN trunking is shown, for example in enterprise premises D.



□

Gigabit Ethernet Interfaces

Overview

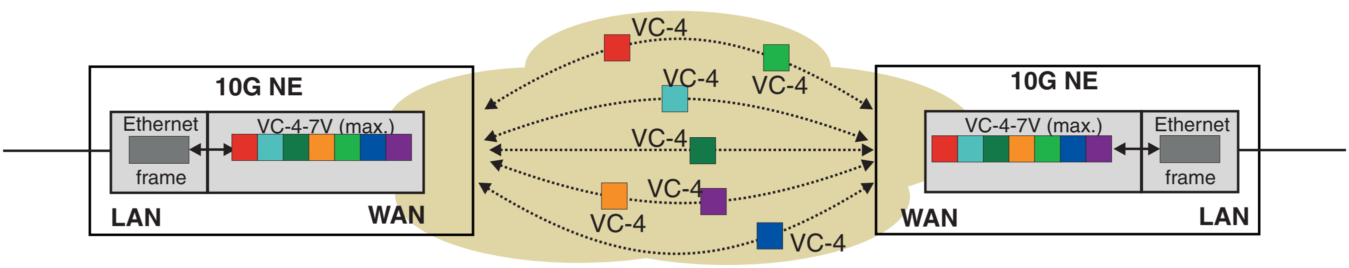
WaveStar® TDM 10G supports Gigabit Ethernet interfaces on the port units GE1/SX2 and GE1/LX2. The GE1/SX2 port unit conforms to the standards outlined in IEEE 802.3, and supports the 1000BASE-SX interface. The GE1/LX2 port unit also conforms to the standards outlined in IEEE 802.3, and supports the 1000BASE-LX interface.

Capabilities

The GE1/SX2 and GE1/LX2 port units supported by the WaveStar® TDM 10G allows you to transport Gigabit Ethernet signals over SDH networks by encapsulating ethernet packets in virtually concatenated VCs. The GE1/SX2 and the GE1/LX2 port units support point-to-point connectivity. Each GE1/SX2 port unit offers two 1000BASE-SX Ethernet LAN ports. Each GE1/LX2 port unit offers two 1000BASE-LX Ethernet LAN ports. Each port of both port units supports two Ethernet lines (one transmit and one receive, allowing full duplex operation). Each line can be associated with a virtual concatenated link over the SDH network (also called “WAN link”). The capacity per Gigabit Ethernet line is user provisionable to a maximum of 7 VC-4s. All connections to the 1000BASE-SX Ethernet interface on the GE1/SX2 port unit or to the 1000BASE-LX Ethernet interface on the GE1/LX2 port unit require Dual SC Connectors.

Virtual Concatenation

VC-4 concatenation can be used for the transport of payloads that do not fit into a single VC-4. Two methods for VC-4 concatenation are defined, contiguous and virtual concatenation. Both methods provide concatenated bandwith of X times Container-N at the path termination. The difference is the transport between the path termination. Contiguous concatenation maintains the contiguous bandwidth throughout the whole transport. It requires concatenation functionality at each network element. Virtual concatenation breaks the contiguous bandwidth into individual VCs, transports these VCs and recombines them to a contiguous functionality only at the path termination equipment i.e. the GE1/SX2 or the GE1/LX2 Gigabit Ethernet port unit.



The H4 POH byte is used for the sequence and multiframe indication specific for virtual concatenation.

Due to different propagation delay of the VC-4s a differential delay will occur between the individual VC-4s. This differential delay has to be compensated and the individual VC-4s have to be realigned for access to the contiguous payload area. The realignment process compensates at least a differential delay of max. 32 ms between the fastest and slowest VC-4.

LCAS/VCB

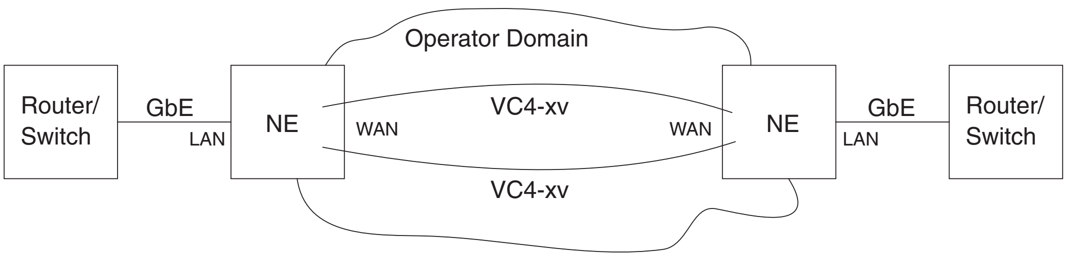
LCAS allows flexible resizing of the bundle: in-service bandwidth reprovisioning changes and automatic fall-down in case of failure on single VC4s (due to network or equipment failures or differential delay out of range). Objective is to have only short traffic hits during LCAS bandwidth changes comparable to those imposed by path or ring switching (SNCP or MS-SPRing).

Point-to-point connectivity

The following two figures show possible point-to-point Gigabit Ethernet (GbE) network applications.

SNCP or MS-SPRing protection

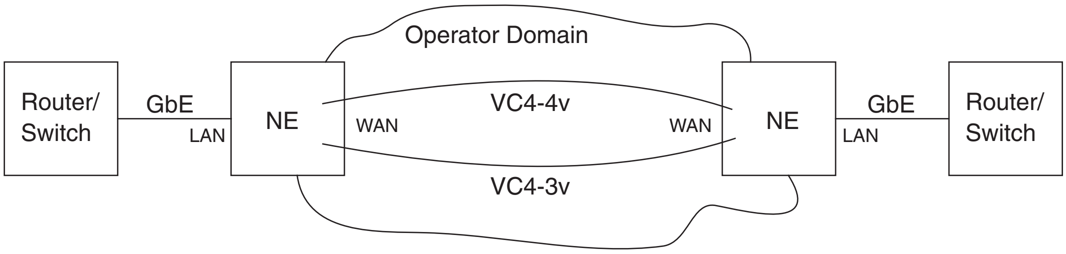
Protection of the individual VC-4s that form the VC-4-Xv is possible via SNCP and MS-SPRing protection schemes.



LCAS based protection

If that protection scheme is used half of the VC4s of the virtual concatenated bundle is routed over one fiber, the other half over another fiber. If one fiber fails, about half of the GbE WAN bandwidth is maintained during failures.

If MS-SPRing is available (optional): half of the VC4 is routed via pre-emptible protection access bandwidth.



Bridge Modes

The Ethernet Gigabit circuit pack supports two modes of bridge operation: VLAN tagging or repeater mode. The mode can be provisioned per LAN/WAN port pair.

VLAN Tagging

Customer identification and isolation on WAN ports is performed through VLAN tagging. In case the end user frames are untagged, a default LAN port based VLAN tag will be prepended to the end user frames. The FCS field is recalculated. In case the end user frames are already tagged those will be matched against the “valid VLAN list”. Unmatched frames will be discarded.

The VLAN tag is a 4 byte tag, formatted as a regular IEEE802.1Q VLAN tag. For detailed information of VLAN tag structure, refer to IEEE802.1Q, section 9.3.

A VLAN tag will always be present on WAN links although not strictly needed in point to point applications. The benefit is interworking with bridges supporting LAN based VPNs and VLAN trunking with multiple end users sharing one SDH path.

Repeater Mode

In the repeater mode the functionality is targeted at “transparent EtherNET transport”, with as few as possible provisioning items by the service provider.

The features of the repeater mode are:

- point-to-point topology
- no MAC address learning
- no spanning tree protocol
- no quality of service
- no VLAN ingress filtering or classification for end-customer tagged or untagged frames
- no VLAN tag inserted on the WAN link for untagged frames

- Ethernet performance monitoring per port is still applicable
- Flow control is still applicable.

□

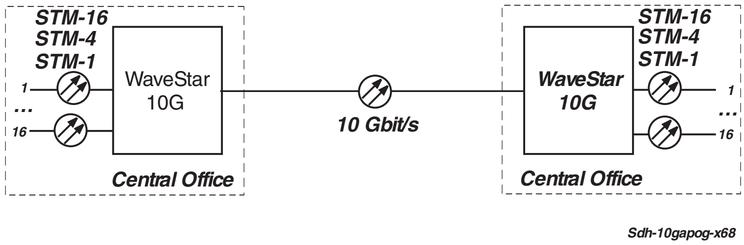
Point-to-Point (End) Terminal Application

Benefits

The typical network application of the WaveStar® TDM 10G (STM-64) Terminal Multiplexer is a 10-Gbit/s (STM-64) point-to-point terminal application. The main benefits here are increased transmission capacity and a smaller footprint compared to a 2.5 Gbit/s (STM-16) solution.

Concept

Figure 3-4 WaveStar® TDM 10G in a Point-to-Point Application



The 10 Gbit/s point-to-point application is served by two WaveStar® TDM 10G (STM-64) terminal multiplexers. To span longer distances without using a regenerator in intermediate nodes in-shelf optical booster amplifiers are part of the WaveStar® TDM 10G (STM-64) in the point-to-point application. A typical distance is up to 120 km. The span length can be increased to max. 150 km by using external optical amplifiers (cf. next section).

1x1 MSP

1x1 Multiplex Section Protection (MSP) including preemptible protection access (low priority traffic) for the STM-64 interfaces in the point-to-point application is supported as an option.

1+1 MSP

1+1 Multiplex Section Protection (MSP) without using preemptible protection access (low priority traffic) for the STM-64 interfaces in the point-to-point application is supported as an option (1+1 MSP is based on broadcasting).

□

Increased Span Length: External Optical Amplifiers

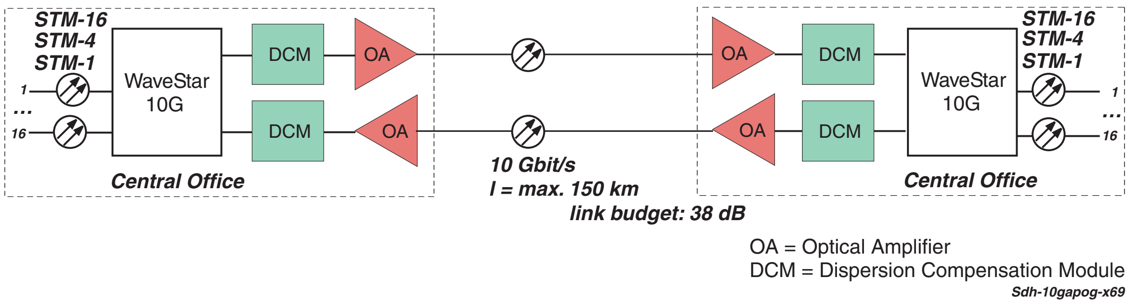
Benefits If STM-64 rings or point-to-point connections are used in a backbone network, situations might occur where the desired span length is beyond 120 km. Here, Lucent Technologies offers a solution which comprises the use of external optical amplifiers manufactured by Ditech Communications Corporation.

Concept Optical amplifiers out of Ditech's STAR series consist of one booster and one pre-amplifier part. The booster part is connected via a Dispersion Compensation Module (DCM) to the transmit interface of the respective STM-64 port unit. The STM-64 port unit used together with the STAR amplifier has to have a dedicated wavelength of 1549.32 nm. This requirement is met by the LEY228. For ordering information on this pack, please refer to chapter 7. The pre-amplifier part is connected via a Dispersion Compensation Module to the receive interface of the respective STM-64 port unit.

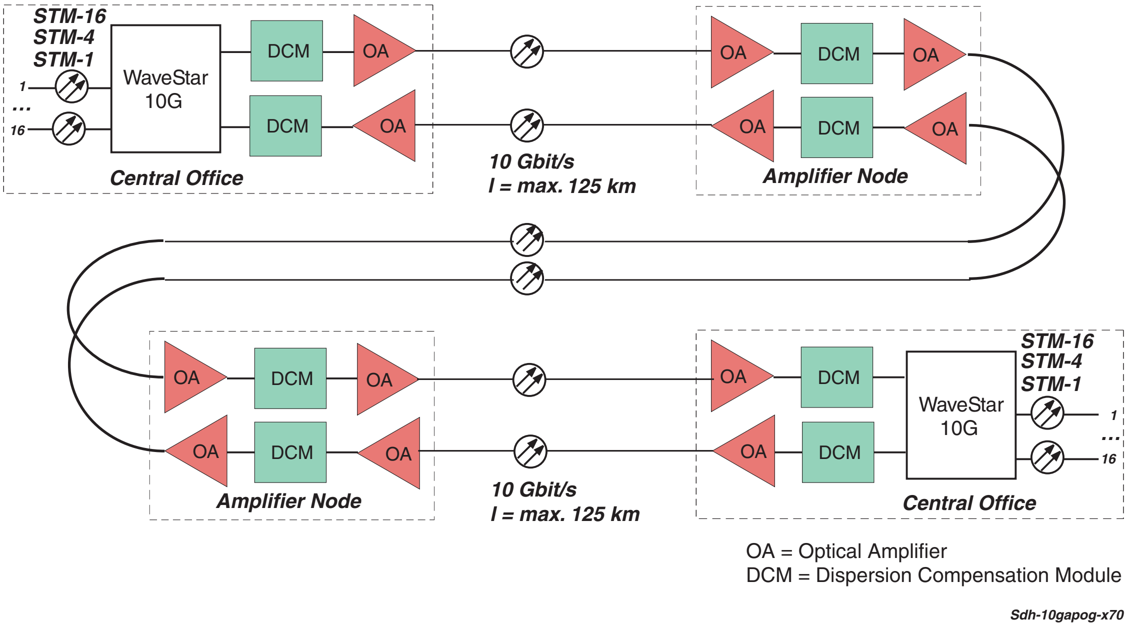
Applications Two main applications can be distinguished:

- Single span application
- Multiple span application

A simple example for a single span application is shown in the following figure.



An example for a 3-hop multispan application is shown in the following figure.



For long distances beyond 150 km, Ditech inline amplifiers can be used. In the amplifier nodes, one inline amplifier is needed for each direction. Up to 5 spans can thus be combined to a multispan connection of up to 5 x 125 km.

Management capabilities of Ditech amplifiers

The Ditech amplifiers in the WaveStar® TDM 10G network can be full, reduced or non remote managed. A proprietary local management connection is always available. For more information contact your Lucent Account Executive.

☐

Dual Node Ring Interworking (MS-SPRing – MS-SPRing)

What is Dual Node Ring Interworking?

Dual node ring interworking (DNI) is a configuration that provides path-level protection for selected STM-N circuits that are being carried through two rings. Protection for the route between the two rings is provided by interconnecting the rings at two places. (See Figure 3-5, "Dual Node Ring Interworking Protection" (3-18).)

Each circuit that is provisioned with DNI protection is dual-homed, meaning it is duplicated and subsequently terminated at two different nodes on a ring. The two interconnecting nodes in each ring do not need to be adjacent.

DNI Protection

The self-healing mechanisms of the two rings remain independent and together protect against simultaneous single failures on both rings (not affecting the interconnections). The DNI configuration additionally protects against failures in either of the interconnections between the rings, whether the failure is in a facility or an interconnection node.

Interworking

All WaveStar® TDM 10G tributary interfaces (STM-16, STM-4 and STM-1) can support dual node ring interworking. A WaveStar® TDM 10G STM-64 ring can interwork with 2-fiber MS-SPRing, including rings using

- WaveStar® BandWidth Manager
- WaveStar® TDM 10G (STM-64)
- WaveStar ADM16/1 STM-16 interfaces

Additionally, there can be intermediate network elements in the interconnection routes between the two rings.

Primary and Secondary Nodes

In the MS-SPRing, a bidirectional DNI-protected circuit to and from the terminating node is added and dropped at both a primary node and a secondary node, both of which interconnect with the other network. The primary and secondary nodes are defined and provisioned on a per-circuit basis.

Drop and Continue

WaveStar® TDM 10G supports the drop and continue method of DNI, in which the primary node is between the terminating node and the secondary node and is the node that performs the drop-and-continue and path-selection functions. The primary node drops the circuit in the direction of the other network and also continues (bridges) the circuit to the secondary node. The secondary node drops the circuit in the direction of the other network and adds the circuit from the other network in the direction of the terminating node. The primary node either adds the circuit received on its tributary interface from the other network, or else passes through the duplicate signal received on the line from the secondary node, depending on standards-compliant path selection criteria.

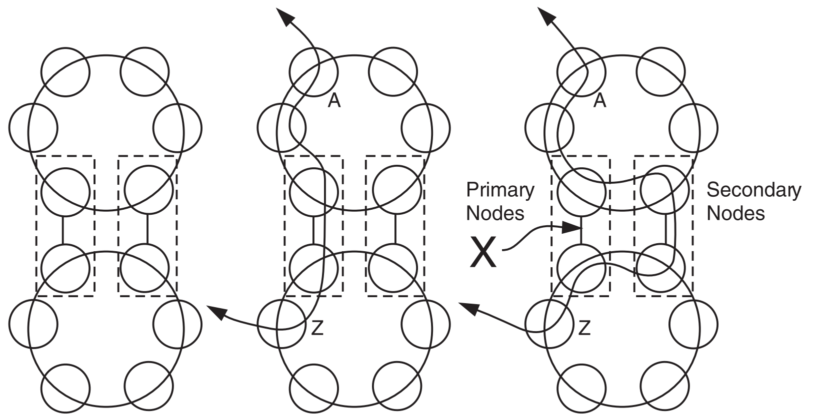
Protection Switching Example

The following figure illustrates a failure of the interconnection to a primary node at the point labeled "X" in the figure. The failure results in a DNI switch at the primary node in the top ring. A DNI protection switch in a WaveStar® TDM 10G occurs in ≤ 50 milliseconds (not counting the detection time) plus a provisionable hold-off time nominally of 100 milliseconds.

DNI Traffic Flow

The following figure shows a DNI configuration transporting traffic between nodes A and Z.

Figure 3-5 Dual Node Ring Interworking Protection



Types of Connections

The two types of connections shown in Figure 3-6, "DNI Between WaveStar® TDM 10G MS-SPRing and WaveStar® ADM16/1 STM-16 Ring" (3-20) are

- a direct intraoffice connection between the primary nodes, Node 1 and Node 2, at the first central office (CO 1).
- an optically extended, direct secondary connection between the secondary nodes (Node 3 at the second central office (CO 2) and Node 4 of the WaveStar® ADM16/1 STM-16 ring). This type of connection is achieved through the STM-1 low-speed interfaces at the interconnected nodes and can go through other equipment.

Both types of connections can be used in either primary or secondary nodes.

Collapsed Nodes

A further, more sophisticated, possibility is to use the WaveStar® TDM 10G (STM-64) itself as the DNI node. Via the STM-16 interfaces, the STM-16 ring can be directly connected to the WaveStar® TDM 10G (STM-64), as depicted in Figure 3-8, “DNI Between WaveStar® TDM 10G MS-SPRing and WaveStar® ADM16/1 STM-16 Ring (Collapsed Node)” (3-22). So, the complete DNI node is included in one network element.

DNI Protection Switching

STM-1, STM-4 or STM-16 SDH Interface

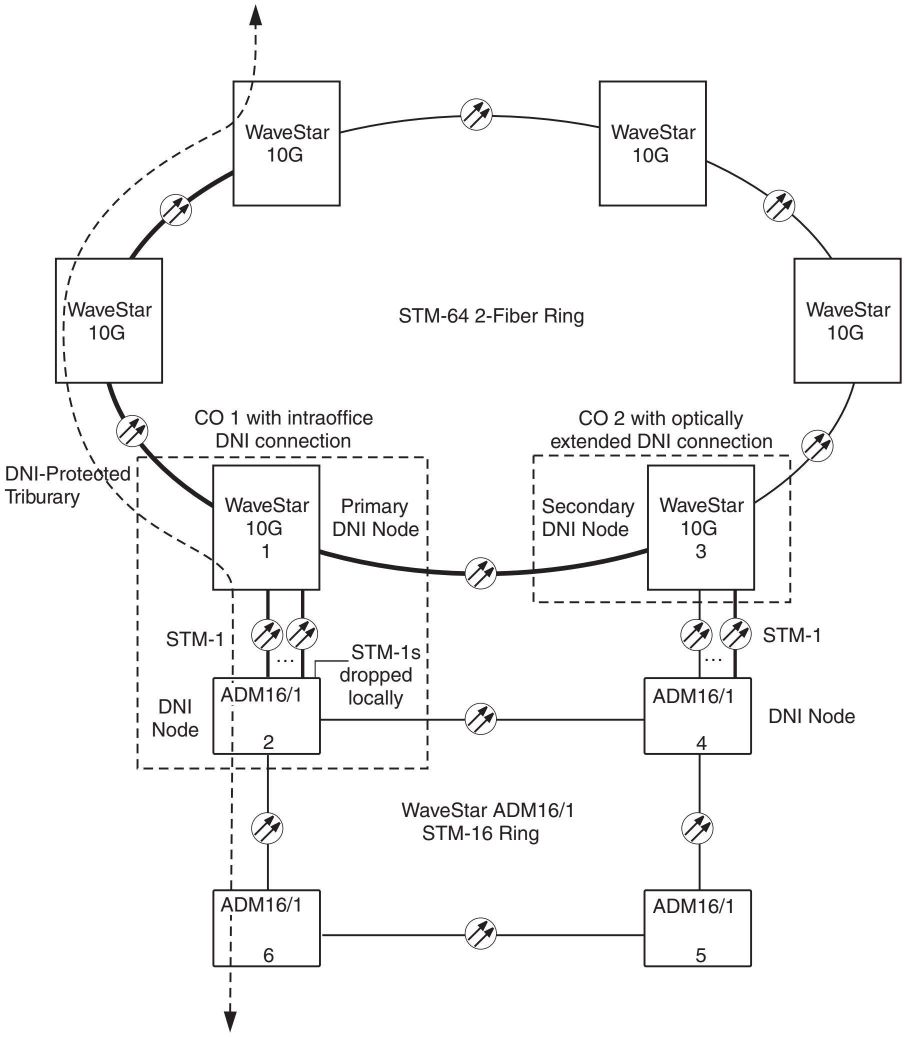
In the configuration illustrated in Figure 3-6, “DNI Between WaveStar® TDM 10G MS-SPRing and WaveStar® ADM16/1 STM-16 Ring” (3-20), WaveStar® TDM 10G DNI protection switching results from the following failure conditions (grouped by priority, from highest to lowest):

- LOP, P-AIS, or Unequipped
- Excessive Bit Error Rate (EXC)
- Signal degrade (DEG)

Example: DNI via STM-1 Tributaries

The following figure illustrates a DNI configuration that uses STM-1 interfaces between a WaveStar® TDM 10G STM-64 ring and a WaveStar® ADM16/1 STM-16 ring.

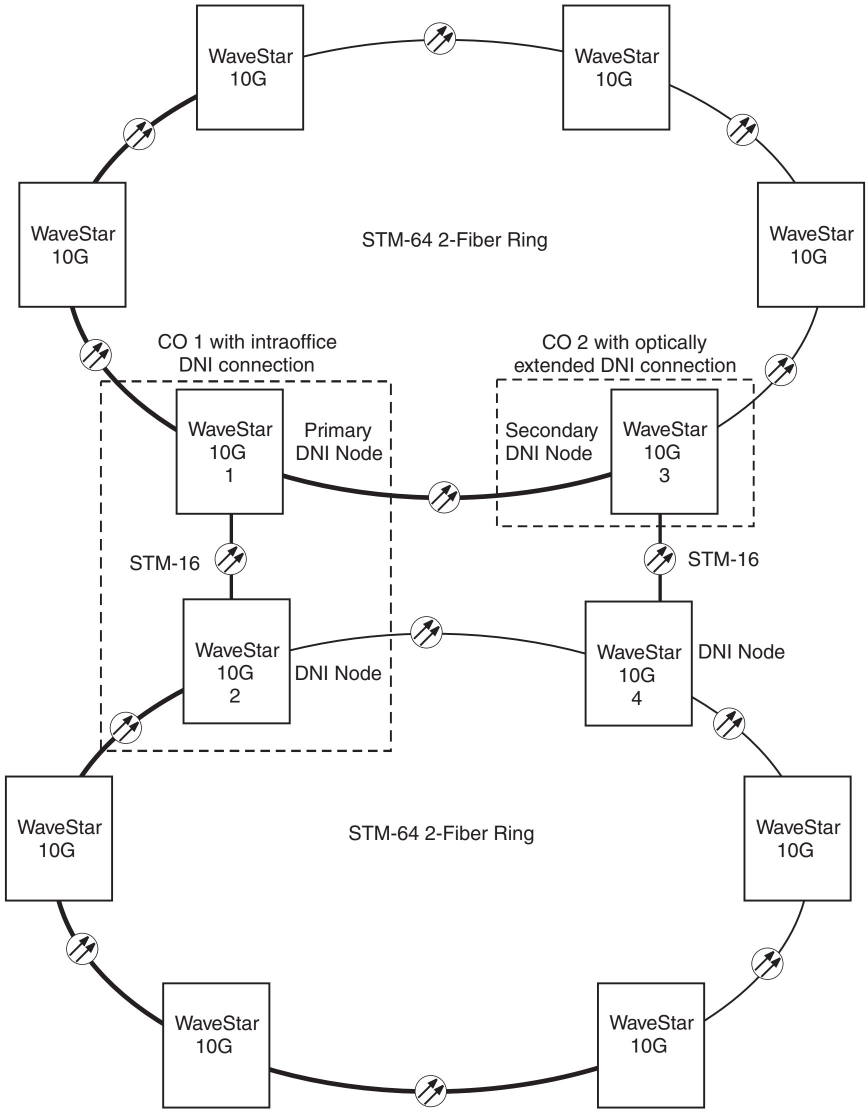
Figure 3-6 DNI Between WaveStar® TDM 10G MS-SPRing and WaveStar® ADM16/1 STM-16 Ring



Example: DNI via STM-16 Tributaries

The following figure illustrates a DNI configuration that uses STM-16 interfaces between two WaveStar® TDM 10G STM-64 rings.

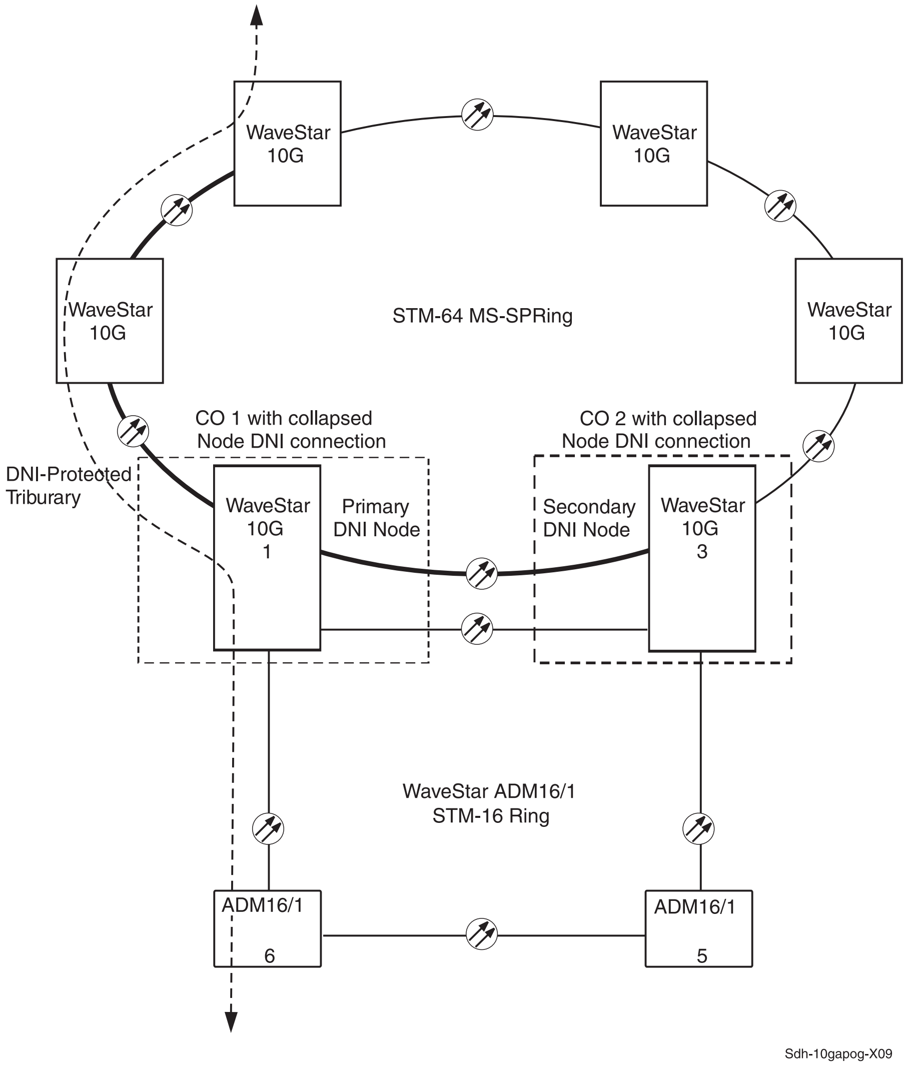
Figure 3-7 DNI Between Two WaveStar® TDM 10G MS-SPRings



Example: DNI with Collapsed Nodes

The following figure illustrates a DNI configuration that uses the WaveStar® TDM 10G itself as DNI node to connect a WaveStar® TDM 10G STM-64 ring and a WaveStar® ADM16/1 STM-16 ring.

Figure 3-8 DNI Between WaveStar® TDM 10G MS-SPRing and WaveStar® ADM16/1 STM-16 Ring (Collapsed Node)



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Sub-Network Connection Protection (SNCP)

Overview

The principle of a Sub-Network Connection Protection (SNCP) is based on the duplication of the signals to be transmitted and the selection of the best signal available at the sub-network connection termination. The two (identical) signals are routed over two different path segments (Sub-Network Connections, SNCs), one of which is defined as the main SNC and the other as standby SNC. The same applies to the opposite direction (bidirectional SNCP). The system only switches to the standby SNC if the main SNC is faulty.

Sub-Network Connection Protection (SNCP) provides path-level protection for VC-3, VC-4, VC-4-4c, and VC-4-16c signal rates in STM-64, STM,16, STM-4 or STM-1 optical rings. It is possible to add/drop SNCP protected traffic from/to all ports in the NE.

However, the Expansion shelf has the following limitations in case the big switch configuration is used:

- SNCP is not possible for port units on the Expansion shelf when BOTH (Working and Protection) paths come from ports outside the Expansion shelf, unless they both come from the MAIN shelf.
  (E.g. SNCP traffic cannot be dropped from an STM64 SNCP ring to the expansion shelf).
- SNCP is not possible for STM64 port units when (precisely) one of the (Worker or Protection) paths comes from the Expansion Shelf.
  (E.g. an STM64 port unit cannot get the worker path from the Main Shelf and the protection path from the Expansion Shelf)
- SNCP is not possible for port units on the Main shelf when one (Working or Protection) path comes from the Expansion shelf, while the other path comes from an STM64 port unit

The type of SNCP implemented in this release is a SNCP with non-intrusive monitoring (SNC/N).

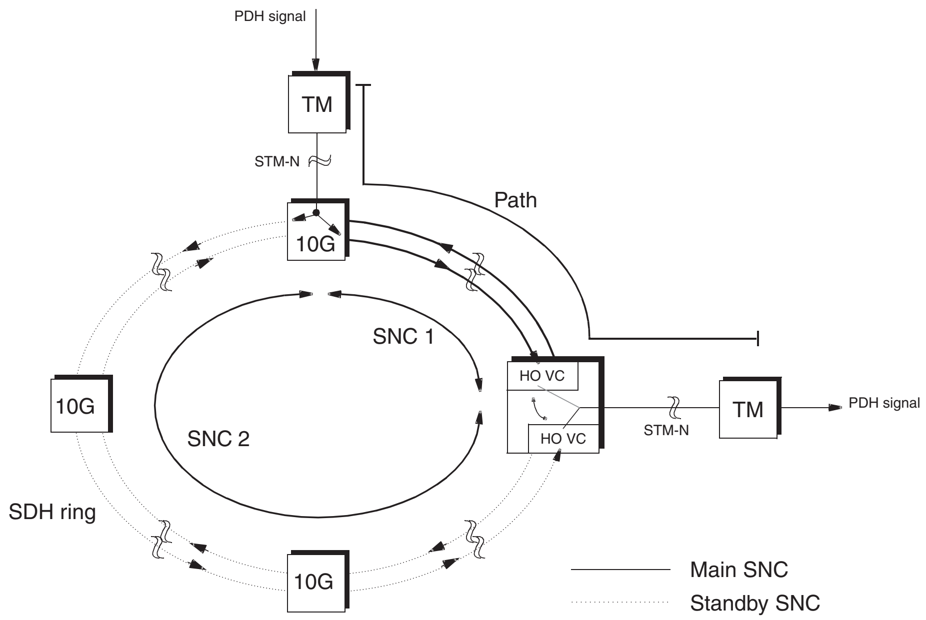
Benefits

This feature allows you to provide additional end-to-end survivability for selected circuits in a network comprising any mix of topologies (e.g. ring, mesh, unprotected, multiplex section protection and MS-SPRing).

Topologies

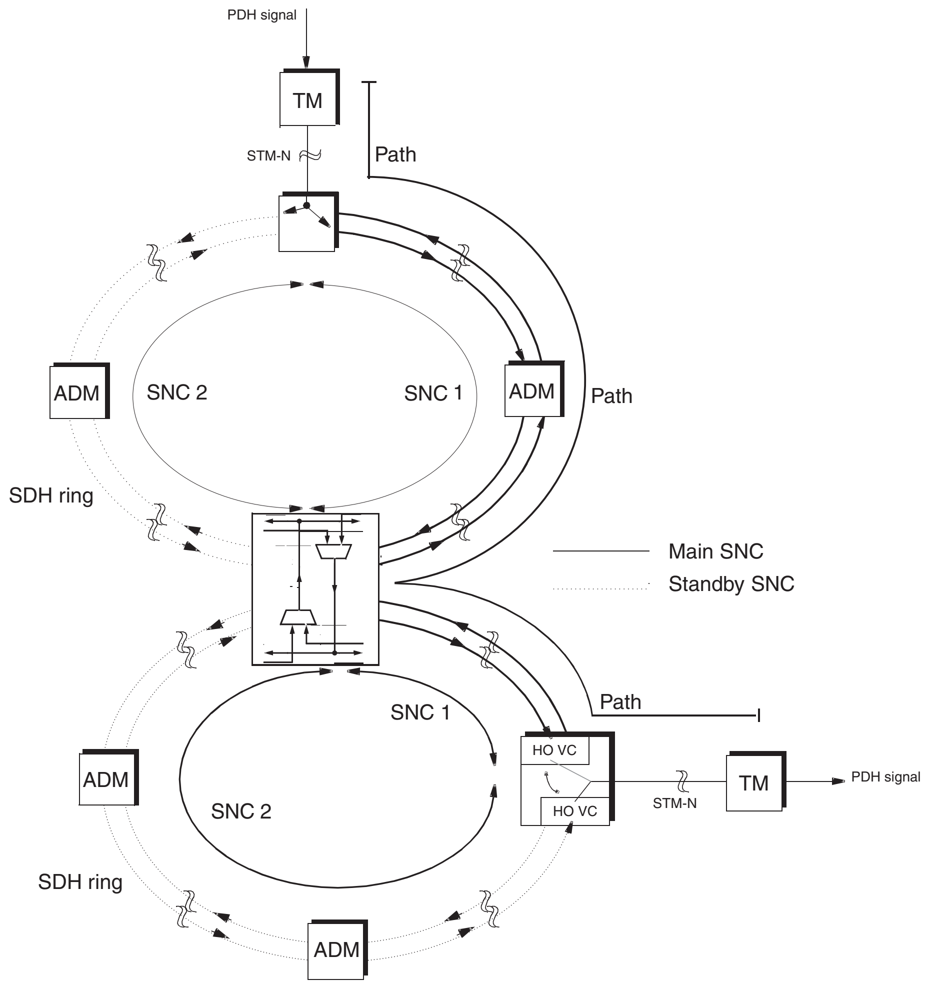
The WaveStar® CIT Cross-Connection Wizard supports the creation of SNCP protected paths in single rings and in connected rings (ring-to-ring configuration, i.e., one NE connects to two rings). Please note that in the ring-to-ring configuration the full SNCP is available within each ring. The connection between the rings, this means the connection within the network element, is unprotected, because there is no dual node ring interworking.

The following figure shows a single ring SNCP application. SNC 1 is the working (main) SNC, SNC 2 is the protection (standby) SNC in this example. The path termination is always outside the WaveStar® TDM 10G (STM-64). For simplification, the SNCP switch is only shown for a unidirectional connection.



The following figure shows a ring-to-ring SNCP configuration. Here, the SNCP also consists of a broadcast in transmit direction. The signal then moves through the first ring via SNC 1 (working) and SNC 2 (protection). The ring is connected to another ring via one single NE.

For simplification, the SNCP switch is only shown for an unidirectional connection.



Switching criteria

The following switching criteria trigger an automatic SNCP protection switch

- Signal failure (AUdAIS, AUdLOP, Unequipped)
- Signal degrade
- Circuit pack failure
- Trace Identifier Mismatch (TIM).

Controller failures in the NE do not affect the capability of automatic SNCP protection switching.

SNCP protection switching can be configured revertive or non-revertive with WaveStar® CIT. When revertive switching is configured, a wait-to-restore time can be defined. The default configuration is non-revertive.

Switching time

For automatic SNCP protection switching, the total time to complete the protection switch does not exceed 50 ms. It is possible to provision a hold-off time, i.e. a time period before initiating a switch.

Manual switch

The following manual switching actions are possible with WaveStar® CIT:

- manual to working: switches the traffic to the main SNC if it is not faulty
- manual to protection: switches the traffic to the standby SNC if it is not faulty
- forced to working: causes switchover to the main (working) SNC (even if this SNC is faulty)
- forced to protection: causes forced switchover to the standby (protection) SNC (even if this SNC is faulty)

The “Clear” request clears any active manual switch request. Clear will also release the wait-to-restore timer when provided for revertive switching.

□

Dual Node Ring Interworking between MS-SPRing and SNCP ring

Overview

WaveStar® TDM 10G (STM-64) supports Dual Node Ring Interworking (DNI) with the Drop-and-Continue method between a MS-SPRing and a SNCP ring.

Benefits

This feature allows for

- highly survivable services where circuits are carried through interconnected rings with different protection schemes
- advanced networking capabilities with a single network element that supports OC-48/STM-16 and OC-192/STM-64 rings and interconnects traffic directly from one ring to another.

Concept

The ring interworking between a MS-SPRing and a SNCP ring provides a high degree of protection of the traffic crossing from one ring to the other.

It is capable of protecting against the failure of

- one interconnecting node
- two interconnecting nodes (each on different rings, but on the same interconnect)
- the connection between two interconnecting nodes.

Note that, within the MS-SPRing, any line or node failure (including interconnecting node) will be protected at Multiplex Section level by the standard MS-SPRing scheme, as described in ITU-T Recommendation G.842.

There are two variants of interconnection between rings. The two interconnected rings being in

- the same network element or
- in different network elements.

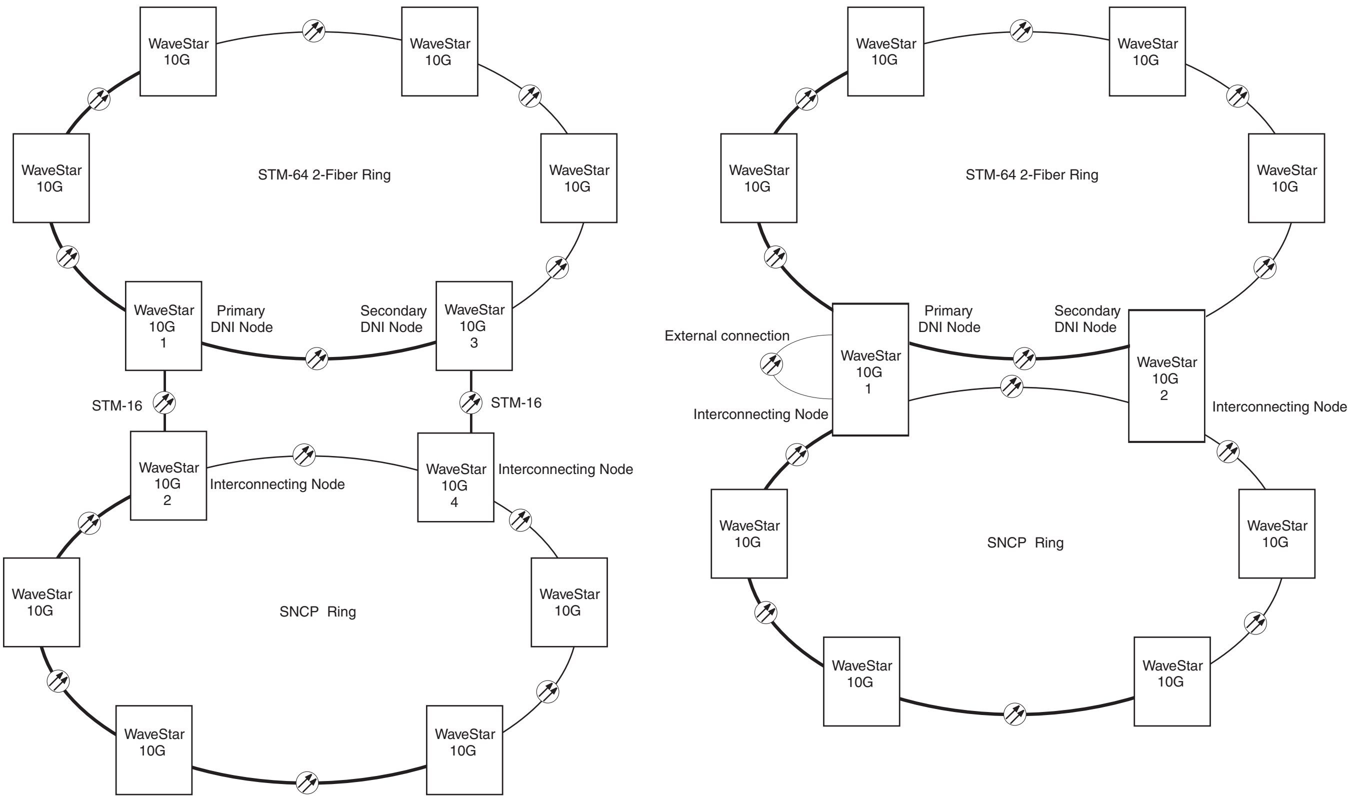
The SNCP and MS-SPRing behaves as described in ITU-T Recommendation G.841. The MS-SPRing is either a STM-64 or a STM-16 2-Fiber MS-SPRing The SNCP ring is either a STM-64, a STM-16, a STM-4 or an optical STM-1 SNCP ring.

The following combinations of ring interworking between a MS-SPRing and a SNCP ring are supported:

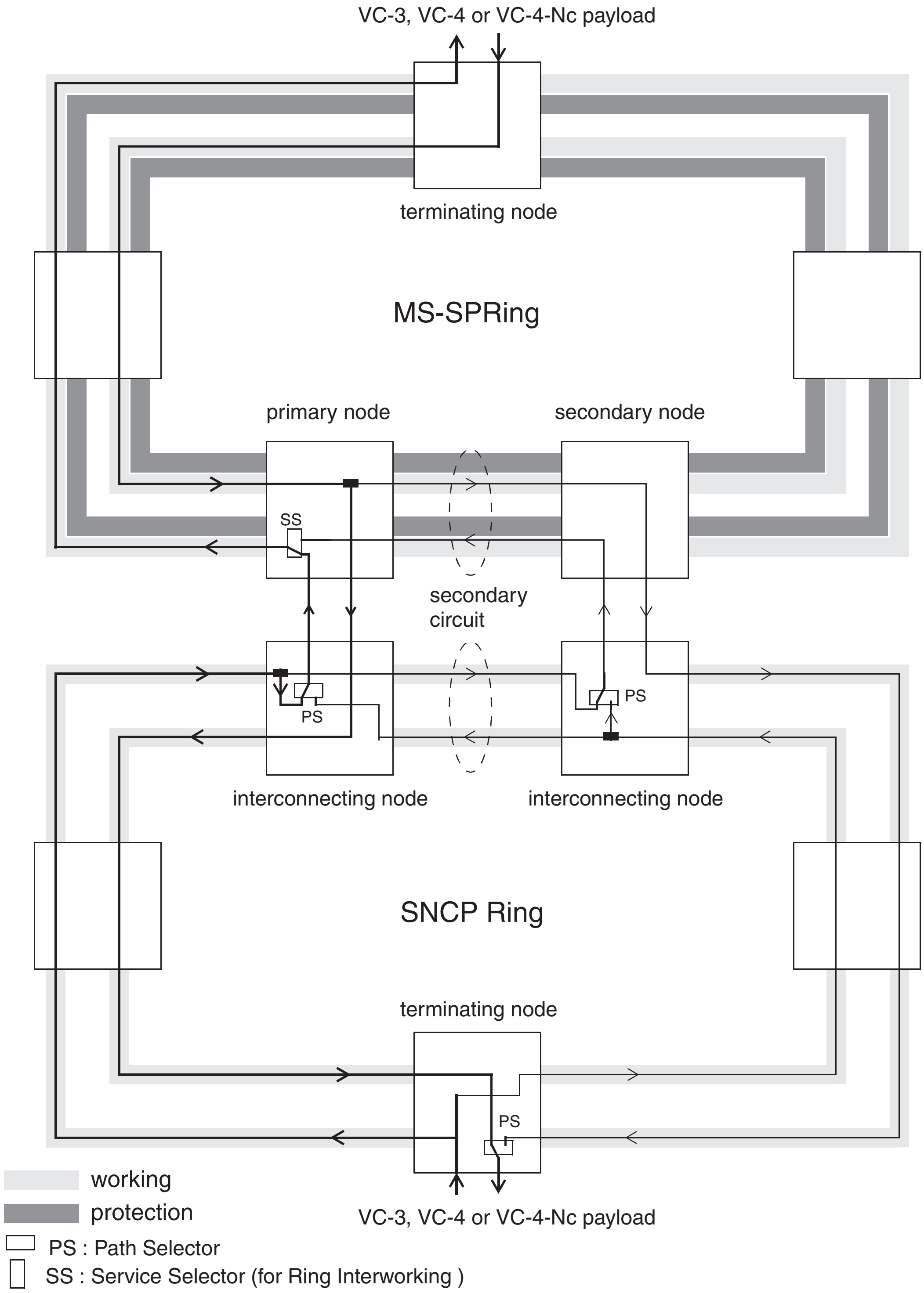
- STM-64 MS-SPRing with either STM-16 or STM-4 or optical STM-1 SNCP ring.
- STM-16 MS-SPRing with either STM-64 or STM-16 or STM-4 or optical STM-1 SNCP ring.
- STM-64 MS-SPRing with STM-64 SNCP ring, with both rings in separate nodes.

Both MS-SPRing and SNCP ring support VC-3, VC-4, VC-4-4c and VC-4-16c signal rates. The interconnection between rings can be done at any of these rates. The ring interworking does not require inter-ring signalling. Ring interconnection may occur among multiple rings.

The following figure shows the two variants of interconnection between the rings.



Functional Details The following figure shows in more detail the interworking between the two rings (one MS-SPRing and one SNCP ring) in different network elements.



MS-SPRing Nodes

The MS-SPRing nodes support the Drop-and-Continue method, i.e.

- in one direction, the traffic is extracted from a working channel on the ring (Drop), and transmitted towards the opposite side on the ring (Continue);
- in the other direction, the signal is selected from either a traffic entering the ring (Add), or a channel from one side on the ring (Continue), and it is transmitted towards the opposite side on the ring.

The selector is called ring interworking service selector. The interconnecting node providing the Drop-and-Continue function for a tributary is called the primary node for this tributary.

The Continue traffic is only carried over the working bandwidth between the primary and secondary nodes, i.e. the channel assignment (timeslot) on the multiplex section used between the primary and secondary nodes is the same as that used between the primary and terminating nodes. The Drop-and-Continue on the protection bandwidth is not supported in this release.

The ring interworking service selector in the primary node is used to protect against ring interconnection failures. It protects at path level, based on path defects detection. It supports the SNC/N protection type only, and operates in either the revertive or the non-revertive mode. By default, it operates in the revertive mode, with a Wait-to-Restore time of 5 minutes. In other words, the ring interworking service selector shall behaves just like any other path selector.

The service selector in the primary node can be operated by the user.

The ring interworking service selector in the primary node behaves independently of the MS-SPRing scheme. Though these two protection mechanisms (i.e. path protection and MS-SPRing) are cascaded back-to-front in a primary node, they do not interfere since they do not protect at the same level. Therefore it is required to support a hold-off time for the service selector in order to avoid a double protection (hence a double transmission hit) in some failure scenarios (like a line failure between the primary and secondary nodes). The default hold-off time is 100 ms.

The hold-off time to the ring interworking service selector is also required to avoid propagation of switching from one ring to the other (e.g. a path protection switch in the SNCP ring leading to a service selector switch at the primary node in the other ring).

An interconnecting node failure is protected at Multiplex Section level by the standard MS-SPRing scheme.

The two interconnecting nodes (i.e. the primary and secondary nodes) within the MS-SPRing do not need to be adjacent.

SNCP Ring Nodes

The SNCP Ring nodes support the Drop-and-Continue method. Note that the connections for this Drop-and-Continue method differ from that used in a MS-SPRing interconnecting node (primary node). For each direction of transmission in the SNCP ring, the signal is dual-fed from the terminating (source) node around both sides of the ring. When each of the dual-fed signals hits an interconnection node, it is dropped at that node and continued onto the other interconnection node using drop-and-continue. Thus, each interconnection node can select from two signals sent on a different way around the ring. The output of the selector in each interconnection node is then transmitted to the other ring (MS-SPRing). In the other direction, the signal coming from the other ring (MS-SPRing) is transmitted towards the terminating (sink) node, away from the other interconnection node. Finally, the terminating (sink) node makes the selection between the two signals from the two directions around the ring. Due to the symmetry of this scheme, the two interconnecting nodes are completely equivalent.

The path selector in the interconnecting node supports the SNC/N protection type only, and operates in either the revertive or the non-revertive mode. By default, it operates in the revertive mode, with a Wait-to-Restore time of 5 minutes. In other words, the ring interworking service selector behaves just like any other path selector.

The path selector in the interconnecting node can be operated by the user.

A hold-off time to the path selector avoids propagation of switching (i.e. one protection switch leading to another). The default hold-off time is 100 ms.

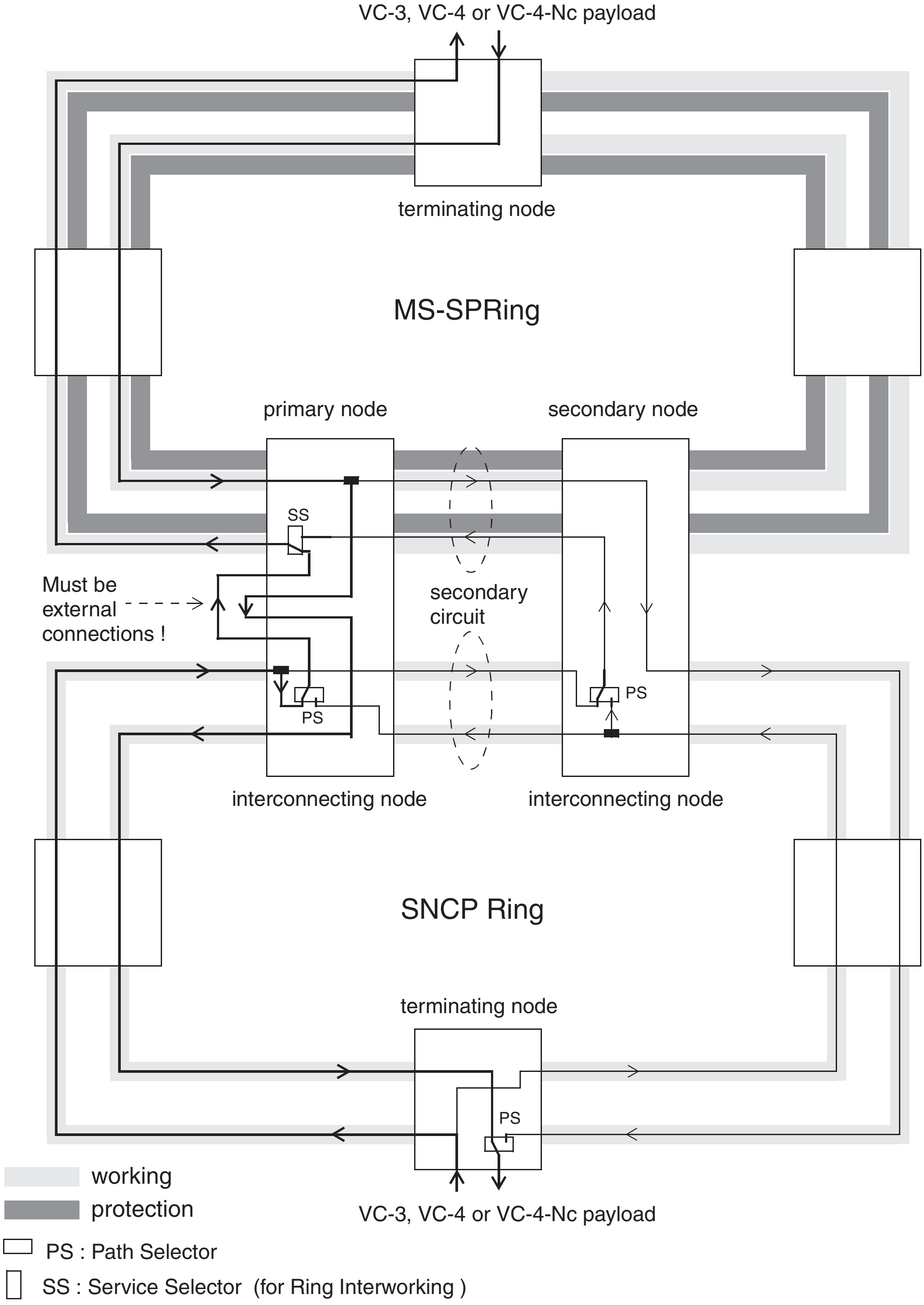
The two interconnecting nodes within the SNCP ring do not need to be adjacent.

Both rings in the same NE

The ring interworking between a MS-SPRing and a SNCP ring is supported with both rings in different NEs or with both rings in the same NE.

For this latter case, the recommended method is to connect the circuits in this limited category through an additional pair of optical ports and fibers, as if between separate NEs. One pair of unprotected optical ports could be used for all such circuits in the NE unless the number of these circuits requires additional capacity.

A bidirectional VC-3/VC-4/VC-4-Nc circuit, which is interconnected between a MS-SPRing and a SNCP ring, is depicted in the following figure, according to this feature restriction.



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Interworking With WaveStar® OLS80G and OLS400G

Growing Demand for Extra Capacity

Because the demand from customers for extra capacity is growing every day, there is a limiting factor for most network operators: the number of fibers available.

DWDM

Dense Wavelenght Division Multiplexing (DWDM) systems can be used both at the STM-64 and at the STM-16 interfaces of the WaveStar® TDM 10G (STM-64):

- WaveStar® OLS 80G and OLS 400G can be connected directly to the STM-16 interfaces
- WaveStar® OLS 400G can be connected directly to the STM-64 interfaces
- Passive WDM can be connected directly to the corresponding STM-64 interfaces.

WaveStar® OLS80G

Using the WaveStar® OLS 80G system, the traffic of max. 16 STM-16 signals can be transmitted via one single optical line. Using special lasers (“coloured laser”) in the WaveStar® TDM 10G (STM-64) system, which all have their individual wavelengths, it is possible to connect the STM-16 interfaces of WaveStar® TDM 10G (STM-64) directly to OLS 80G systems.

Alternatively, Optical Translator Units (OTUs) can be used to translate the outcoming wavelength of the STM-16 interface to wavelengths specified for DWDM systems

WaveStar® OLS400G

Using the WaveStar® OLS 400G system, the traffic of max. 40 STM-64 signals or 80 STM-16 signals can be transmitted via one single optical line. Mixes of STM-64 and STM-16 signals on the same fibre are also possible. Using special lasers (“coloured laser”) in the WaveStar® TDM 10G (STM-64) system, which all have their individual wavelengths, it is possible to connect the STM-64 or STM-16 interfaces of the WaveStar® TDM 10G (STM-64) directly to OLS 400G systems.

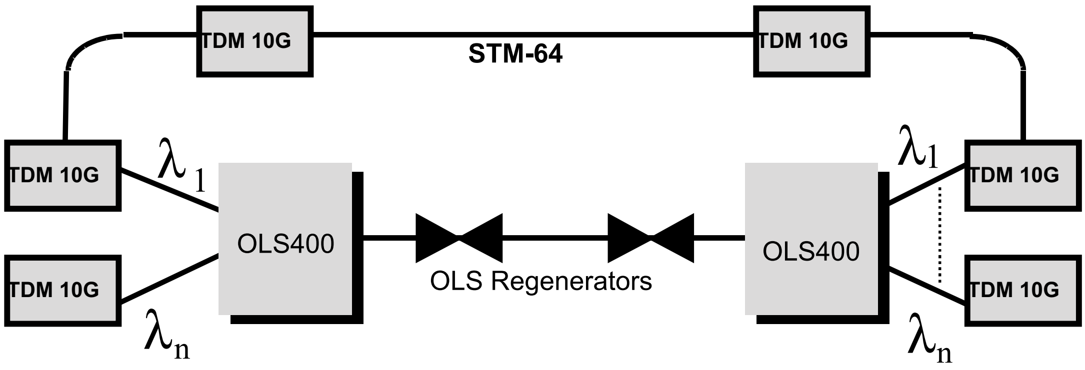
Alternatively, Optical Translator Units (OTUs) can be used to translate the outcoming wavelength of the STM-64/STM-16 interface to wavelengths specified for DWDM systems

For STM-64, distances of up to 400 km can be bridged by using the WaveStar® OLS 400G system together with the WaveStar® TDM 10G (STM-64).

For more information about OLS 40G, refer to 365-575-300, Optical Line System 40G Applications, Planning, and Ordering Guide. For more information about OLS 400G, refer to 365-575-730, Optical Line System 400G Applications, Planning, and Ordering Guide.

Example The following figure shows an example topology using the WaveStar® OLS400G to transmit traffic from several WaveStar® TDM 10G (STM-64) aggregate interfaces via one single optical line.

Figure 3-9 WaveStar® TDM 10G (STM-64) Interworking with WaveStar® OLS400G



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Interworking With Passive WDM

What is passive optics?

16 different STM-64 port units are available to transmit or receive 16 different wavelengths within the 1550 nm range for use with the Metropolis® Passive DWDM Filter Units (16CH-MUX, 16CH-DEMUX, 16CH-MUXINT, 16CH-MUXINT), which can fit into a rack with the WaveStar® TDM 10G (STM-64).

□

Interworking With WaveStar® Bandwidth Manager

What is WaveStar® BandWidth Manager?

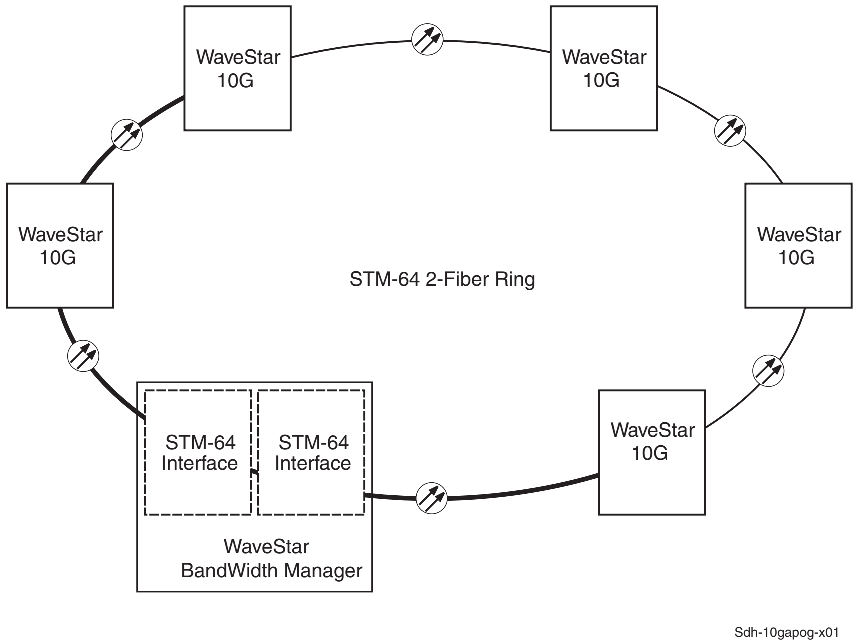
The WaveStar® BandWidth Manager (BWM) is the best path to convergence for layered bandwidth management in one network element. The WaveStar® BandWidth Manager integrates all access and transport rings within a network and efficiently manages bandwidth among these rings via a modular, scaleable Synchronous Transport Mode (STM) fabric. The switching fabric is surrounded by a common input/output and managed by a common system controller.

BWM as direct part of STM-64 ring

WaveStar® Bandwidth Manager can be equipped with integrated STM-64 interfaces, so BWM can be used as direct part of the MS-SPRing protected STM-64 ring.

The following figure illustrates the interworking of the WaveStar® TDM 10G (STM-64) with the WaveStar® BandWidth Manager.

Figure 3-10 WaveStar® TDM 10G (STM-64) Interworking with WaveStar® BandWidth Manager



MSP protected STM-64 link

Another network application with the BWM and the WaveStar® TDM 10G (STM-64) is a MSP 1+1 protected (STM-64) link.

BWM connection via STM-16, STM-4 or STM-1

It is also possible to connect BWM via STM-16, STM-4 or STM-1 interfaces to WaveStar® TDM 10G (STM-64).

□

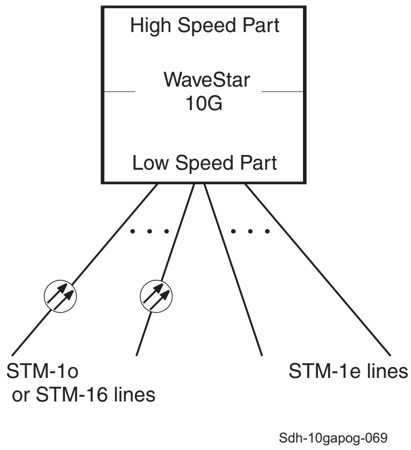
Hairpinning

What is Hairpinning?

In a “hairpinning” topology, tributary traffic is routed into a network element and then back out of the network element without ever being placed on a ring for transport. The distributed on-shelf cross-connection capability of the WaveStar® TDM 10G, consisting of a low speed part and a high speed part, makes it ideal for hairpinning. You can bring traffic in from one remote site and cross-connect it in the low speed part at the VC-3, VC-4, VC-4-4c or VC-4-16c level back out to other remote sites without consuming any capacity in the high speed part, i.e., on the ring. In fact, WaveStar® TDM 10G can be operated even without being connected to a ring. (See example below.) Alternatively, you can use a mixture of add/drop and hairpinning of compatible payloads through a mixture of interfaces.

100% Hairpinning Example

The following figure shows a topology in which all traffic is hairpinned, rather than added to a ring for transport. Configurations without any 10 Gbit/s interfaces, i.e. mere LXC-16/4, are supported.



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Folded Rings

What is a Folded Ring?

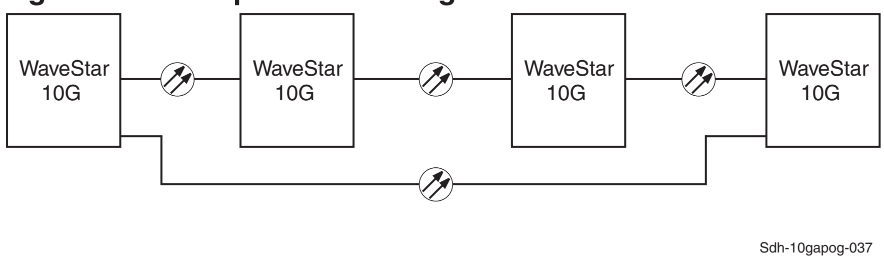
A folded ring is a ring that uses a linear cable route between its end nodes. All traffic passes through the same geographical locations, perhaps even in the same cable sheaths between nodes, instead of through diverse locations. This is useful for networks in which not all locations are ready to be connected. In many cases, a network starts out as a linear add/drop chain because of short-term service needs between some of the nodes. Later, it evolves into a ring when there is a need for service and fiber facilities to other nodes in the network. It is easier to evolve the linear add/drop network into a full ring configuration if a folded ring is used in the nodes that have this short-term service need. Folded rings have upgrade, operational, and self-healing advantages over other topologies for this type of evolution.

Folded Ring Example

In the folded ring configuration a linear add/drop chain has been upgraded to a folded ring configuration by connecting the end nodes together and reconfiguring the equipment.

The following figure shows a folded ring configuration.

Figure 3-11 Simple Folded Ring



Reliability

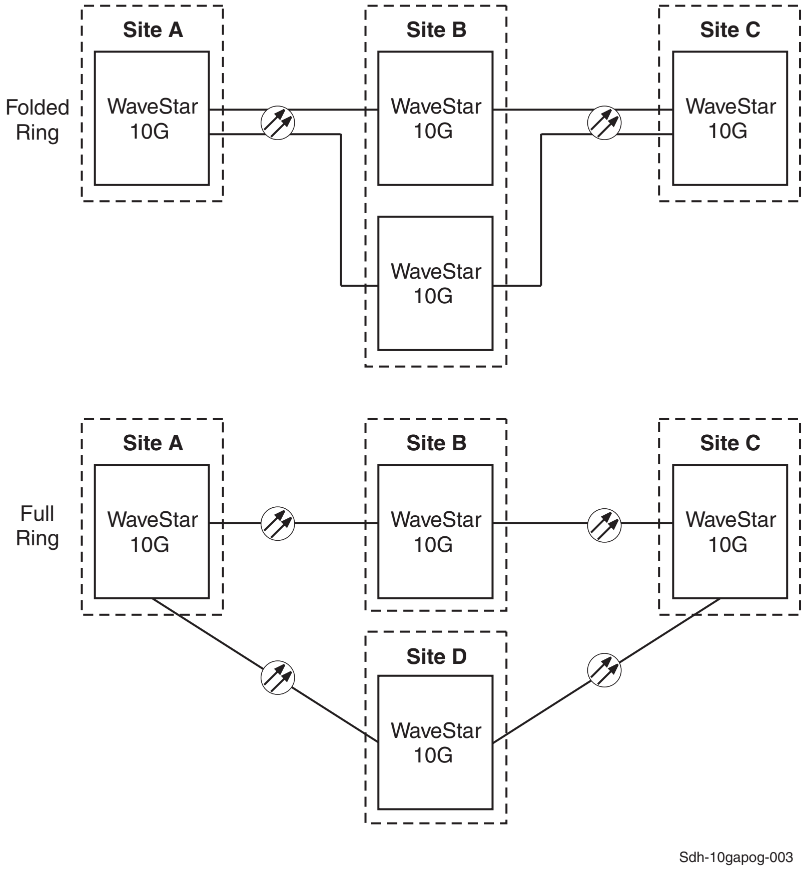
A folded ring configuration protects traffic from node failures. It cannot protect against a fiber cut if all the fibers are in the same cable. However, it does enhance the reliability of a linear route until there is enough traffic to warrant expanding to full rings.

Growth Example

The need for a second terminal at Site B depends on the amount of low-speed traffic to be terminated at Site B and the distance between Sites A and C (cf. figure below). If no add/drop traffic is required at the time the network is built, you could use a 0% add/drop node so that later upgrades can be performed in-service.

The following figure shows a network that was built with a folded ring and expanded into a full ring.

Figure 3-12 Folded Ring Evolution



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STM-64 Backbone Ring

Overview

A major application of the WaveStar® TDM 10G is in STM-64 backbone ring topologies. The figure below illustrates a configuration with an STM-64 backbone ring and several STM-16 rings attached to the backbone ring. This example shows the following types of STM-16 interface connections between a WaveStar® TDM 10G STM-64 ring and WaveStar® ADM16/1 STM-16 rings:

- Dual-homed ring (0x1) interface connections to a WaveStar® TDM 10G ring at Nodes A and E
- Single-homed ring (0x1) interface connections (unprotected) to a WaveStar® TDM 10G ring at Nodes B and C

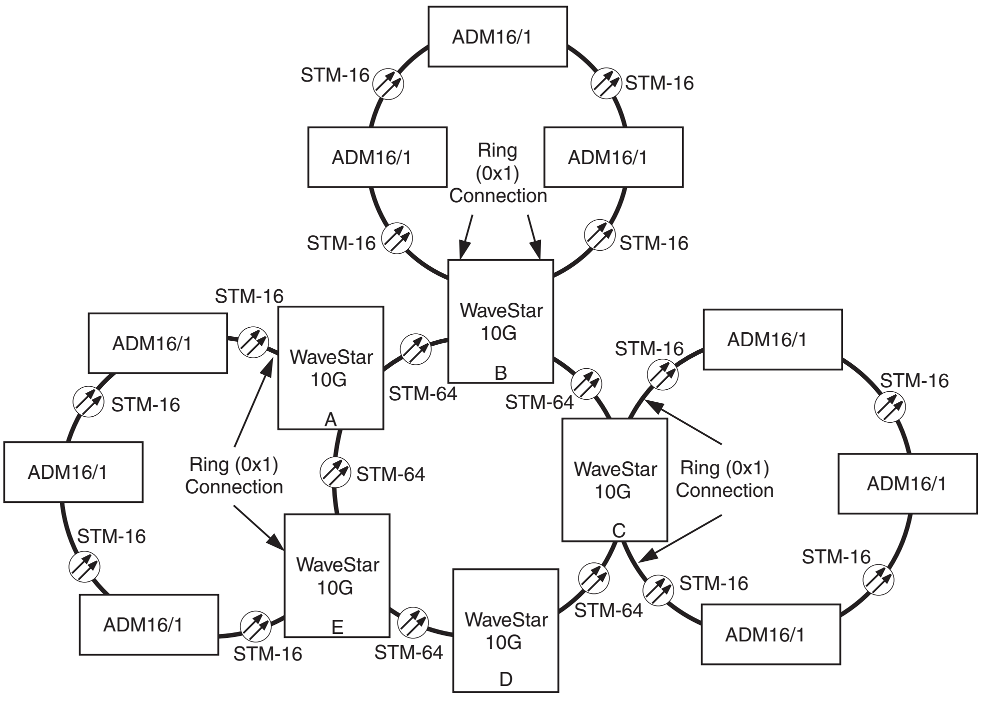
Dual-Homed vs. Single-Homed

In a dual-homed ring 0x1 interface configuration, one ring connects to the other by means of a 0x1 STM-16 or STM-1 interface connection at each of two WaveStar® TDM 10G nodes. In a single-homed ring 0x1 interface configuration, one ring connects to the other by means of two 0x1 STM-16 or STM-1 interface connections to a single WaveStar® TDM 10G node.

Backbone Ring Example

The following figure shows single-homed and dual-homed configurations in an STM-64 backbone ring.

Figure 3-13 STM-64 Backbone Ring



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Preemptible Protection Access

What is Preemptible Protection Access?

Preemptible protection access is the capability or practice of accessing the protection capacity of a ring in order to carry extra traffic. WaveStar® TDM 10G offers preemptible protection access in STM-64 and STM-16 MS-SPRing protected rings as an economical way to obtain more capacity for traffic that does not need to be protected. If a failure occurs, the protection capacity is taken back for normal protection use by the ring.

□

Non-Preemptible Protection Access (NUT)

What is Non-Preemptible Protection Access?

Non-preemptible protection access (NUT) offers the user the possibility to exclude timeslots from the MS-SPRing protection. That means there is the capability not to access a portion of the protection bandwidth in case of a protection switch, i.e. making some of the protection timeslots unaccessible for protection purposes, i.e. making the traffic in these selected timeslots non-preemptible.

NOTE: If a node is present in a ring, which is not capable of processing NUT (i.e. BWM), then NUT must be avoided on any timeslot!

□

Remote Hubbing

What is Remote Hubbing?

A network element is a hub when it is a collection point for low rate lines. If the low rate lines are from remote sites, then the network element is performing remote hubbing. The WaveStar® TDM 10G add/drop multiplexer performs remote hubbing for linear and ring networks. It can lower transport costs by consolidating STM-1 and STM-16 traffic and placing it on an STM-64 ring.

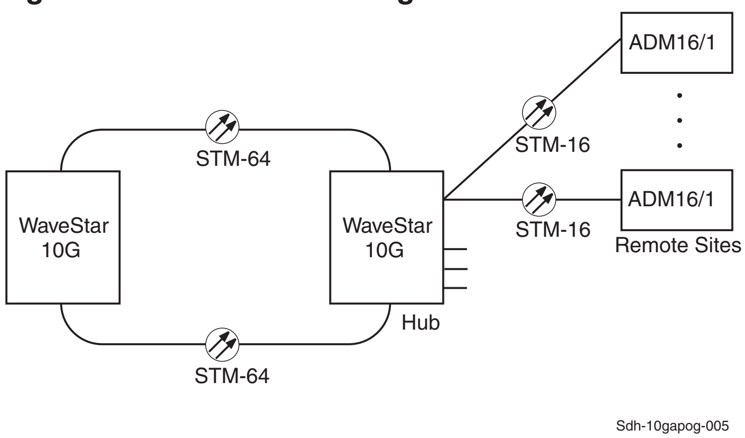
Remote Hubbing Linear Networks

The following figure shows a WaveStar® TDM 10G STM-64 ring serving a cluster of WaveStar® ADM16/1 multiplexers located at remote sites in a loop environment. In this example, all the traffic for the ADM16/1 multiplexers passes through the WaveStar® TDM 10G hub using STM-16 optical extensions. Remote hubbing could also be performed using an STM-1 or STM-4 optical extension from the remote site.

Linear Network Example

The following figure shows a WaveStar® TDM 10G connected to remote WaveStar® ADM16/1s through STM-16 interfaces.

Figure 3-14 Remote Hubbing



Remote Hubbing Ring Networks

In some situations the traffic volume of a route does not warrant the expense of a full ring. It may be practical to evolve a linear network to a ring network gradually, moving first to a folded ring or a collapsed ring configuration. Facilities may not be available for dual ring interworking in one of these configurations. However, you can still gain the benefit of a ring architecture on the route by using two STM-1 or STM-16 interfaces in a single WaveStar® TDM 10G node to interwork the rings. In this way the WaveStar® TDM 10G performs as a hub for traffic from the lower rate ring that is to be carried on the STM-64 ring.

Closing STM-16 Rings Over a WaveStar® TDM 10G STM-64 Ring

Overview

If a linear network is geographically close enough to a backbone system, then the linear network can be upgraded to a ring network by connecting both ends to the backbone. Traffic from the newly-formed ring can be transported by the backbone system, thereby closing the ring. This is referred to as closing the ring or ring transport.

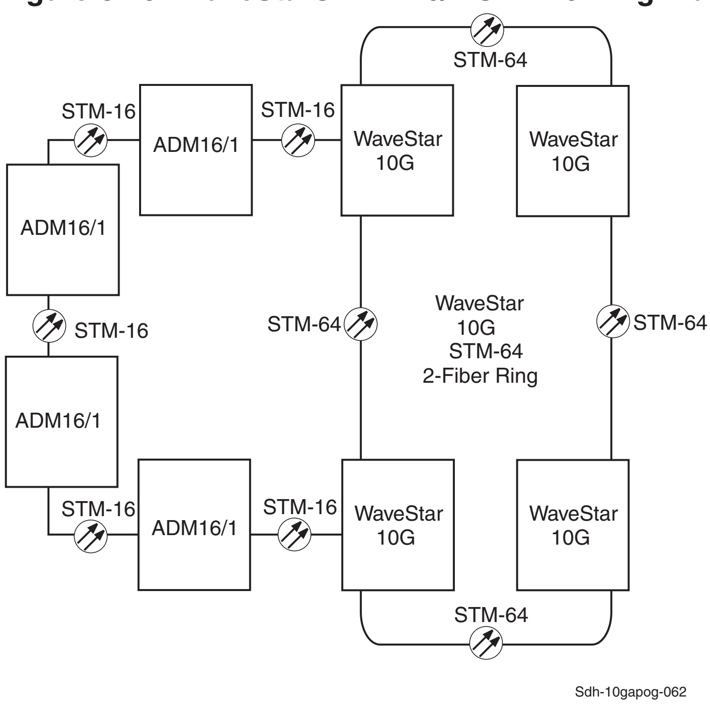
ADM16/1 STM-16 Ring Transport

A WaveStar® ADM16/1 STM-16 ring is an end-to-end self-healing network. A WaveStar® TDM 10G STM-64 ring carrying backbone traffic can be used to close (or complete) a WaveStar® ADM16/1 STM-16 ring. The example below shows how WaveStar® TDM 10G STM-16 low-speed interfaces can provide transport for a WaveStar® ADM16/1 STM-16 ring. The WaveStar® TDM 10G STM-64 ring provides 16 STM-1s of bandwidth to close the WaveStar® ADM16/1 ring.

Example

In the following figure, a WaveStar® TDM 10G STM-64 ring is used to close an STM-16 ring. The example topology shown here is also known as dual-homing.

Figure 3-15 WaveStar® ADM16/1 STM-16 Ring Transport



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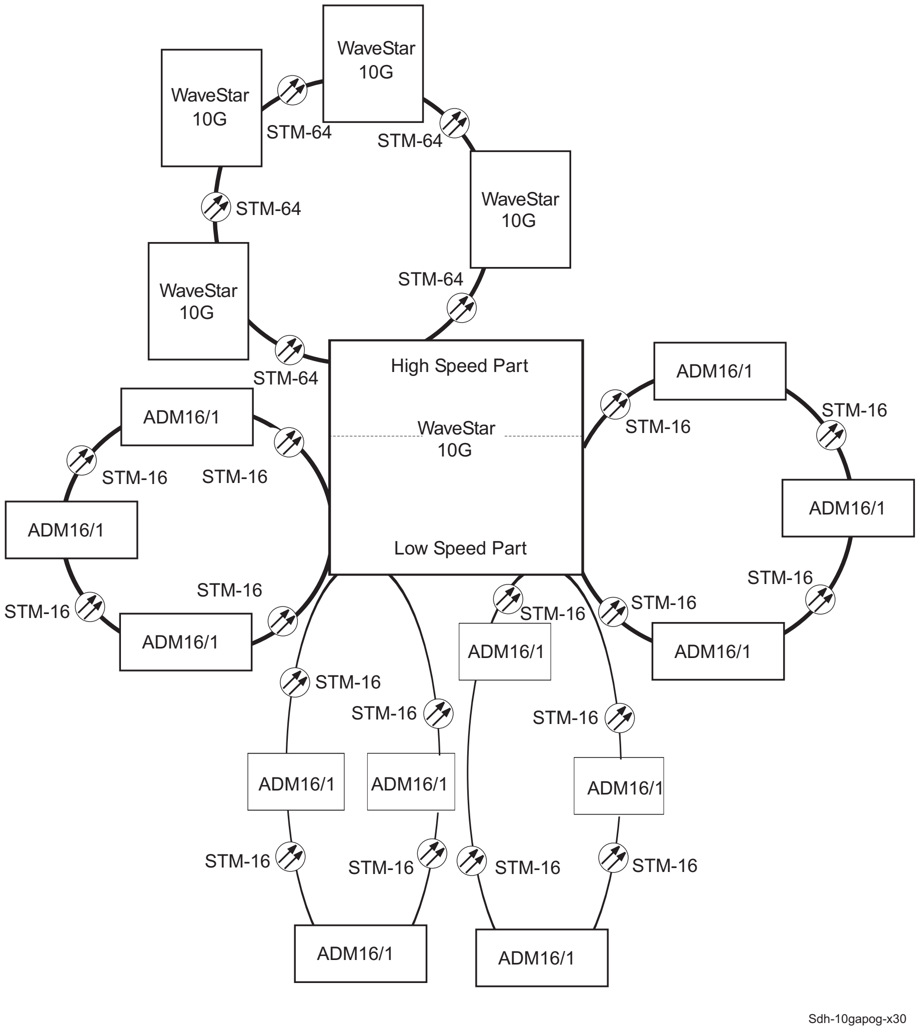
Multiple STM-16 Ring Closures within one WaveStar® TDM 10G

Overview The WaveStar® TDM 10G system has the possibility to function as a ring closure network element because the architecture of the system makes it possible to have 2 x STM-64 and up to 8 x STM-16 interfaces in one single shelf. So, up to four STM-16 rings can be attached to one WaveStar® TDM 10G. For all rings, MS-SPRing protection can be configured.

Example In the following figure, four STM-16 rings are attached to one WaveStar® TDM 10G.

Figure 3-16 Four STM-16 Ring Closures Within one WaveStar® TDM 10G



□

Broadband Transport

Broadband Services

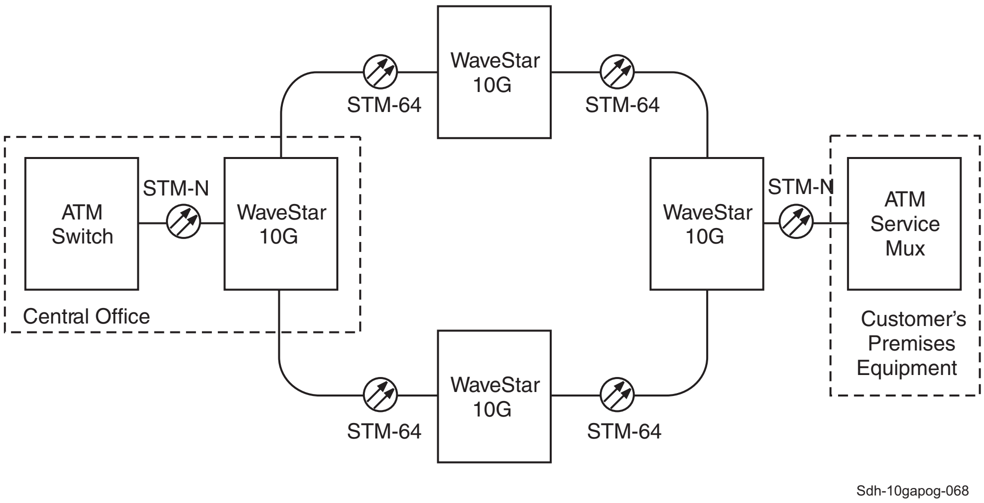
WaveStar® TDM 10G can transport VC-4-4c or VC-4-16c payloads over STM-16 or STM-64 lines. Figure 3-17, "Broadband Service Transport" (3-47) shows a WaveStar® TDM 10G transporting asynchronous transport mode (ATM) traffic. Other broadband services include:

- LAN interconnection
- Video distribution from a video server
- Medical imaging

ATM Transport

The following figure shows WaveStar® TDM 10G transporting ATM traffic between a central office and a customer's premises.

Figure 3-17 Broadband Service Transport



Important! The forwarding rate of multicast or broadcast frames is restricted to 1.1/N Gbit/s; where N is the amount of ports in the multicast group. Frame loss is to be expected at rates above 1.1/N Gbit/s.

Interface Mixing

Overview

The WaveStar® TDM 10G add/drop multiplexer supports a mix of STM-1e, STM-1o, STM-4, STM-16 and Gigabit Ethernet interface circuit packs both within the same shelf and between Main Shelf and Extension Shelf. This gives you the flexibility to make more efficient use of your shelf capacities and to upgrade nodes independently of one another.

Shelf Fill

Many shelves in central offices today are only partially filled. This is because earlier systems required any particular shelf to contain only electrical interfaces or only optical interfaces, or only interfaces of the same rate. Therefore, the odd numbers of low-speed interface circuit packs often ended up in shelves by themselves, leaving unused slots. By accommodating any combination of STM-1e, STM-1o, STM-4, STM-16 and Gigabit Ethernet circuit packs in one shelf, WaveStar® TDM 10G can reduce the number of shelves by increasing circuit pack slot usage (shelf fill).

End-to-End Interface Mixing

A circuit can enter a WaveStar® TDM 10G network through one type of interface and exit through another type, if the signal rate and format at both ends are compatible. For example, an STM-1 that is carrying 140 Mbit/s traffic must connect to a network element that is provisioned for an STM-1 that is carrying 140 Mbit/s traffic, and not to a network element that is provisioned for an STM-1 that is carrying 2 Mbit/s circuits.

Network Evolution

WaveStar® TDM 10G interfacing mixing capabilities offer more efficient network evolution and let planners deploy equipment based on the needs of the particular application. For example, network needs (sudden demand) may require SDH deployment in one area before others.

□

365-371-554
Issue 1, October 2003

0% Add/Drop Node

What is 0% Add/Drop?

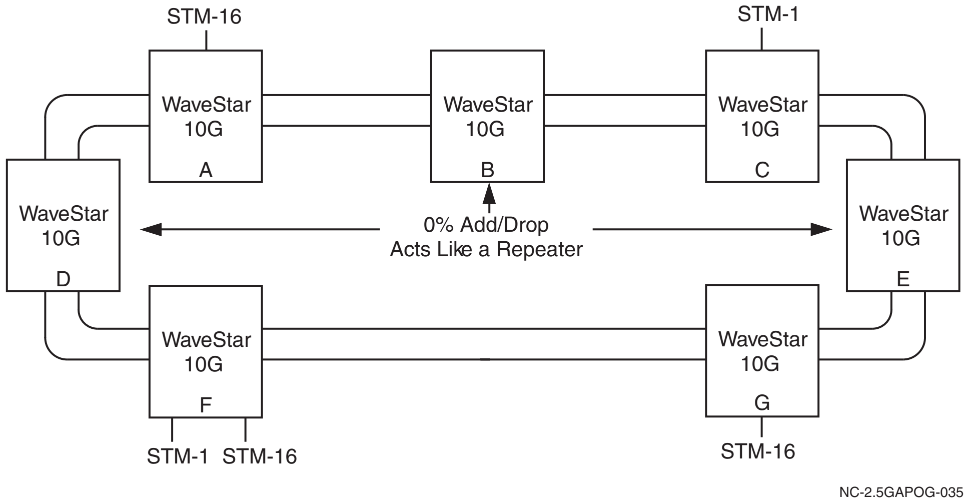
A 0% add/drop configuration is one in which a network element is used as if it were a repeater. This creates a network node at which 0% of the network capacity is added or dropped. All traffic is through traffic.

A 0% add/drop node provides access to the STM-64 DCC to perform remote operations, administration, maintenance, and provisioning for other nodes in the ring. Additionally, it provides a convenient growth path for in-service upgrades when add/drop capability is needed in the future.

Growth Example

The following figure shows a network in which several nodes currently use 0% add/drop. As the demand for services increases, you can add low speed interface circuit packs as necessary to support add/drop traffic at nodes that do not currently require such connections.

Figure 3-18 0% Add/Drop Application



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4 Product Description

Overview

Purpose

This chapter describes the WaveStar® TDM 10G (STM-64) in terms of basic architecture, physical configuration and circuit packs.

Chapter Structure

After a concise system overview, the transmission architecture is presented. A closer look is taken to the switch function.

The shelf configurations of the two WaveStar® TDM 10G (STM-64) shelf types are described, followed by a short description of the circuit packs contained.

Furthermore, this chapter deals with synchronization aspects within the network element and outlines the control architecture and the power distribution concept.

Contents

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Concise System Description

Overview

The WaveStar® TDM 10G (STM-64) is a next-generation, high capacity SDH multiplexer for STM-64 applications that multiplexes synchronous STM-1 (optical and electrical), STM-4, STM-16 and Gigabit Ethernet signals onto the STM-64 MS-SPRing protected ring (ADM) or onto the STM-64 line (TM) for transport to distant STM-64 multiplexers. The method used to map the interface signals complies with the AU-4 mapping procedure specified by the ITU-T. The system also supports AU-3, AU-4-4c and AU-4-16c mapping for the interface signals.

Applications

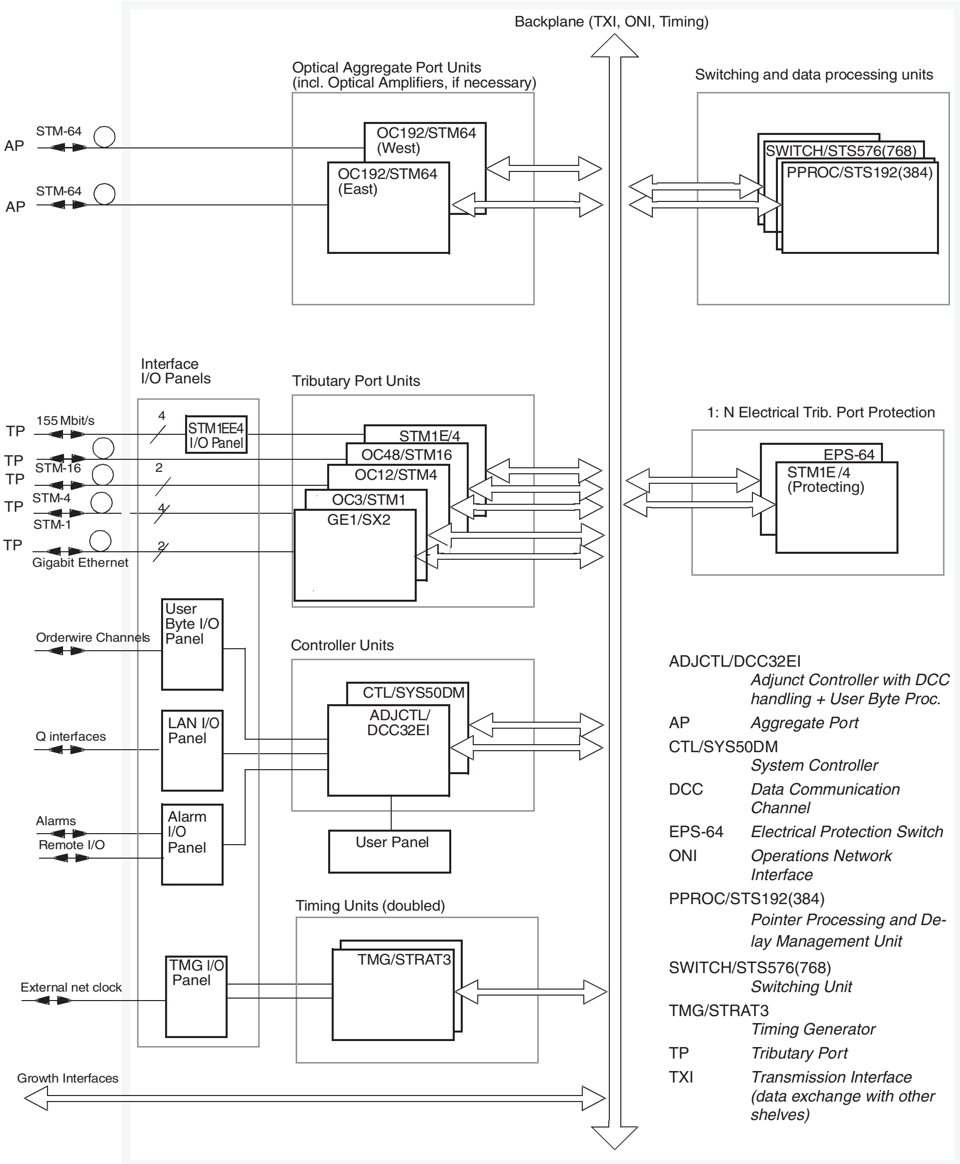
The system can be used as an Add/Drop multiplexer, and as Terminal multiplexer, each using only one subrack. If additional tributary interfaces are required, the system can be expanded by an extension shelf. The system provides built-in Cross-connect facilities and flexible interface circuit packs. Local and remote management and control facilities are provided via the Q interface and the Embedded Communication Channels. The Cross-connect circuit packs are the core of the WaveStar® TDM 10G (STM-64) system.

Basic Architecture

The basic WaveStar® TDM 10G (STM-64) architecture covers the network element as a whole and does not go into further detail on how the functions are being distributed to several shelves and on the required number of the individual circuit packs. This will be discussed later in this chapter.

The following figure gives an outline of the basic WaveStar® TDM 10G (STM-64) architecture.

Figure 4-1 Basic Architecture WaveStar® TDM 10G (STM-64) Example: Main Shelf



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Transmission Architecture

Overview

The WaveStar® TDM 10G add/drop multiplexer uses two port units (transmission interface circuit packs) to connect as a node on a STM-64 MS-SPRing protected ring (one port unit in the terminal multiplexer application to connect to an optical line). It uses up to 16 (Main Shelf only) or up to 32 (+ Extension Shelf) tributary port unit circuit packs to connect add/drop traffic to other network elements. For information about the port units, refer to Appendix B.

Transmission Provisioning

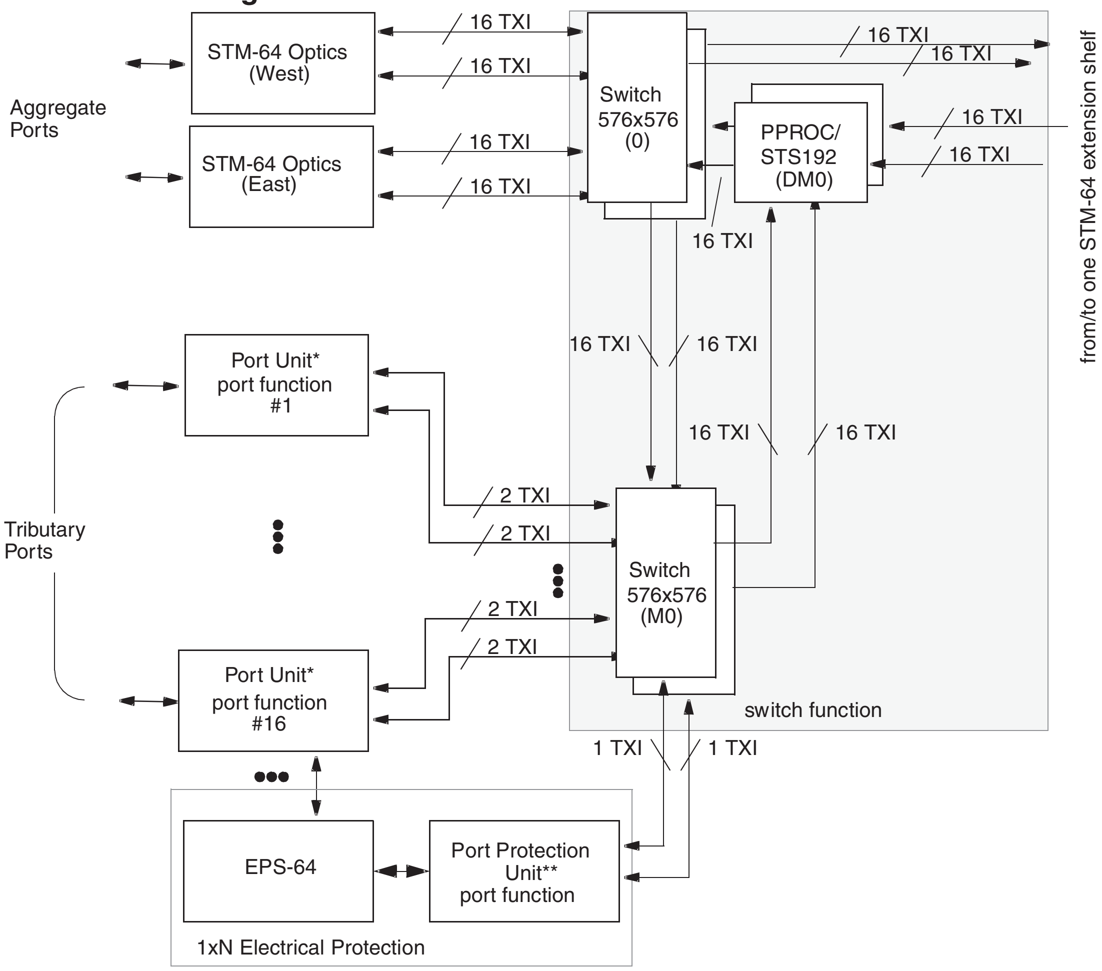
Provisioning of the transmission circuit packs is controlled by the system controller circuit pack (in the low speed part of the Main Shelf) in response to commands received over the SDH Data Communication Channels (DCC) or from a WaveStar® Customer Interface Terminal (CIT) connected to the respective port on the user panel.

Transmission Architecture

WaveStar® TDM 10G transmission port units interconnect with a 192x192 (SWITCH/STS576) or 256x256 (SWITCH/STS768) STM-1 port switch by means of backplane wiring (TXI).

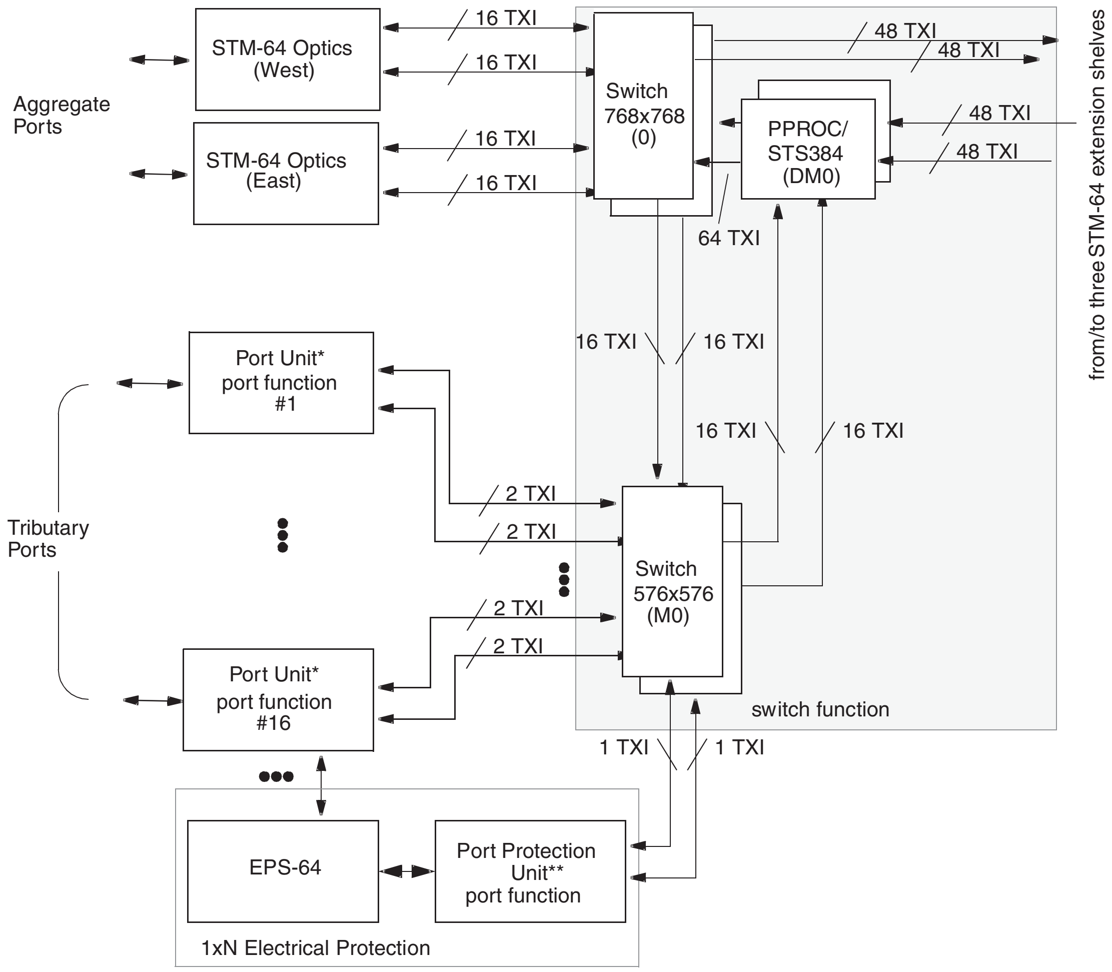
Block Diagrams The following figure shows a block diagram of the transmission architecture in the Main Shelf.

Figure 4-2 Transmission Architecture in Main Shelf



*) Port Units for the following interfaces: STM-1(el), STM-1(o), STM-4, STM-16
**) 1XN Electrical Protection for STM-1(el) Port Units
TXI: Electrical 622 Mbit/s connection between circuit packs and between main shelf and extension shelf
EPS-64: Electrical Protection Switch
For an explanation of the extensions of the switching and PPROC circuit packs, please refer to Figure 4-4

Figure 4-3 Transmission Architecture in Main Shelf

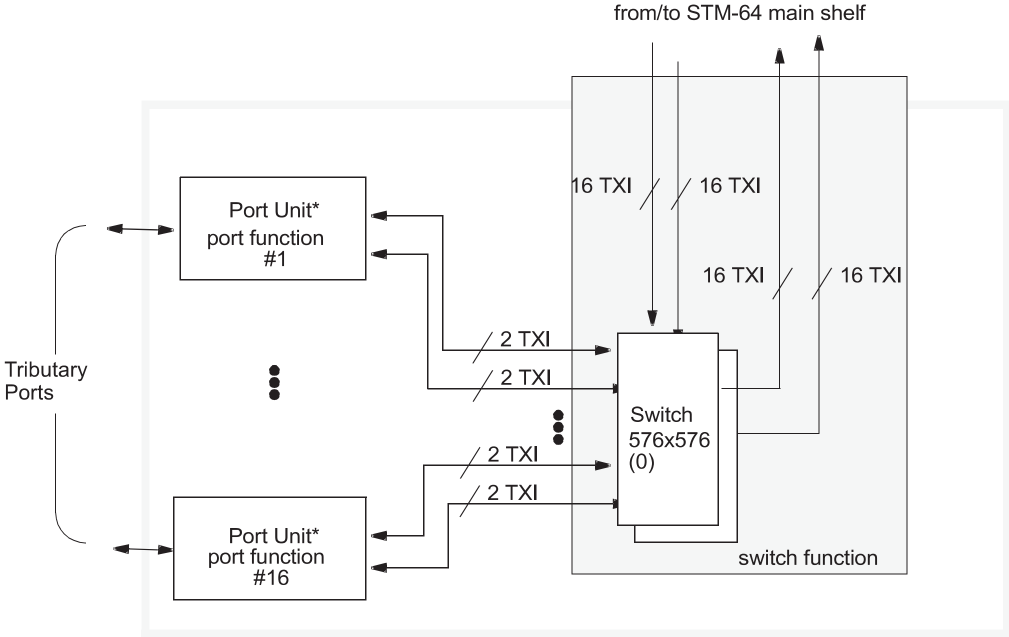


*) Port Units for the following interfaces: STM-1(el), STM-1(o), STM-4, STM-16
**) 1XN Electrical Protection for STM-1(el) Port Units

TXI: Electrical 622 Mbit/s connection between circuit packs and between main shelf and extension shelf
EPS-64: Electrical Protection Switch
For an explanation of the extensions of the switching and PPROC circuit packs, please refer to Figure 4-4

The following figure shows the transmission architecture in the Extension Shelf.

Figure 4-4 Transmission Architecture in Extension Shelf



*) Port Units for the following interfaces: STM-1(el), STM-1(o), STM-4, STM-16
TXI: Electrical 622 Mbit/s connection between circuit packs and between main shelf and extension shelf

□

Switch Function

Overview

The Cross-connect is implemented as a two stage, higher order (HO) switch, and consists therefore at least of two switch circuit packs (SWITCH/STS576, 192x192 STM-1 equivalent cross-connect capacity) and a delay management unit (PPROC/STS192). In the case of multishelf configurations, the switch is divided into two shelves (c.f. Figure 4-2, “Transmission Architecture in Main Shelf” (4-6) and Figure 4-4, “Transmission Architecture in Extension Shelf” (4-8) on the previous pages).

For dublicating the switch capacity the 256x256 switch fabric (SWITCH/STS768) is required in the high-speed part of the Main Shelf. It provides an additional capacity of 64 STM-1 equivalents. Besides the larger switch, also the corresponding PPROC/STS192 circuit packs have to be replaced by the PPROC/STS384 circuit packs (c.f. chapter 4, section “Main Shelf” (4-12)).

First Switch Stage

The first switch stage crossconnects all signals coming from the Tributary Port Units either to the second switch stage or back to a tributary port within this shelf. Other functions of the first switch stage are: MSP protection switching, MS-SPRing protection switching or Dual Node Interworking (DNI) protection of the corresponding port functions, and, if equipment protection is configured for a port unit, selection of the current working unit.

Each first stage can switch up to 64 VC-4s (SWITCH/STS576) or 128 VC-4s (SWITCH/STS768) to the second stage via the delay management unit. In sum the tributary part of the main shelf plus the (first) extension shelf can switch up to 64 VC-4s (SWITCH/STS576) or 128 VC-4s (SWITCH/STS768) to the second stage.

Second Switch Stage

The second switch stage crossconnects the signals of the STM-64 port functions and the first switch stages. It also performs the MS-SPRing protection switching functionality.

1+1 Protection

To contribute to the overall system reliability and availability, the Cross-connect circuit packs and the delay management units are 1+1 equipment protected.

Tributary - Tributary Connections

In addition to this add/drop capacity of the first stage switches towards the second stage switch, the first stage switches can cross-connect up to 128 VC-4s within the tributary area of the main shelf or within an extension shelf.

Transmission Delays

The transmission delay in the network element for a signal between a line and a tributary interface or between two line interfaces is 25 µs.

□

Shelf Configurations

Overview

The WaveStar® TDM 10G (STM-64) shelves are designed for application in 600 mm deep ETSI rack frames. Two shelf types are available:

- Main Shelf
- Extension Shelf.

The Main Shelf is a two-row shelf which is sufficient to configure a complete network element. If additional tributary interfaces are needed, the configuration can be expanded by using one Extension Shelf.

The shelf provides the facilities to house the WaveStar® TDM 10G (STM-64) circuit packs. It consists of the mechanics, a backplane, a user panel and interface panels for the individual circuit pack functions.

Interface Panels

Access to the electrical tributary signals, to overhead channels, station alarms, miscellaneous discretes and Q-LAN is possible via the interface panels which are located at the rear of the shelf .

Optical Interfaces

The optical interfaces are located on the front side of the optical circuit packs. From there, the optical fibres are guided to the rack connection panel.

Extension Shelf

Each Extension Shelf supports any mix of interface circuit packs.

Extension shelves can support an additional capacity for inter-shelf connections of up to 64xSTM-1 capacity.

Inter-Shelf Connection

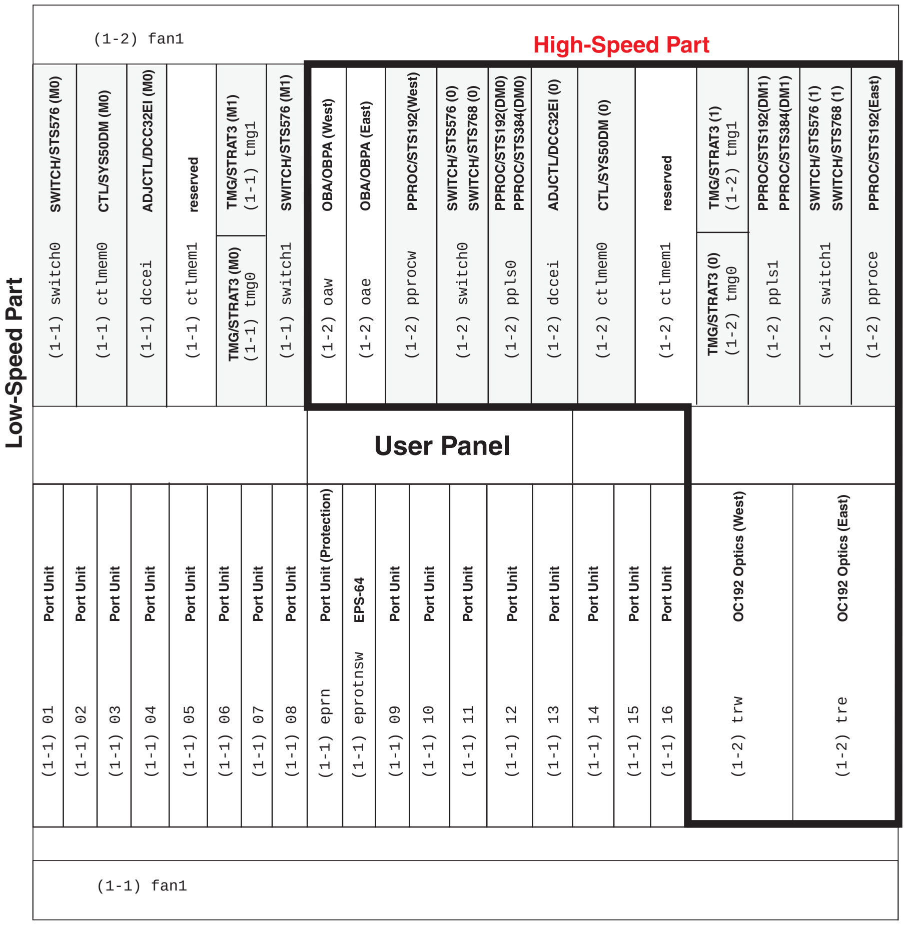
If an NE uses more than one shelf, the inter-shelf connection between Main Shelf and Extension Shelf is done via special interfaces (TXI) located directly on the shelf backplane.

□

Main Shelf

Layout The following figure depicts the WaveStar® TDM 10G Main Shelf plug-in units and circuit pack slots, including the 16 slots used for STM-1(e), STM-1(o), STM-4, STM-16, or GE1 tributary port units.

Figure 4-5 Layout of the WaveStar® TDM 10G Main Shelf (Front)



Explanation of the switching and PPROC circuit pack designation extensions:

(DM0): Delay Management, main
(DM1): Delay Management, protection
(0): Second stage switch (high speed part), main
(1): Second stage switch (high speed part), protection
(M0): First stage switch (low speed part), main
(M1): First stage switch (low speed part), protection

NOTE: For dublicating the switch capacity the SWITCH/STS576 (0/1) circuit packs in the high-speed part of the Main Shelf and also the corresponding PPROC/STS192 (DM0/1) circuit packs have to be replaced by the SWITCH/STS768 and PPROC/STS384 circuit packs.

Main Shelf Parts

From the architectural point of view, the Main Shelf can be divided into two parts which are to a great extent independent from each other:

- the low speed part
- the high speed part.

Each of these parts is equipped with its own Controller circuit pack, where the controller in the low speed part additionally serves as a System Controller for the complete Main Shelf. The controller architecture is described in more detail later.

Circuit Pack Slots

The following table identifies the circuit packs used in the Main Shelf of the WaveStar® TDM 10G. The slots designations in the low speed part of the shelf begin with the string “(1-1)”, the high speed part of the shelf is referred to as “(1-2)”. Refer to the port units descriptions in Appendix B for additional information about the transmission interface circuit packs.

Table 4-1 Circuit Pack Slot Equipage

Slot Designation	Slot Equipage
(1-1)01 to (1-1)16	Any mix of transmission interface circuit packs: • STM-1(e) port units (STM1E/4) • STM-1(o) port units (OC3/STM1) • STM-4 port units (OC12/STM4) • STM-16 port units (OC48/STM16), incl. 16 colors DWDM interfaces for OLS80G and 80 colors for OLS400G • Gigabit Ethernet port units (GE1) Notes: Each of the STM-16 and Gigabit Ethernet port units requires two slots. Allowed slots for these port units are: 02, 04, 06, 08, 10, 12, 14, 16. If the slot (1–1)16 is configured for an optical port unit (STM-1(o), STM-4, STM-16), no 1:N equipment protection of the STM-1(e) port units is possible. If 1:N equipment protection of the STM-1(e) port units is configured, it is not possible to use slot (1–1)16 for optical port units.
(1-2) trw, (1-2) tre	STM-64 port units (OC192/STM64), incl. 40 colors DWDM interfaces and 32 interfaces for passive WDM

Table 4-1 Circuit Pack Slot Equipage (continued)

Slot Designation	Slot Equipage
(1-1) eprn	Electrical protection. Equipped with a STM1E/4 circuit pack to protect the STM1E/4 port units. This slot can also be left empty, if no such protection is required.
(1-1) eprotsw	Electrical protection switch. Equipped with a EPS-64 protection switching circuit pack to provide the 1:N switching function for protected STM1E/4 port units. This slot can also be left empty, if no such protection is required.
(1-1) switch0	Fabric switch 0. The SWITCH/STS576 circuit pack in this slot can make cross-connections for 192 STM-1 equivalent circuits. This switch is paired with fabric (1-1) switch 1 in a 1+1 non-revertive protection mode configuration.
(1-1) ctlmem0	Controller for the system including non-volatile memory. The CTL/SYS50DM circuit pack in this slot is the working controller for the low speed part of the shelf and additionally the system controller for the whole shelf.
(1-1) dccei	Adjunct controller, DCC and external interface. The ADJCTL/DCC32EI circuit pack in this slot terminates up to 32 data communications channels and interfaces them to the shelf 10Base-T LAN.
(1-1) ctlmem1	The slot is left empty for the current release of WaveStar® TDM 10G.
(1-1) switch1	Fabric switch 1. The SWITCH/STS576 circuit pack in this slot can make cross-connections for 192 STM-1 equivalent circuits. This switch is paired with fabric (1-1) switch 0 in a 1+1 non-revertive protection mode configuration.

Table 4-1 Circuit Pack Slot Equipage (continued)

Slot Designation	Slot Equipage
(1-1) tmg1 (1-1) tmg0	Two half-height Stratum 3 timing generator circuit packs are located one above the other in this slot. They are the master TMGs in the shelf (and also for the Extension Shelf). When WaveStar® TDM 10G is initially powered on after shipment from the factory, the lower TMG/STRAT3 is the active circuit pack and the upper TMG/STRAT3 is the standby circuit pack. However, both circuit packs are of equal level and protection switching is non-revertive, so there is no default configuration.
(1-2) oaw (1-2) oae	Optical Booster Amplifiers, equipped in case of OC192/STM64 LH interfaces or OBPA in case of VH interfaces.
(1-2) pprocw	The PPROC/STS192 circuit pack in this slot supports the OC192 port unit function assigned to the western aggregate port. The CP is responsible for pointer processing and synchronization to the system clock and for POH monitoring.
(1-2) switch0	Fabric switch 0. The circuit pack in this slot can make cross-connections for 192 (SWITCH/ STS576) or 256 (SWITCH/STS768) STM-1 equivalent circuits. This switch is paired with fabric (1-2) switch 1 in a 1+1 non-revertive protection mode configuration.
(1-2) ppls0	The circuit pack in this slot (PPROC/STS192 or PPROC/STS384) provides frame delay management between the switch functions of the low speed part of the shelf and the high speed part ((1-1) sw. 0).
(1-2) ctlmem0	The CTL/SYS50DM circuit pack in this slot is the working shelf controller for the high speed part. The system controller for the whole shelf is located in slot (1-1) ctlmem0.
(1-2) dccei	Adjunct controller, DCC and external interface. The ADJCTL/DCC32EI circuit pack in this slot terminates up to 32 data communications channels and interfaces them to the shelf 10Base-T LAN. The pack also provides the OH Byte access (together with the User Byte I/O panel)

Table 4-1 Circuit Pack Slot Equipage (continued)

Slot Designation	Slot Equipage
(1-2) ctlmem1	The slot is left empty for the current release of WaveStar® TDM 10G.
(1-2) switch1	Fabric switch 1. The circuit pack in this slot can make cross-connections for 192 (SWITCH/STS576) or 256 (SWITCH/STS768) STM-1 equivalent circuits. This switch is paired with fabric (1-2) switch 0 in a 1+1 non-revertive protection mode configuration.
(1-2) tmg1 (1-2) tmg0	Two half-height Stratum 3 timing generator circuit packs are located one above the other in this slot. They are slave TMGs. Their function is to distribute the system clock from the active master TMG to the circuit packs in the high speed part of the shelf or to the Extension Shelf. When WaveStar® TDM 10G is initially powered on after shipment from the factory, the lower TMG/STRAT3 is the active circuit pack and the upper TMG/STRAT3 is the standby circuit pack. However, both circuit packs are of equal level and protection switching is non-revertive, so there is no default configuration.
(1-2) ppls1	The circuit pack in this slot (PPROC/STS192 or PPROC/STS384) provides frame delay management between the switch functions of the low speed part of the shelf and the high speed part ((1-2) sw. 1).
(1-2) pproce	The PPROC/STS192 circuit pack in this slot supports the STM-64 port unit function assigned to the eastern aggregate port. The CP is responsible for pointer processing and synchronization to the system clock and for POH monitoring.

Minimum Complement of Circuit Packs

The minimum complement of circuit packs required for an operational WaveStar® TDM 10G Main Shelf is

- SWITCH/STS576 (two in low speed part, two in high speed part)
- CTL/SYS50DM (one in low speed part, one in high speed part)
- ADJCTL/DCCEI (one in low speed part, one in high speed part)
- TMG/STRAT3 (two in low speed part, two in high speed part)
- PPROC/STS192 (four in high speed part).

A shelf equipped with these circuit packs and the two OC192/STM64 port units would have no add/drop capability but would be fully functional. Other essential parts of the system which always have to be installed in the shelf are the Power Filter Units (PFU), the Fan Units (two) and the User Panel (for ordering: these are part of the Main Shelf assembly).

Interface Panels

A variety of Interface Panel boards exist to be connected in between customer cabling and the backplane. All Interface Panel boards are inserted from the rear of the equipment.

The Interface Panel boards contain the physical connectors and, if applicable, hardware to adjust the impedance.

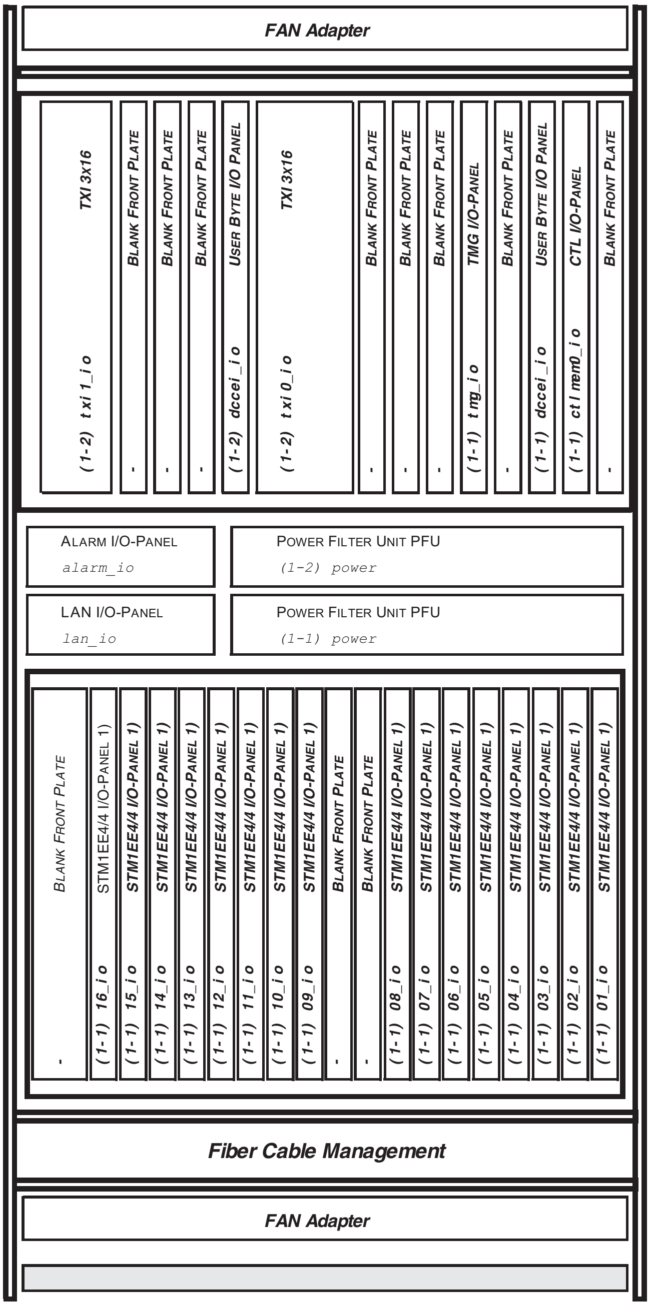
Interface Panel boards available:

- STM1EE4/4 I/O Panel, provides STM-1(e) physical interfaces
- TMG I/O Panel, provides external timing inputs/outputs
- CTL I/O Panel, to connect control signals of Main Shelf to Extension Shelf.
- LAN I/O Panel, provides the external LAN interface (for ordering: this is part of the Main Shelf assembly)
- Alarm I/O Panel, provides office alarm and remote I/O interfaces (for ordering: this is part of the Main Shelf assembly)
- User Byte I/O Panel, provides interfaces for external orderwire equipment.

Interface Panel Mounting

The following figure shows the interface panels mounted on a WaveStar® TDM 10G main shelf (rear view).

Figure 4-6 Rear View of Main Shelf (With Interface Panels Mounted)



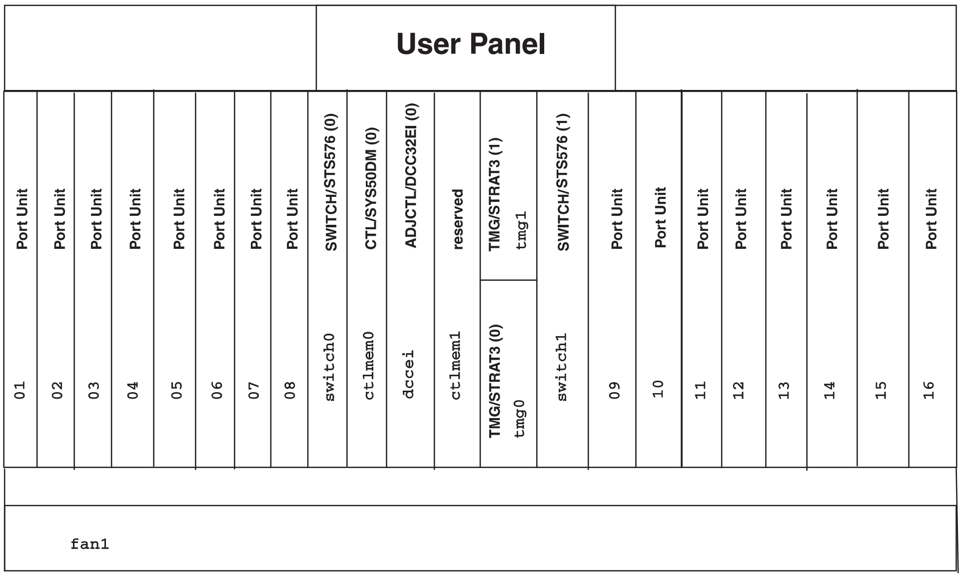
1) only equipped if STM1E/4 circuit pack is equipped, otherwise a Blank Front Plate is mounted

□

Extension Shelf

Layout The following figure depicts the WaveStar® TDM 10G Extension Shelf plug-in units and circuit pack slots, including the 16 slots used for STM-1(e), STM-1(o), STM-4, STM-16, or GE1 tributary port units.

Figure 4-7 Layout of the WaveStar® TDM 10G Extension Shelf



Circuit Pack Slots The following table identifies the circuit packs used in the WaveStar® TDM 10G. Refer to the port units descriptions in Appendix B for additional information about the transmission interface circuit packs.

Table 4-2 Circuit Pack Slot Equipage

Slot Designation	Slot Equipage
01 to 16	Any mix of transmission interface circuit packs: • STM-1(e) port units (STM1E/4) • STM-1(o) port units (OC3/STM1) • STM-4 port units (OC12/STM4) • STM-16 port units (OC48/STM16) • Gigabit Ethernet port units (GE1) Each of the STM-16 and Gigabit Ethernet port units requires two slots.

Table 4-2 Circuit Pack Slot Equipage (continued)

Slot Designation	Slot Equipage
switch0	Fabric switch 0. The SWITCH/STS576 circuit pack in this slot can make cross-connections for 192 STM-1 equivalent circuits. This switch is paired with fabric switch 1 in a 1+1 non-revertive protection mode configuration.
ctlmem0	The CTL/SYS50DM circuit pack in this slot is the working controller for the shelf. It can be used for CIT and EMS connections. Furthermore it collects all alarms and signals them on the User Panel and the office alarm interface.
dccei	Adjunct controller, DCC and external interface. The ADJCTL/DCC32EI circuit pack in this slot terminates up to 32 data communications channels and interfaces them to the shelf 10Base-T LAN.
ctlmem1	The slot is left empty for the current release of WaveStar® TDM 10G.
tmg1 tmg0	Two half-height Stratum 3 timing generator circuit packs are located one above the other in this slot. They are slave TMGs. Their function is to distribute the system clock from the active master TMG (Main Shelf) to the circuit packs in the Extension Shelf. When WaveStar® TDM 10G is initially powered on after shipment from the factory, the lower TMG/STRAT3 is the active circuit pack and the upper TMG/STRAT3 is the standby circuit pack. However, both circuit packs are of equal level and protection switching is non-revertive, so there is no default configuration.
switch1	Fabric switch 1. The SWITCH/STS576 circuit pack in this slot can make cross-connections for 192 STM-1 equivalent circuits. This switch is paired with fabric switch 0 in a 1+1 non-revertive protection mode configuration.

Switch Function

The switch function in the Extension Shelf is the first stage of the STM-64 two-stage switch function and crossconnects all signals coming from the port unit slots, either to the second stage (residing in the high-speed part of the Main Shelf) or back to a tributary port within this shelf. From the second stage signals can also go to the first stage in the LS part of the Main Shelf (or in further extension shelves with later releases) and the tributary ports there. But, of course, this again consumes capacity of the HS-LS connection.

Minimum Complement of Circuit Packs

The minimum complement of circuit packs required for an operational WaveStar® TDM 10G Extension Shelf is

- SWITCH/STS576 (two)
- CTL/SYS50DM (one)
- ADJCTL/DCCEI (one)
- TMG/STRAT3 (two)

A shelf equipped with these circuit packs would have no add/drop capability but would be fully functional together with an associated Main Shelf. Other essential parts of the system which always have to be installed in the shelf are the Power Filter Unit (PFU), the Fan Unit and the User Panel (for ordering: these are part of the Extension Shelf assembly).

Interface Panels

A variety of Interface Panel boards exist to be connected in between customer cabling and the backplane. All Interface Panel boards can be inserted from the rear of the equipment.

The Interface Panel boards contain the physical connectors and, if applicable, hardware to adjust the impedance.

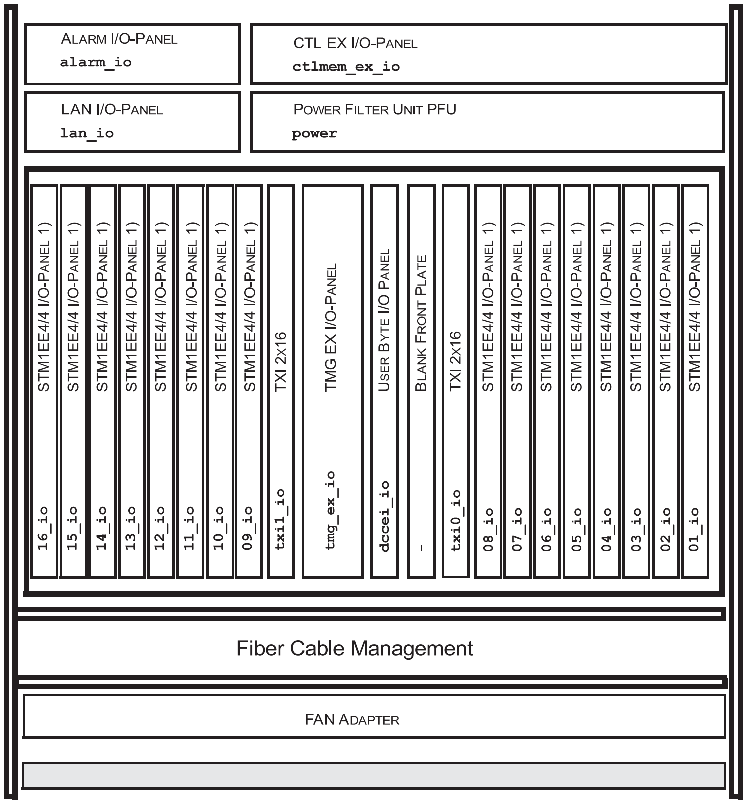
Interface Panel boards available:

- STM1EE4/4 I/O Panel, provides STM-1(e) physical interfaces
- TMG-EX I/O Panel, to connect timing signals of Main Shelf to Extension Shelf
- CTL-EX I/O Panel to connect control signals of Main Shelf to Extension Shelf.
- LAN I/O Panel, provides the external LAN interface (for ordering: these are part of the Extension Shelf assembly)
- Alarm I/O Panel, provides office alarm and remote I/O interfaces (for ordering: these are part of the Extension Shelf assembly)
- User Byte I/O Panel, provides interfaces for external orderwire equipment.

Interface Panel Mounting

The following figure shows the interface panels mounted on a WaveStar® TDM 10G extension shelf (rear view).

Figure 4-8 Rear View of Extension Shelf (With Interface Panels Mounted)



1) only equipped if STM1E /4 CP is equipped, otherwise a Blank Front Plate is mounted

□

Protection Configurations

Overview

This section describes the shelf configuration guidelines that have to be observed in case of the following protection mechanisms:

- 2-fiber MS-SPRing
- 1+1 MSP
- 1:N STM-1(e) equipment protection

All protection mechanisms are only supported within one shelf, so it is not possible to have a circuit pack in the Main Shelf be protected by a circuit pack in the Extension Shelf.

Please note that the STM-16 circuit packs always occupy two slots in the shelf, i.e. 01 and 02, 03 and 04, etc. The physical and logical connections, however, are to the even slot number (02, 04, etc.).

MS-SPRing

The MS-SPRing related STM-16 circuit pack pairs have to be plugged in to the following dedicated port unit slot pairs: 02-04, 06-08, 10-12, 14-16 or 02-16, 04-14, 06-12, 08-10.

MSP

MSP can only be established between two separate circuit packs (which are of the same type), i.e. it is not allowed to establish MSP between 2 ports on the same circuit pack. MSP between different ports on different circuit packs can be configured independently, e.g. one port of circuit pack 1 can be protected with one port of circuit pack 2 while the second port on circuit pack 1 is protected by circuit pack 3. The MSP related circuit packs are not restricted to specific slots.

For STM-16 port units, any pair combination of allowed slot positions can be applied: 02, 04, 06, 08, 10, 12, 14, 16.

For optical STM-1 and STM-4 port units, any pair combination of allowed slot positions can be applied: 01...16.

Also the DCC can be protected together with the MSP. As the number of ports which can be configured as DCC ports is limited, this enhances the possibilities with regard to protected ports carrying DCC, because the protecting port does not count into this number.

STM-1(e) Equipment Protection

The 1:N equipment protection of the STM1E/4 circuit packs can be configured in the Main Shelf only.

The desired number of working circuit packs can be plugged in slots (1-1) 01 to (1-1) 16. The standby circuit pack has to be plugged in slot (1-1) eprn. Furthermore the Electrical Protection Switch circuit pack (EPS-64) is necessary for the equipment protection and has to be plugged in slot (1-1) eprotnsw. If 1:N equipment protection is used, then slot (1-1) 16 can only support a STM-1E/4 circuit pack (no other CPs possible there).

All inserted STM1E/4 circuit packs automatically belong to the protection group. A manual lockout for individual circuit packs is possible to exclude these from the protection group.

□

Multiple Shelf Configurations

Overview

A multishelf configuration consists of one Main Shelf and one Extension Shelf and is shown in Figure 4-9, “STM-64 Multi-shelf Configuration” (4-26). This multishelf configuration is used if e.g. 1+1 MSP for up to 64 STM-1 Port Units is required. The connection between the shelves is done via the intershelf cable kits which transport data (TXI), timing and control signals. The STM-64 Main Shelf has the external Timing and OS/Alarm interfaces for the whole multishelf configuration.

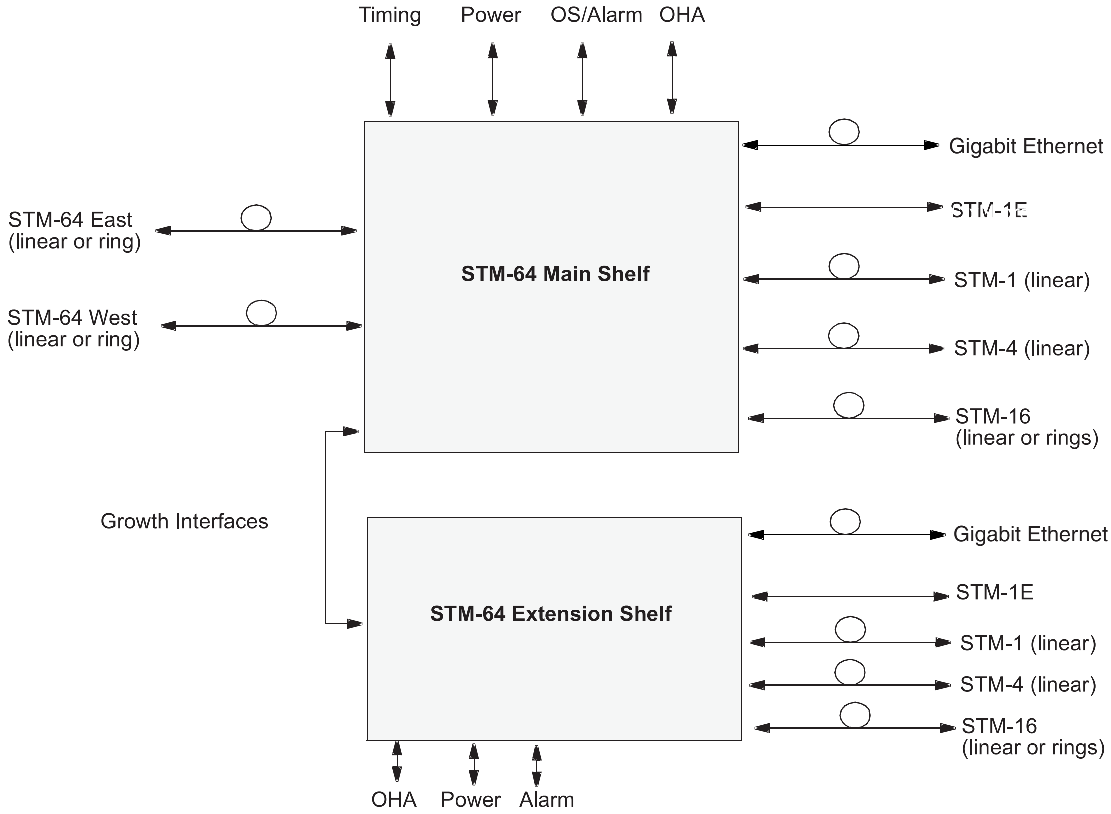
Mechanical Aspects

One WaveStar® TDM 10G Main Shelf and one Extension Shelf fit into a rack (2.2 m height).

The WaveStar® TDM 10G shelf in the top position of a rack requires a heat baffle immediately below it. WaveStar® TDM 10G shelves in the other rack positions require heat baffles directly above and below them. There must be no gaps above or below the heat baffles that separate the shelves. Please note for ordering that one heat baffle comes with each installation kit.

The heat baffle mounted below the lowest shelf in the rack is required to ensure adequate air flow between the lowest shelf and the bottom of the rack.

Figure 4-9 STM-64 Multi-shelf Configuration



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Circuit Packs

Overview The following circuit packs are used in the TDM 10G (STM-64) shelves:

Short Names	Function	Max. # in Main Shelf	Max. # in Ext. Shelf
OC192/STM64	Optical Interface Unit STM-64	2	-
OC48/STM16	Optical Interface Unit STM-16	8	8
OC12/STM4	Optical Interface Unit 2 x STM-4	16	16
OC3/STM1	Optical Interface Unit 4 x STM-1	16	16
GE1/SX2	Optical Interface Unit 2 x Gigabit Ethernet (1000BASE-SX)	8	8
GE1/LX2	Optical Interface Unit 2 x Gigabit Ethernet (1000BASE-LX)	8	8
STM1E/4	Electrical Interface Unit 4 x STM-1el	16	16
EPS-64	Electrical Protection Switch	1	-
PPROC/STS192	Pointer Processing Unit	4	-
PPROC/STS384		2 (HS-shelf)	-
SWITCH/STS576	Switching Unit 192x192 STM-1	4	2
SWITCH/STS768	Switching Unit 256x256 STM-1	2 (HS-shelf)	-
TMG/STRAT3	Timing Unit	4	2
CTL/SYS50DM	Controller Unit	2	1
ADJCTL/ DCC32EI	DCC Controller Unit	2	1

Short Names	Function	Max. # in Main Shelf	Max. # in Ext. Shelf
OBA	Optical Booster Amplifier (for STM-64 LH interface)	2	-
OBPA	Optical Booster and Pre-Amplifier (for STM-64 VH interface)	2	-

Remarks:

Max. 16 Tributary Port Units can be used in a shelf. This can also be a mix of different types of Port Units. OC-48/STM16 units need two slots.

1:N protection is possible for the STM1E/4 circuit packs in the Main Shelf. A separate slot is reserved for the protecting unit. In the Extension Shelf, no 1:N protection is possible.

The function of each circuit pack will now be described briefly.

Optical Interface circuit packs

The WaveStar® TDM 10G (STM-64) can be equipped with STM-64, STM-16, STM-4, and STM-1 Optical Interface circuit packs which are available in several types:

- STM-64 1550 nm Short Haul (acc. to ITU-T G.691)
- STM-64 1550 nm Intermediate Haul (acc. to ITU-T G.691, S-64.2a/3a, 60 km)
- STM-64 1550 nm Long Haul (acc. to ITU-T G.691 L-64.2/3; in combination with Optical Booster Amplifier circuit pack)
- STM-64 1550 nm Very Long Haul (acc. to ITU-T G.691 V-64.2/3; in combination with Optical Booster and Pre-Amplifier circuit pack)
- STM-64 for direct interfacing with DWDM system (OLS 400G; 40 colors)
- STM-16 1310 nm Long Haul (acc. to ITU-T G.957 L-16.1)
- STM-16 1550 nm Long Haul (acc. to ITU-T G.957 L-16.2/3)
- STM-16 for direct interfacing with DWDM system (OLS 80G; 16 colors)
- STM-16 for direct interfacing with DWDM system (OLS 400G; 80 colors)

- STM-4 1310 nm Short Haul (acc. to ITU-T G.957 S-4.1), 2 interfaces per circuit pack
- STM-4 1310 nm Long Haul (acc. to ITU-T G.957 L-4.1), 2 interfaces per circuit pack
- STM-4 1550 nm Long Haul (acc. to ITU-T G.957 L-4.2), 2 interfaces per circuit pack
- STM-1 1310 nm Short Haul (acc. to ITU-T G.957 S-1.1), 8 interfaces per circuit pack
- STM-1 1310 nm Long Haul (acc. to ITU-T G.957 L-1.1), 4 interfaces per circuit pack

Refer to the port units descriptions in Appendix B for additional information about the optical interface circuit packs.

Gigabit Ethernet circuit packs

The GE1 interfaces allow you to transport Gigabit Ethernet signals over SDH networks by encapsulating Ethernet packets in virtually concatenated VC-4s. The GE1 interfaces support point-to-point connectivity. The port units provide two fully independent bidirectional ports each.

GE1/SX2:

- 770 to 860 nm, Short Reach (acc. to IEEE802.3, clause 38.3), 2 interfaces per circuit pack.

GE1/LX2:

- 1270 to 1335 nm, Long Reach (acc. to IEEE802.3, clause 38.4), 2 interfaces per circuit pack.

Electrical Interface circuit packs

The electrical interface circuit packs provide the synchronous STM-1 interfaces and the aligning into AUs.

The following Electrical Interface circuit packs can be provided:

- STM1E/4 (155e Mbit/s; 4 interfaces per circuit pack; supports 1:N STM-1(e) equipment protection)

Refer to the port units descriptions in Appendix B for additional information about the electrical interface circuit packs.

Electrical Protection Switch circuit pack

The Electrical Protection Switch circuit pack (EPS-64) supports the 1:N equipment protection of the STM1E/4 circuit packs. Using the EPS-64 in the Main Shelf, up to 16 STM1E/4 can be protected by one protecting STM1E/4.

Cross-connect circuit pack

The SWITCH/STS576 and SWITCH/STS768 circuit packs are connected with the interface circuit packs via the backplane bus

(TXI). The Higher Order Cross-connect size is equivalent to 192x192 (SWITCH/STS576) or 256x256 (SWITCH/STS768) STM-1s.

The WaveStar® TDM 10G (STM-64) provides equipment redundancy for the Cross-connect circuit pack.

Pointer Processing circuit pack

The pointer processing circuit pack supports 64 (PPROC/STS192) or 128 (PPROC/STS384) STM-1s of pointer processing and path level monitoring. Various payloads are supported from the AU-3 up to the AU4-16c rate. Furthermore, the PPROC/STS192 is responsible for the delay management between the aggregate and tributary sides as well as between several shelves in multishelf configurations.

Timing circuit packs

The WaveStar® TDM 10G can be equipped with four Timing Generator circuit packs (TMG/STRAT3): two as working generators and the others as stand-by.

The TMG/STRAT3 is designed as Stratum-3e version meeting the requirements of ITU-T Rec. G.813.

Timing modes available are:

- Free running
- Hold-over (deviation from the last source max. 4.6 ppm in two weeks)
- Locked with reference to:
    - one of the external sync. inputs
    - one of the STM-N (N=1,4,16, 64) inputs.

Power Filter Units

The Power Filter Unit (PFU), which is integrated in the shelf performs the necessary filtering functions for the primary voltage to meet the ETSI requirements. To maintain high availability this functionality is duplicated.

The actual DC/DC conversion is located on the individual circuit packs. The power feeds remain duplicated between the PFU and the circuit packs.

Controller circuit packs

WaveStar® TDM 10G (STM-64) uses two types of controller circuit packs:

- CTL/SYS50DM – two circuit packs in the Main Shelf: the one in the high speed part serves as shelf controller for the high speed part and the one in the low speed part serves as shelf controller for the low speed part and as a system controller for the whole NE. If an Extension Shelf is used, this is also equipped with a CTL/SYS50DM serving as a shelf controller.
- ADJCTL/DCC32EI - the adjunct controller, which handles the Data Communication Network (DCN), the LAN and other external control interfaces and provides the access to the OH Bytes. One adjunct controller is assigned to each shelf controller.

A further description of the control architecture in the shelves can be found on “Control” (4-37).

□

Synchronization

Overview

WaveStar® TDM 10G synchronizes add, drop and through signals by using one timing source for all transmission. The timing source is normally locked to an external reference signal, such as one from the SDH Equipment Clocks (SEC) or from the Synchronization Supply Units (SSU). In the Main Shelf, there are 2 timing generator circuit packs for each, the low speed and the high speed part, to provide 1+1 non-revertive protection of the timing sources. If an Extension Shelf is used, this contains an additional 1+1 protected timing generator circuit pack.

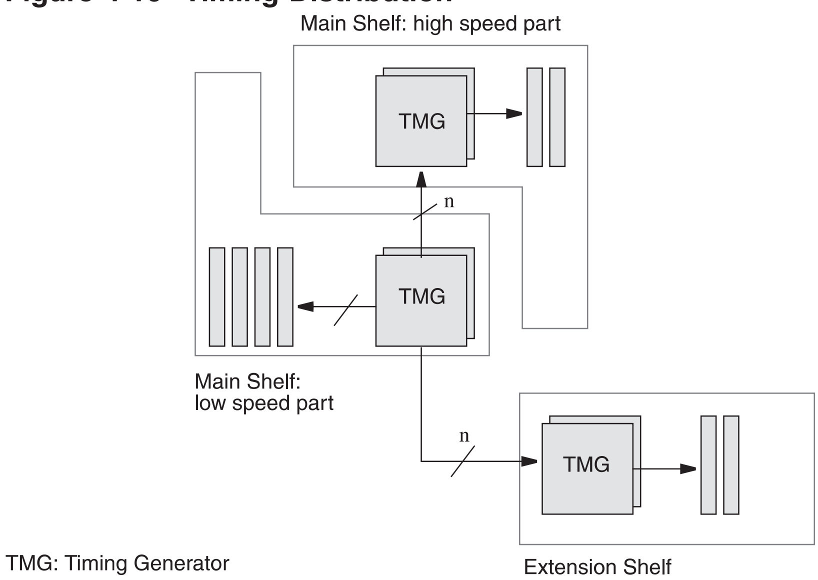
Master timing generator

The master timing generator for all configurations is located in the low speed part of the Main Shelf. The output clock signals of the slave timing generators in the high speed part of the Main Shelf and, if any, in the Extension Shelf, are fixed coupled to the output clock of the master.

Timing generator circuit packs

The timing generator circuit packs distribute timing signals throughout the shelf. These are used for clock, frame synchronization and multiframe synchronization.

Figure 4-10 Timing Distribution



Synchronization Modes

WaveStar® TDM 10G runs in any of these synchronization modes

- Free-running operation
- Hold-over mode
- Locked mode.

Timing Reference Signal Collection

Up to 8 timing reference signals can be specified in the priority list by using WaveStar® CIT or SNMS:

- 2 provisionable external station clock inputs (75 Ω or 120 Ω, 2048 kHz or 2048 kbit/s) according to G.703.
- 6 reference signals derived from any incoming SDH port (except STM1e) with the following restrictions:
  - Maximum 4 ports can be assigned on the Main (low-speed) Shelf
  - The port must be the first port on the unit
  - The port unit must be in an even slot (not applicable for STM-64)
  - The protection port in a 1+1 protection group cannot be assigned
  - Ports on the Expansion Shelf cannot be assigned.

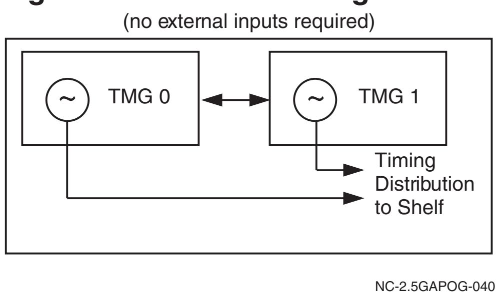
Only one of these reference signals can be selected as the active timing reference for the system at a time.

Free Running Mode

In the free running mode, the Stratum 3 clock in the active TMG/STRAT3 timing generator circuit pack is not locked to an external timing reference signal. However, the standby timing generator remains locked to the active timing generator.

The following figure illustrates the free running mode, in which the WaveStar® TDM 10G is synchronized by timing signals generated in the TMG/STRAT3 circuit pack.

Figure 4-11 Free Running



Holdover Mode

The active timing generator enters the holdover mode if all timing reference signals fail. In the holdover mode, the active timing generator keeps its internal Stratum 3 clock at the point at which it was synchronized to the last known good reference signal. The standby timing generator remains locked to the active timing generator. When the reference signal is restored, the active timing generator exits the holdover mode and resumes the normal locked timing mode.

Holdover mode is automatically available when the shelf is in the locked timing mode. The TMG/STRAT3 timing generator circuit packs monitor the quality of reference signals they receive. If one of the reference signals fails, WaveStar® TDM 10G uses the next in the priority list. If all reference signals fail, WaveStar® TDM 10G enters the holdover mode.

Locked Mode

In the locked mode, the TMG/STRAT3 circuit packs are synchronised to a timing reference signal from an incoming STM-64 line, STM-N tributary or external netclock. From this timing reference signal the TMG/STRAT3 circuit packs derive the timing signals used to synchronize the transmission port units.

The timing reference signal is continuously monitored for error-free operation. If the reference signal becomes corrupted or unavailable, the TMG/STRAT3 circuit packs select the timing reference signal that is next in the priority list. A corrupted signal includes excessive frequency offset. The behavior of the timing generators is controlled by timing reference frequency monitoring. If too fast deviations are measured a notification will occur. Control initiatd by the user is possible by switching among several defined states.If all configured timing reference signals are corrupted or unavailable, the TMG/STRAT3 circuit packs enter the holdover mode.

Timing Equipment Protection

WaveStar® TDM 10G uses non-revertive 1+1 protection switching to protect its timing circuit packs. In all shelves or shelf parts (low speed part, high speed part of Main Shelf), initially the TMG/STRAT3 circuit pack in the lower (0) position of the TMG slots is the active circuit pack and the TMG/STRAT3 circuit pack in the upper (1) position of the TMG slot is the standby circuit pack. If the active circuit pack fails and causes a switch to the standby circuit pack, the standby circuit pack becomes the active circuit pack. It remains the active circuit pack, even when the failed circuit pack is replaced. The replacement circuit pack becomes the standby circuit pack. There is no automatic revertive switching.

If the active timing generator were to fail while in holdover mode, then the standby timing generator would become the active timing generator and would switch to holdover mode (before switching, it was fed by the active timing generator) until the reference signal is restored to an acceptable quality.

Timing Provisioning

The WaveStar® TDM 10G synchronization mode can be set to locked or free running by using WaveStar® CIT. Additionally, either timing generator circuit pack can be switched to be the active timing generator. When WaveStar® TDM 10G is provisioned for the locked mode, the holdover mode is entered automatically upon loss of all reference signals or when forced holdover is provisioned.

Control and Status

As commands are issued or as failures occur and are cleared, the timing system switches from one state to another. The status of the timing is retrievable for user observation. Commands can be issued to obtain status reports or to manually change the synchronization state from one to another.

There are three categories of commands

- Modify – to provision operating parameters
- Retrieve – to obtain parameter values, states and statuses
- Operate – to lockout a switch, force a switch or clear a state

Synchronization Switching

Synchronization operations that can be user-controlled by commands include

- Non-revertive synchronization equipment switching
- Synchronization reference switching
- Synchronization mode switching

Timing Marker

The timing quality of all optical SDH data signals (STM-1, STM-4, STM-16, STM-64) is coded in the timing marker (also known as synchronization status marker, SSM) as per ITU-T Rec. G.783. The timing marker is located in the lower four bits of the S1 byte of the STM-N signal SOH.

Furthermore, the system supports the coding of the timing quality of the external 2.048 Mbit/s timing reference signals (inputs T3, outputs T4) in the synchronization status marker as per ITU-T G.704.

The used bit combinations are listed in the following table. The remaining combinations are reserved for future use.

S1 Bits	Quality Level
0010	Clock according to ITU-T Rec. G.811
0100	Transit node clock according to ITU-T Rec. G.812
1000	Local node clock according to ITU-T Rec. G.812
1011	Synchronization Equipment Timing Source (SETS)
1111	Do not use for synchronization (DUS)

The quality level “DUS” is inserted

- in the return path of TMG/STRAT3 active timing reference to avoid timing loops
- DUS can also be configured by the operator to isolate synchronisation domains from each other.

TMG-64K/6.3M I/O Panel

The TMG-64/6.3M I/O Panel provides both system interface access to the external timing inputs and outputs of the Master TMG‘s and timing distribution and collection connectors to the Extension Shelf.

The external timing inputs are designed for a 64 kB data stream. A first comparator stage detects the information and delivers a digital data stream without polarity information. A second decoder and devider extracts the clock information and delivers a 32 kHz reference signal. This is the input for a PLL which works with a 2.048 MHz VCXO (Voltage Controlled Crystal Oscillator). A lock control circuit detects if the input is present and the PLL is locked to switch the the VCXO signal to the external timing inputs of the TMG’s.

The external timing outputs are designed for a 6.312 MHz sine-wave reference clock signal. A first line receiver detects the 2.048 MHz reference clock signal of the TMG’s and delivers a digital clock. This is feed to a devider which delivers a 8 kHz reference signal. This is the input for a PLL which works with a 6.312 MHz VCXO. A lock control circuit detects if the input is present and the PLL is locked to switch the VCXO signal to the external timing outputs. The sine wave signal is formed by a LC filter.

External Reference Input (T3)

The circuit pack supports two external timing reference inputs with Composite Clock (CC). The input impedance of the 64/8-kB/s CC external timing reference inputs is 110 Ω (symmetrical).

- Frequency range 4 to 13 (kHz): Return loss > 12 dB
- Frequency range 13 to 256 (kHz): Return loss > 18 dB
- Frequency range 256 to 384 (kHz): Return loss > 14 dB.

External 64 kB/s Timing Signals

The electrical specification of the CC is as follows:

- 64 kHz with 8 kHz bipolar violation (64/8 kB/s) (appropriate AIS signal)
- Line code: bipolar, Return-to-Zero with 5/8 duty cycle
- Medium: shielded, balanced twisted pair
- Puls amplitude: 0.63 V 0-p to 1.1 V 0-p
- Impedance: 110 Ω (balanced).

□

Control

Overview

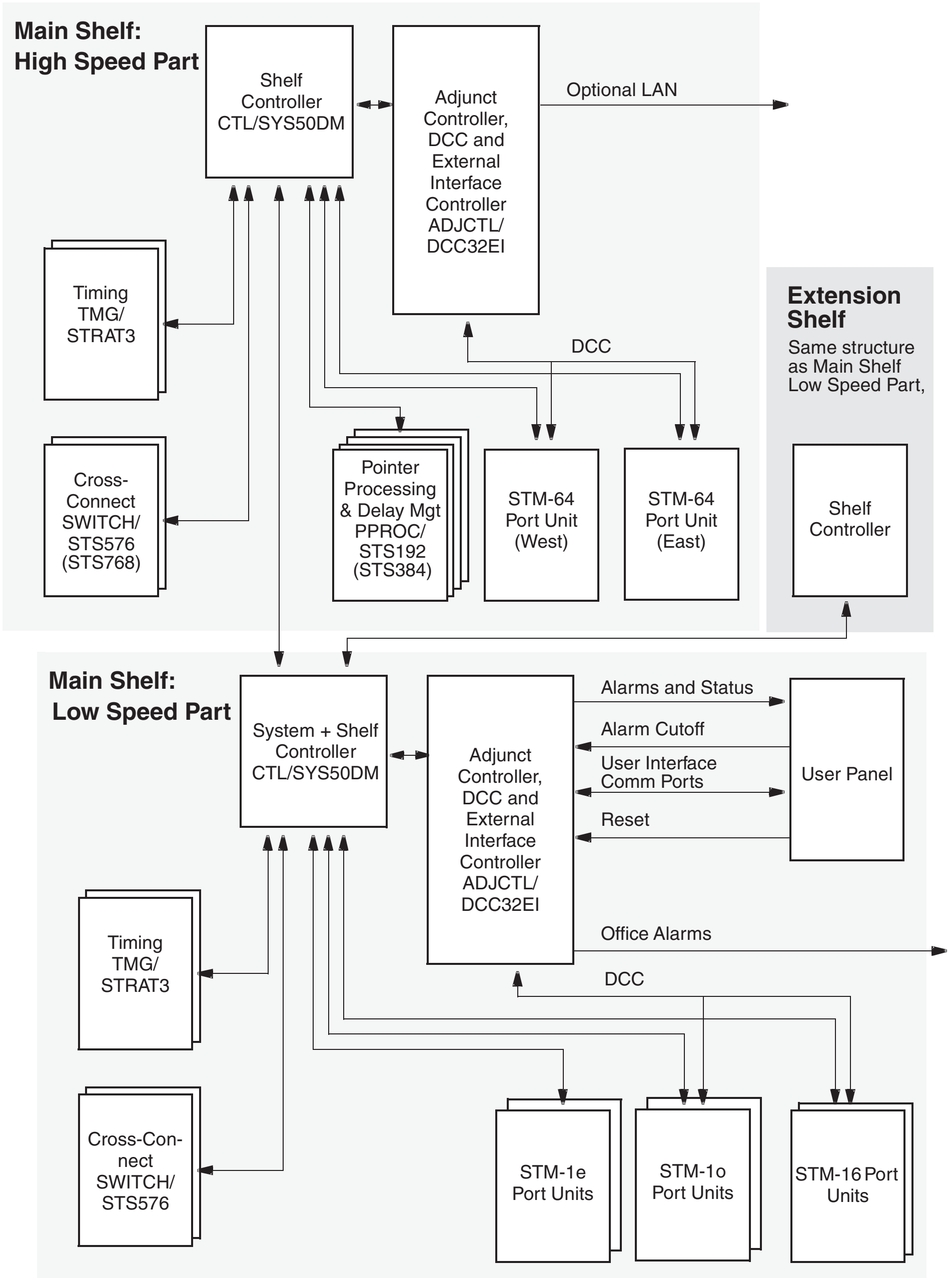
From the control architecture point of view, the WaveStar® TDM 10G (STM-64) main shelf can be regarded as two separate shelves. These two parts are called the high-speed part and the low-speed part. For each part, the functions are controlled by a shelf controller circuit pack and by function microcontrollers on the port units (transmission circuit packs). The shelf controller controls the port units and also the timing and switching circuit packs which have no internal function controllers. Overall shelf operation is controlled by signals received over the SDH Data Communication Channel (DCC) or the intraoffice LAN (IAO LAN).

The controller in the low-speed part additionally serves as a System Controller for the complete network element (Main Shelf and, if any, Extension Shelf).

Control Architecture

The follwoing figure shows the major paths of control and status information among the circuit packs in the WaveStar® TDM 10G (STM-64) shelf.

Figure 4-12 WaveStar® TDM 10G Control Architecture



Control Circuit Packs

WaveStar® TDM 10G (STM-64) uses two types of controller circuit packs:

- CTL/SYS50DM
- ADJCTL/DCC32EI.

CTL/SYS50DM

The CTL/SYS50DM circuit pack contains the main processor and memory controlling the WaveStar® TDM 10G (STM-64) shelf.

The primary functions it performs include the:

- communication with the function controllers in the port units to perform provisioning and maintenance.
- direct control of the timing and switching circuit packs in the shelf
- control of the transmission and reception of user data and orderwire data by way of the ADJCTL/DCC32EI circuit pack
- reset of circuit packs as necessary
- monitoring of the shelf power.

ADJCTL/DCC32EI

The adjunct controller serves as an interface to the system controller. It obtains, processes and stores information for transfer to and from the system controller. Additionally, it supports the status indicators on the User Panel.

The adjunct controller provides the following external interfaces (physically on interface panels on the rear of the shelf or on the user panel on the front, respectively):

- Station Alarm Interfaces
- Q-LAN 10 Base-T interface; for network management, also local NE management
- G.703 interfaces; Orderwire bytes X19 (for E1), E2 as 64-kbit/s channels. E1 is part of the Regenerator Section overhead and E2 is part of the Multiplex Section overhead. Each channel is 64 kbit/s.
- V.11 interface for the X20 Byte; for F1. F1 is part of the Regenerator Section overhead and is used as a 64 kbit/s User Channel.

□

Power

Overview

The WaveStar® TDM 10G shelf uses a distributed powering system, rather than bulk power supplies. It distributes -48V/-60V power throughout the shelf, and each circuit pack uses its own onboard power converter to derive the necessary operating voltages.

Dual Power Feeds

Office power feeders A and B are filtered and protected by circuit breakers at the input to the shelf. In the Main Shelf, two sets of office power feeders A and B are used, one for the low speed part and one for the high speeed part. The -48V/-60V supplies are then filtered by the Power Filter Units (PFU) to meet the ETSI requirements. After that, the supplies are distributed separately to each circuit pack, where they are filtered again and fused before being converted to the circuit pack working voltages.

Power Indicator

The green PWR ON indicator on the user panel remains lighted as long as either -48V/-60V supply is received from the circuit breakers.

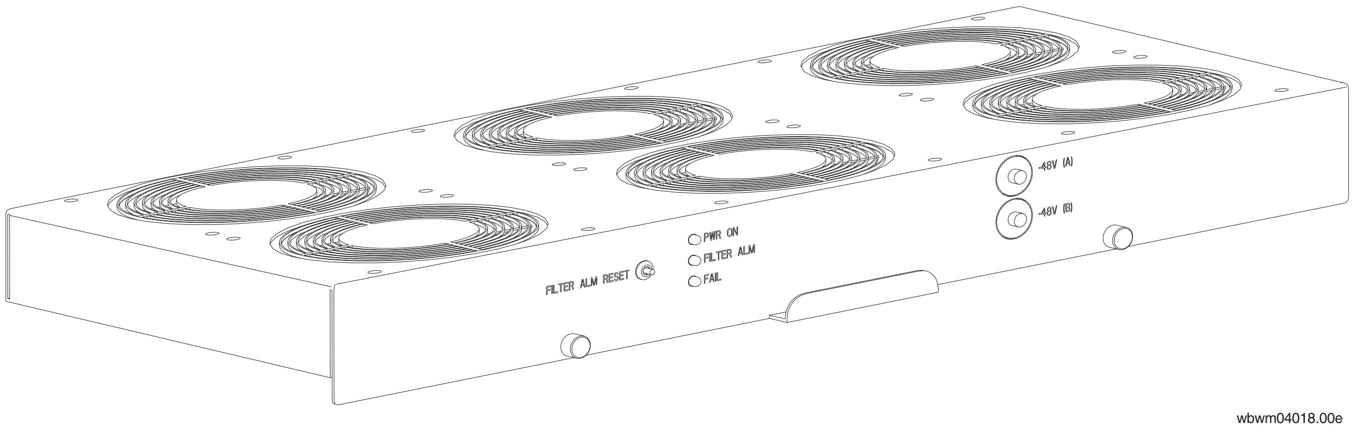
□

Cooling

Overview Cooling is provided by a plug-in fan unit. Fans draw air in through a filter beneath the fan unit and force it through the shelf from bottom to top. Heat baffles are required beneath each shelf to prevent the fan unit from drawing in the exhaust air from the shelf beneath it. The filter should be replaced every 6 months to ensure the proper cooling. A clock counting the six-month-intervalls for the filter reminds that the filter should be changed.

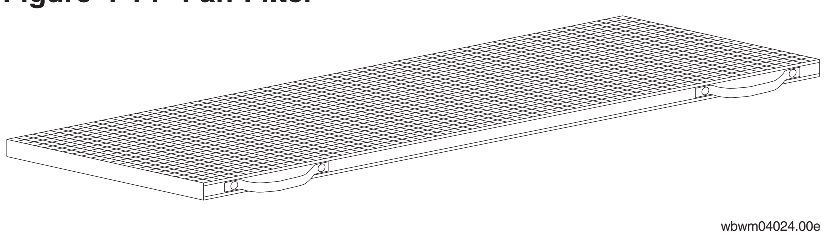
Fan Unit The following figure illustrates the fan unit that mounts in the WaveStar® TDM 10G shelf.

Figure 4-13 Fan Unit



Fan Filter The following figure shows the filter that is installed beneath the fan assembly.

Figure 4-14 Fan Filter



Fan Controller The fan unit includes six fans and a microcontroller that senses air flow, air temperature and fan faults. The microcontroller adjusts the speed of the fans to compensate for the failure of a fan or to conserve power when full air flow is not needed. It also reports the status of the fan unit to the shelf controller.

Controls and Indicators

The front panel of the fan unit includes the following controls and indicators

- Status indicators
  - PWR ON (power on)
  - FILTER ALM (filter alarm)
  - FAIL
- Filter alarm reset button
- Circuit breakers
  - -48V/-60V "A"
  - -48V/-60V "B"

  Important! The fan unit must be installed and operating in a shelf before any circuit packs are installed.

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5 Operations, Administration, Maintenance, and Provisioning

Overview

Purpose This chapter describes hardware and software interfaces used for administration, maintenance, and provisioning activities, the system management function for the administration of the WaveStar® TDM 10G and the maintenance and provisioning features available in the WaveStar® TDM 10G.

Contents

Operations

Overview

Purpose

This section describes the hardware and software interfaces used for administration, maintenance, and provisioning activities. These include

- Visible and audible indicators
- Graphical User Interface (GUI) on the WaveStar® CIT (Customer Interface Terminal)
- Operations interfaces

Please note that administration, maintenance, and provisioning activities via WaveStar® SNMS are described in the separate WaveStar® SNMS documentation set.

Visible and Audible Indicators

Visible and audible indicators notify you of maintenance conditions such as faults and alarms.

Graphical User Interface

The GUI (graphical user interface) on the WaveStar® CIT retrieves detailed information about local and remote network elements. The GUI is also used to provision local and remote WaveStar® TDM 10G circuit packs and the cross-connect switch fabric.

Operations System Interfaces

Operations interfaces include the DCC interfaces on the OC-N/STM-N port units and the IOA LAN (intraoffice LAN) interface. Both the DCC interface and the IAO LAN interface can receive commands from operations systems (network element management systems) or from a remote WaveStar® CIT.

Contents

Visible Alarm Indicators

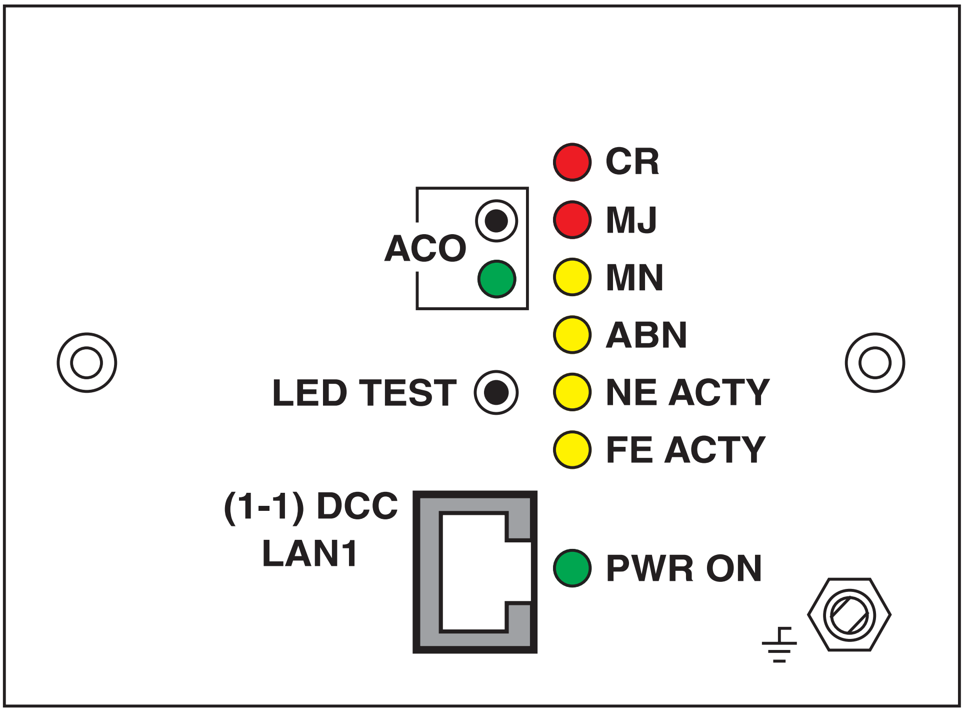
Overview

This section describes the visible indicators in the WaveStar® TDM 10G that are located on the

- User panel
  The user panel is the primary source of shelf-level visible alarm indicators.
- Circuit pack faceplates
- Fan unit
- Circuit breakers.

User Panel: Controls and Indicators

The following figure illustrates the user panel.



Indicators

The user panel provides the following indicators:

LED	Function
CR (Red)	indicates Critical (CR) alarms
MJ (Red)	indicates Major (MJ) alarms
MN (Yellow)	indicates Minor (MN) alarms

LED	Function
ABN (Yellow)	indicates Abnormal (ABN) conditions – temporary conditions that may potentially affect transmission, such as a user-initiated protection switch or a loopback
NE ACTY (Yellow)	indicates Near-end Activity (NE ACTY) – status condition at the local terminal, such as a local span switch in the MS-SPRing
FE ACTY (Yellow)	indicates Far-end Activity (FE ACTY) – status condition on remote terminals, such as a remote span switch in the MS-SPRing
PWR ON (Green)	indicates that power is applied to the shelf.

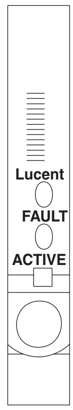
Controls and Connectors

The user panel provides the following controls and connections:

Button/Connection	Function
LED TEST	Test button for testing all shelf LEDs (except PWR ON on the user panel and the fan unit LEDs)
ACO	When the ACO button is pressed the local office alarm interfaces and the appropriate LEDs are simultaneously cut-off and the ACO LED is illuminated on the user panel of this shelf
Ground	ESD (electrostatic discharge) wrist strap ground
LAN	Port to connect a WaveStar® CIT to the system LAN.

Circuit Pack Indicators

The following figure illustrates the position of the LEDs on a circuit pack faceplate.



NC-2.5GAPOG-052

Circuit Pack Faceplate

All circuit pack faceplates are equipped with a Fault indicator and a Power (ACTIVE) indicator.

LED	is continuously lighted	is flashing
Fault (Red)	The WaveStar® TDM 10G has detected a failure in or involving that circuit pack.	Indicates the failure of an input signal • on a port unit an incoming signal to that port unit has failed. • on a synchronization circuit pack an externally timed reference signal has failed.
ACTIVE (Green)	Indicates that the circuit pack (or at least one port on a multi-port pack) is in the active (ON) mode.	When a circuit pack is inserted in a shelf, the green ACTIVE LED flashes as software is downloaded and self-tests are performed.

Fan Unit

The FAIL LED indicates both Severity 1 (service-affecting) and Severity 2 (non-service-affecting) alarms. The FILTER ALM LED indicates only Severity 2 alarms.

The fan unit has the following controls and indicators.

Controls and indicators	Function
Green power on (PWR ON) LED	Lights up when the fan receives -48V/-60V power

Controls and indicators	Function
Red fail (FAIL) LED	Lights up when there is an alarm of any type associated with the fan unit (for example, a fan in the unit fails)
Red filter alarm (FILTER ALM) LED	Lights up when the fan filter needs attention (for example, the filter is dirty and must be replaced)
Filter alarm reset button	Used to reset the FILTER ALM LED after the condition is resolved
Circuit breakers (A and B)	Two flush-mounted -48V/-60V circuit breakers (A and B) to protect against current overload

WaveStar® CIT

Overview

The WaveStar® TDM 10G is shipped with software for a Microsoft Windows® NT or Windows® 2000-based GUI that runs on a customer-furnished desktop or laptop computer. The GUI provides

- Control of operations, administration, maintenance and provisioning activities
- Security features to prevent unauthorized access
- Easily accessible Transaction Language 1 (TL1) interface
- Easily accessible via IAO LAN with TCP/IP protocol interface
- Information and control of maintenance and administrative activities
- Tool tips help facility.

Definition

The WaveStar® CIT is the WaveStar® TDM 10G GUI software running on a PC. It provides pull-down menus and extensive, context-sensitive on-line help. It offers a unified set of features for provisioning, testing, and reporting. The WaveStar® CIT is necessary to install and accept the system.

Minimum Requirements

For a WaveStar® CIT a personal computer is necessary which fulfills the following minimum requirements:

Pentium® 266 MHz processor (*Pentium*® III 500 MHz or higher recommended) with 128 MB of RAM (256 MB of RAM or higher recommended)
Standard floppy-disk drive for 1.44 MB 3.5” floppy disks
500 MB of free hard-disk drive space
CD-ROM drive (16 × recommended)
CompactFlash™ card
SVGA monitor set to 800 × 600 resolution or greater, with 256 colors (1024 × 768, 16 million colors recommended)
10/100BaseT LAN interface, installed and working
Adobe® *Acrobat*® *Reader*® for *Windows*® (version 3.01 or later)
Removable hard-disk drive (optional; required only for system backup).

One of the following operating systems:

- *Microsoft® Windows NT®* 4.0 with Service Pack 5
- *Microsoft® Windows®* 2000 with Service Pack 2
- *Microsoft® Windows XP®*

It is ***strongly recommended*** to use an English *Microsoft® Windows®* version!

The WaveStar® CIT software does ***not*** work with the *Microsoft® Windows®* Chinese-Traditional version.

Notes:

1. *Microsoft® Windows®* 2000 does not clean up drivers properly after the removal or exchange of network cards, causing critical network services to fail. This can cause WaveStar® CIT failing to start after installation, or you will be unable to select the right network card from the list during installation. To solve these problems, deinstall not present network cards from the PC.
2. Formatting the *CompactFlash™* card as described in the *Installation Guide* sporadically fails when you are using a PC running the *Microsoft® Windows®* 2000 operating system. The reason is that not all types of *CompactFlash™* cards might be natively supported by *Windows®* 2000. As a consequence the *CompactFlash™* card becomes unreadable and the NE software cannot be successfully copied to the card. Therefore, it is recommended to use a PC running the *Microsoft® Windows NT®* 4.0 operating system to format the *CompactFlash™* card.

The performance of the user interface can be enhanced by using a higher performance personal computer.

For connecting the WaveStar® CIT to the NE a crossed or straight (depending on the NE) Ethernet LAN cable (10/100BaseT) with 4-wire RJ-45 connectors is used .

WaveStar® CIT Access

The WaveStar® TDM 10G supports local and remote access using a WaveStar® CIT. Remote access uses the DCC (data communications channel) or an external OSI WAN connected to a WaveStar® TDM 10G LAN port. The LAN interface provides both TCP/IP and OSI protocols. At any given time, only one WaveStar® CIT can be connected to a CIT port on the user panel.

Security Function

The WaveStar® TDM 10G provides a security function to protect against unauthorized access to the WaveStar® CIT system functions (such as provisioning). Security is controlled through logins, passwords, WaveStar® CIT port disabling/enabling, and authorization levels for the system functions.

TL1 Interface

You can use the GUI to manage all provisioning, testing, and report generation easily and intuitively, with the GUI handling the TL1 interface behind the scenes.

Many customers develop standardized scripts for use in the field for standard operations. The GUI supports the possibility to write, save, and execute standardized TL1 scripts.

Maintenance and Administrative Activities

The WaveStar® CIT provides detailed information and system control of the following specialized local/remote maintenance and administrative activities:

- Provisioning
- Cross-connect assignments
- Protection switching
- Displaying performance-monitoring data
- Fault management (alarms lists, etc.)
- Polling inventory data of the NE
- Software download to the NE
- Loopback operation and testing
- Reporting.

□

Operations Interfaces

Overview

The WaveStar® TDM 10G supports the following operations interfaces

- Office alarms interface
- Miscellaneous discrete interfaces
- Message-based operations system (OS) interface, access via TCP/IP or OSI communication protocols, support for SNMS
- Data communications channels (DCC).

Office Alarms Interface

The office alarms interface is a set of discrete relays that control audible and visible office alarms. Separate relays handle critical, major, and minor alarms. If desired, critical and major alarm outputs can be wired so that either, neither, or both of the outputs control the major office alarm.

Miscellaneous Discrete Interface

The miscellaneous discrete interface allows an OS to control and monitor equipment co-located with the WaveStar® TDM 10G through a set of input and output contact closures. There are 8 miscellaneous inputs that can monitor conditions such as open doors or high temperature, and 8 miscellaneous discrete outputs to control equipment such as fans and generators. These can be set by the user.

The status of the miscellaneous discrete inputs can be queried from the WaveStar® CIT. The WaveStar® TDM 10G collects miscellaneous discrete alarms and automatically sends them to the OS.

Software Download, Backup and Restore

WaveStar® TDM 10G (STM-64) provides the capability, via the OSI network using the OSI or TCP/IP or FTTD-FTP/FTAM protocol, to download software from the WaveStar® CIT to the NE or from the element/network management system to the NE and support backup and restore of the NE database.

Message-Based OS Interface

The WaveStar® TDM 10G provides Transaction Language 1 (TL1) for commands/messages that complies with applicable standards. The OS interface is accessed through one of the 10/100 BaseT LAN rear-panel connectors. The LAN interface can be configured for TCP/IP and OSI protocols. The system supports software downloads, provisionable data backup, and restore using FTP for the TCP/IP and OSI protocols, respectively.

TL1 Interface

The TL1 (or OS) interface is compatible with Bellcore Network Monitoring and Analysis (NMA), Lucent Technologies Transvu II, and

Lucent Technologies WaveStar® Subnetwork Management System (SNMS). The WaveStar® TDM 10G OS interfaces supported include:

- LAN with TCP/IP or OSI protocol (to SNMS or another compatible OS)
- TCP/IP (via NCC to SNMS)
- TL1 x.25 (via NCC to NMA)
- TL1 TCP/IP (via NCC to NMA)

As stated above, the WaveStar® TDM 10G system OS interface supports TCP/IP directly (without the need for an external mediation/conversion device). The WaveStar® TDM 10G system also supports the use of Lucent's Network Communication Control (NCC) for those who plan to, or want to continue to, use the NCC as part of their operations environment. The NCC can perform conversion (gateway function) of OSI (TL1 based) to TL1 TCP/IP, TCP/IP, and TL1 x.25. These functions may be useful when connecting a mix of deployed mutlivendor network elements to various OS systems.

Interface Security Function

WaveStar® TDM 10G also provides a security function to protect against unauthorized access to OS functions, such as provisioning. Security is controlled through logins, passwords, and authorization levels for the system functions.

Data Communications Channel (DCC)

The WaveStar® CIT and operations interface features extend beyond the local WaveStar® TDM 10G to cover remote sites. This network operations capability uses the SDH section DCC bytes in the STM-N SDH overhead. WaveStar® CIT dialogues and operations interface messages travel in these DCC bytes.

Operations via a bridge TCP/IP and OSI

A Transport Service Bridge (TSB) that reaches the NE via the embedded OSI network (such as the DCC channel) allows TCP/IP to OSI message conversion. Using a TSB, an element/network management system can control an NE by means of a TCP/IP access network, handling functions such as software download or backup/restore.

IP Access

The WaveStar® TDM 10G (STM-64) supports two types of IP Access. In one case, the WaveStar® TDM 10G can serve as a ***TL1 Translation Device*** (T-TD) by acting as a gateway NE that allows an SNMS and/or CIT to communicate to other NEs through an IP access network. This capability allows you to send TL1 commands from an SNMS or CIT located on a TCP/IP based network to various NEs on a connected OSI network. In the second instance, the WaveStar® TDM 10G can functionally encapsulate IP packets within OSI packets to be transmitted through the OSI network to the proper NE. Thus the

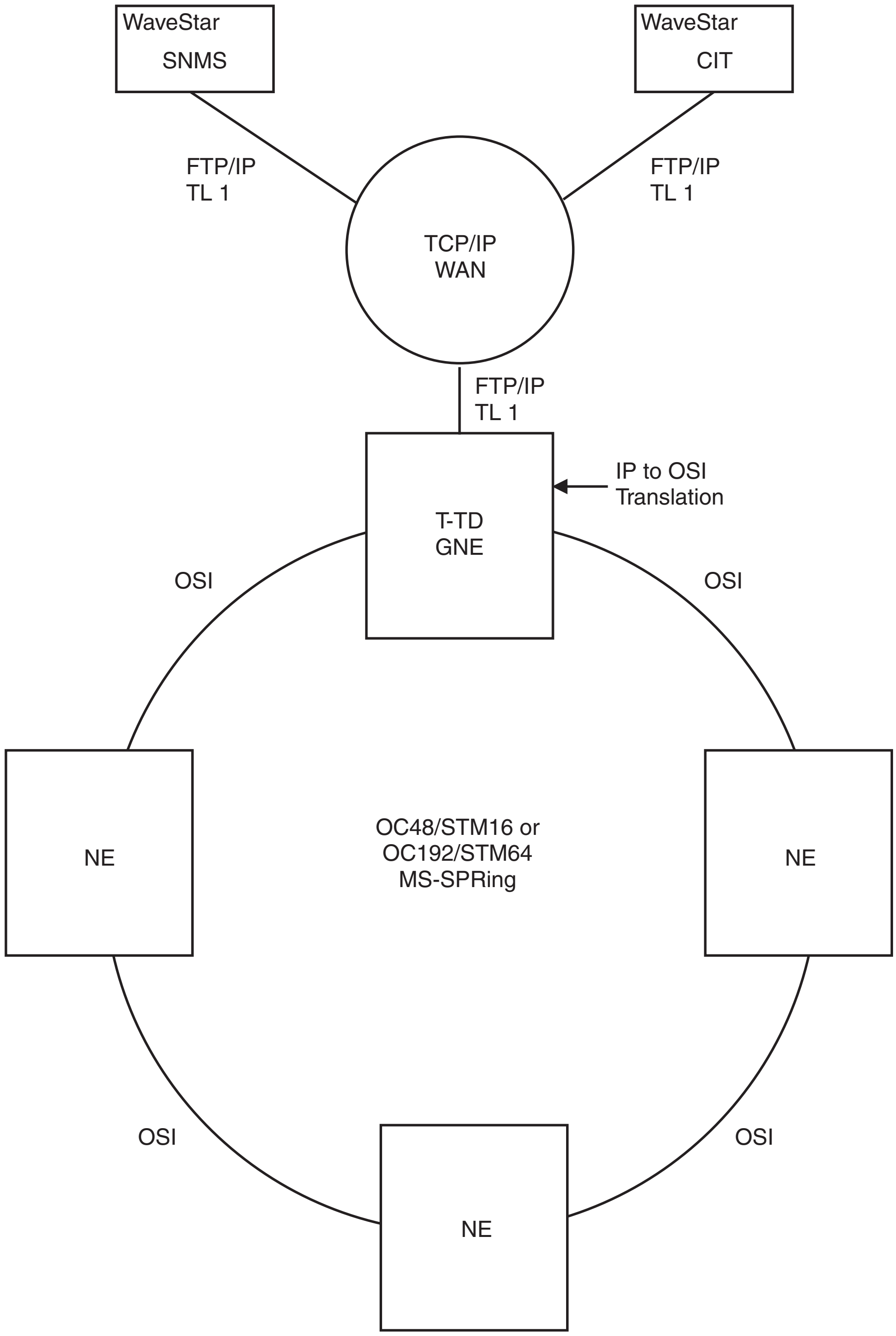
WaveStar® TDM 10G supports IP based protocols such as FTP by providing end-to-end IP connectivity between OS and NE. This capability is called ***IP tunneling***.

TL1 Translation

The WaveStar® TDM 10G (STM-64) can copy the application information within an IP packet into an OSI packet. This translation is performed at the application layer. When acting as a TL1 translation device, the WaveStar® TDM 10G system must be provisioned with a list of possible OSs. If an OS is not on the list residing within the system, a connection from that OS will not be accepted. When the WaveStar® TDM 10G is used as a TL1 translation device it is referred to as the T-TD GNE (Gateway Network Element). The T-TD

GNE provides the same functionality as the NCC TL1 TCP/IP gateway.

Figure 5-1 TL1 Translation Device

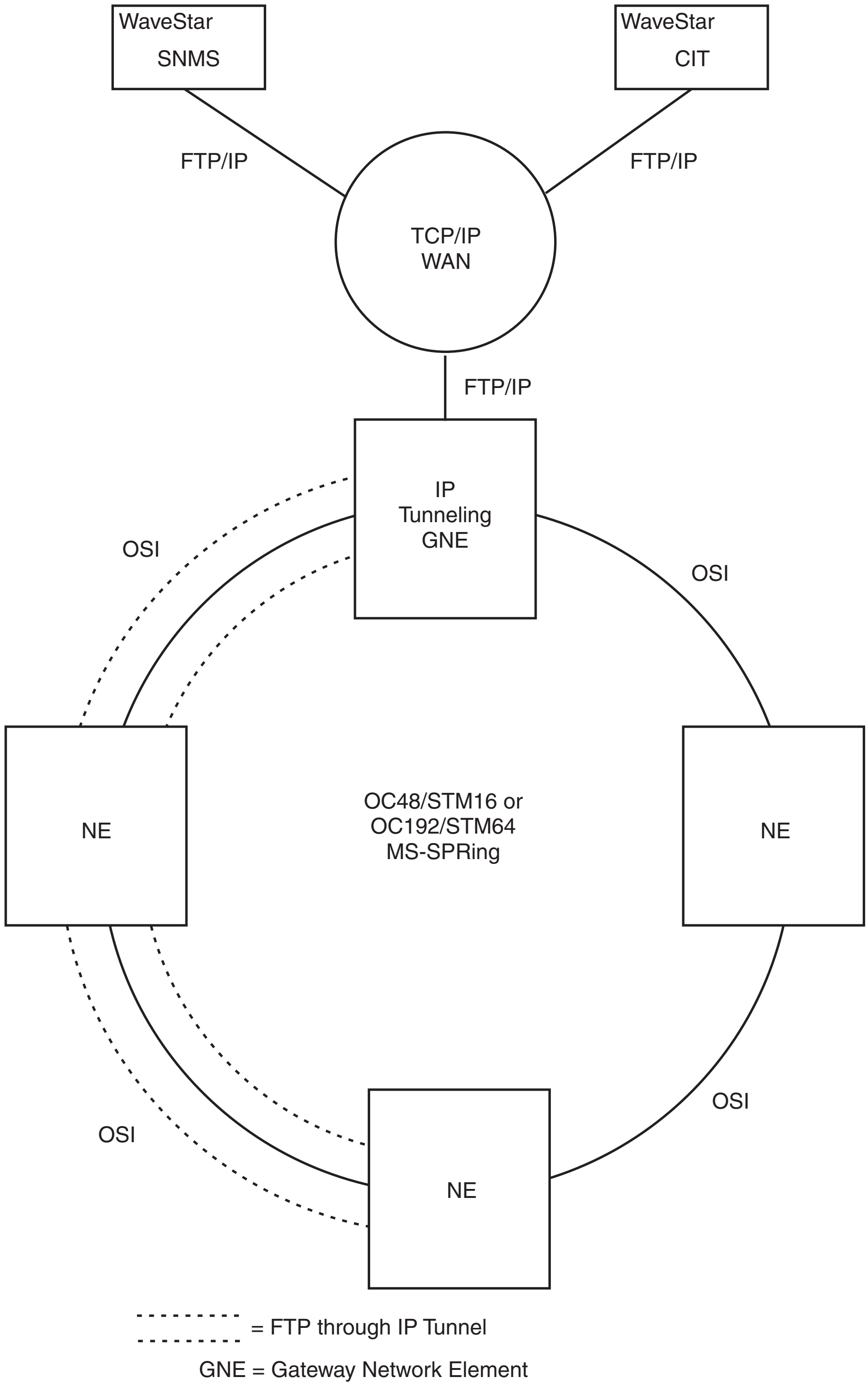


IP Tunneling

IP tunneling allows for file transfer (FTP) through an IP access network. IP tunneling is used to perform end-to-end FTP through the IP and OSI portion of the network. In this instance the WaveStar® TDM 10G serves as a gateway network element that encapsulates an

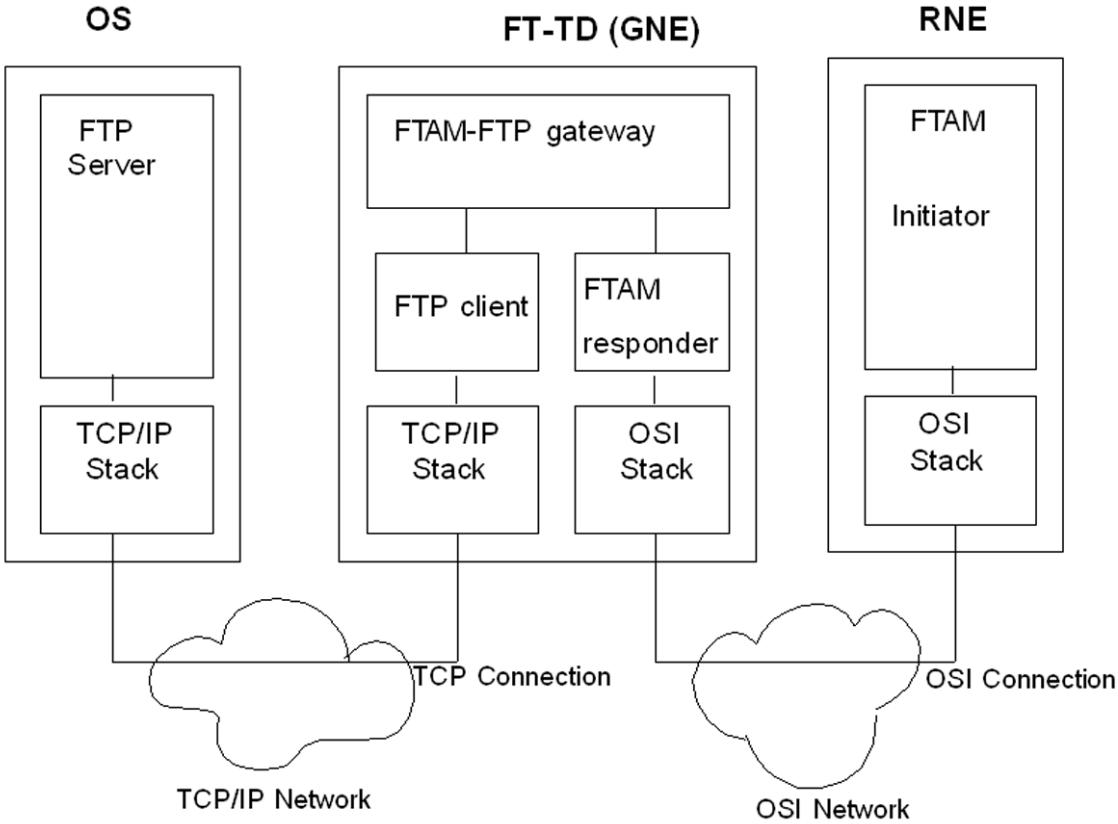
IP packet within an OSI packet. When the final destination of the packet is reached, the IP packet is taken from within the OSI packet and processed by the TCP/IP stack. Thus, IP tunneling allows an SNMS and/or CIT to reach NEs in an OSI based DCN network with FTP over IP. In this case, the end point of the IP tunnel is the actual end for the IP traffic. IP tunneling can be used for any IP based protocol, but the use will be limited to FTP for this product.

Figure 5-2 IP Tunneling



FTAM—FTP gateway (FT-TD)

WaveStar® TDM 10G (STM-64) supports the FTAM-FTP gateway functionality, allowing file transfers across a mixed OSI and TCP/IP network. The FTAM-FTP gateway is used in a mixed OSI and IP network, where the access DCN is IP and the NEs being managed are in a OSI network. The FTAM-FTP gateway translates FTAM (File Transfer and Management) over OSI presentation to FTP over TCP-IP. The FTAM-FTP gateway is also referenced as FT-TD (File Transfer Translation Device).



□

Administration

Overview

Purpose The system management function related to administration of WaveStar® TDM 10G is focused on security features.

Security The WaveStar® TDM 10G provides for secure system access by means of a three-tier mechanism.

□

Security

Overview

This section describes the various security features that the WaveStar® TDM 10G provides to monitor and control access to the system.

Three-Tier Security

The three tiers of security that protect against unauthorized access to the WaveStar® CIT and the network element functions are

- Port security
- Network element login security
- User login security.

Port Security

Port security controls access to the system through a per-port enable/disable mechanism and inactivity time-outs.

Network Element Login Security

NE login security controls access to the system through a lockout mechanism to disable all but administrative logins.

User Login Security

User login security controls access to the system on an individual user basis by means of

- Login ID and password assignment
- Login and password aging
- Autonomous indications and history records
- User privilege codes.

Login and Password Assignment

To access the system, the user must enter a valid login ID and password. The WaveStar® TDM 10G allows up to 500 login IDs and passwords. Two of these login IDs are for the Superuser authorization level. The others are for Privileged User, Maintenance, Reports Only, and General User authorization levels.

Login and Password Aging

The following aging processes provide additional means of monitoring and controlling access to the system:

- Login aging deletes individual logins if unused for a pre-set number of days or on a particular date (for example, for a visitor or for temporary access during installation)
- Password aging requires that users change passwords periodically.

Autonomous Indications and History Records

The system provides autonomous indications and history log records of successful and unsuccessful logins, as well as intrusion attempts for security audits.

User Privilege Codes

When a user is added to the NE, a separate user privilege code, which may include an authorization level, is assigned to that user for each of the functional categories, based on the type of work the user is doing. The user privilege codes may be accompanied by an authorization level represented by a number between 1 and 5, with 5 being the highest level of access. It is permissible to grant access to any combination of commands using a privilege code, except for full privileges, which are reserved for the two pre-installed superusers.

Functional Categories

The functional categories for the user privilege codes may include

- Security (S)
- Maintenance (M)
- Performance monitoring (PM)
- Testing (T)
- Provisioning (P).

Authorization Levels

Users can execute any commands at their functional categories' authorization level, as well as all commands at lower levels. For example, a user with authorization level 4 in the maintenance category can also execute commands listed in levels 3, 2, and 1 in the maintenance category.

□

Maintenance

Overview

Purpose

This section introduces the maintenance features available in the WaveStar® TDM 10G.

Definition

Maintenance is the system's capability to continuously monitor its equipment and the signals that it carries in order to notify the user of any current or potential problems. This enables the user to take appropriate proactive (preventive) or reactive (corrective) action.

Types of Maintenance

Maintenance information and control are provided by

- Maintenance signals
- Fault detection, isolation, and reporting
- Provisioning consistency audits (future release)
- Loopbacks and tests
- Protection switching
- Performance monitoring
- Reports.

Contents

Maintenance Signals

Overview

This section describes the maintenance signals available in the WaveStar® TDM 10G.

Definition

WaveStar® TDM 10G maintenance signals notify downstream equipment that a failure has been detected and alarmed by some upstream equipment (Alarm Indication Signal) or the WaveStar® TDM 10G, and they notify upstream equipment that a downstream failure has been detected (yellow signals).

Standards Compliant

The fault monitoring and maintenance signals supported in the WaveStar® TDM 10G are ITU-T-compliant.

Monitoring Failures

The WaveStar® TDM 10G continuously monitors its internal conditions and its incoming signals. Read access to the path trace information is provided for all signals.

Incoming SDH signals are monitored for:

- Loss of Signal (LOS)
- Loss of Frame (LOF)
- Multiplex Section Alarm Indication Signal (MS-AIS)
- Multiplex Section Signal Degrade (MS-DEG)
- Multiplex Section Server Signal Fail (SSF)
- Multiplex Section Excessive Bit Error Rate (MS-EXC)
- Higher Order Remote Defect Indication (HP-RDI) for STM-64 and STM-16
- Unequipped
- Path Alarm Indication Signal (P-AIS)
- Loss of Pointer (LOP)
- Path Signal Degrade (P-DEG)
- Path Excessive Bit Error Rate (P-EXC)
- Trace Identifier Mismatch (TIM)

Signal Maintenance

When defects are detected, the WaveStar® TDM 10G inserts an appropriate maintenance signal to downstream and/or upstream equipment. The SDH maintenance signals include Multiplex Section Remote Defect Indications (MS-RDI) and Path AIS.

Path Unequipped

The WaveStar® TDM 10G inserts the Path Unequipped identifier to downstream and/or upstream equipment if paths are intentionally not carrying traffic.

Fault Detection and Reporting

When a fault is detected, the WaveStar® TDM 10G employs automatic diagnostics to isolate the failed circuit pack or signal. Failures are reported to local maintenance personnel and to the OS so that repair decisions can be made. If desired, OS personnel and local personnel can use the WaveStar® CIT to gain more detailed information about a specific fault condition.

Fault History

All alarmed fault conditions detected and isolated by the WaveStar® TDM 10G are stored and made available to be reported, on demand, through the WaveStar® CIT. In addition, a history of the past 500 alarm and status conditions and WaveStar® CIT or OS-initiated events is maintained and available for on-demand reporting. Each event is date and time stamped.

Reports

The WaveStar® TDM 10G automatically and autonomously reports all detected alarm and status conditions through the

- Office alarm relays
- User panel
- Equipment LEDs
- Message-based OS.

□

Provisioning Consistency Audits

Overview

This section describes the provisioning consistency audits planned to be available to the full extent in a future release of the WaveStar® TDM 10G.

Definition

The WaveStar® TDM 10G provides a function that monitors (audits) the consistency of the provisioning information related to ring administration and cross-connections. This function alerts you to situations that may result in lost traffic or protection switching problems.

Ring Squelch Map

The ring squelch map consists of the provisioned source and destination Target Identifiers (TID) for each cross-connection at each node in the ring. Incorrect information in this map could result in misconnected traffic or traffic being dropped unnecessarily during failure conditions. The corresponding part of the audit function flags all instances of unknown TID values in the squelch map. It also propagates changes to the TID in any node in the ring and to all other nodes so that they can automatically update their squelch maps. Thus, you do not have to change the squelch maps manually.

□

Loopbacks and Tests

Overview

This section describes the automatic and manual loopbacks and tests that the WaveStar® TDM 10G performs.

Loopback Definition

A loopback is a troubleshooting test in which a signal is transmitted through a port unit to a set destination and then returned to the originating port unit. The transmitted and received signals are measured and evaluated by the user to ensure that the received signal is accurate and complete when compared to the originating signal.

Software-Initiated Loopbacks

The WaveStar® TDM 10G can perform software-initiated loopbacks within the port units. Active loopbacks are indicated by the abnormal (ABN) LED on the user panel.

Installation Self-Test

Installation self test and diagnostics are executed automatically during installation and after power up to verify correct system operation. Additional diagnostic tests are performed for fault isolation. These tests ensure that the system is capable of performing its required functions. If a defect is detected, the replaceable unit which should be replaced to repair the defect is identified.

Circuit Pack Self-Test

The WaveStar® TDM 10G supports a variety of self-tests designed to verify the health of individual transmission circuit packs.

□

Protection Switching

Overview

This section describes the protection switching and redundancy mechanisms available in the WaveStar® TDM 10G.

Definition

The following types of protection and redundancy are available:

- 1+1 MSP on the tributary side (STM-1, STM-4 and STM-16 level)
- 1+1 MSP on the aggregate side (STM-64 terminal multiplexer)
- MS-SPRing at the STM-64 or STM-16 level including Dual Node Ring Interworking (DNI)
- Sub-Network Connection Protection (SNCP) including DNI towards MS-SPRing
- Redundant cross-connection switching circuit pack and delay management unit
- Redundant Timing circuit packs
- Redundant STM-1(e) electrical interface circuit pack (1:N equipment protection, N = max. 16)
- Duplicated power feed throughout the system.

1+1 MSP

Multiplex Section Protection (1+1 MSP) of the optical interface units is possible for all bitrates. Revertive or non-revertive and uni- or bidirectional operation is supported. This protection mechanism complies with a maximum traffic interruption time less than 50 ms.Preemptible protection access (low priority traffic which will be interrupted in case of a protection switching event) is supported for the case of MSP protected aggregates (in a Terminal Multiplexer). For all bitrates the lock-out state is provisionable. The MSP can now be activated and de-activated in-service.

MS-SPRing

In ring Add/Drop applications, at the STM-64 or STM-16 level, the WaveStar® TDM 10G (STM-64) supports the MS-SPRing protection mechanism. One of the main differences between SNC and MS-SPRing protection is that the latter one is a shared protection mechanism. This means that in most cases MS-SPRing will add substantially to the total ring capacity. This protection mechanism complies with a maximum traffic interruption time less than 50 ms.

Sub-Network Connection Protection (SNCP)

The principle of an SNCP is based on the duplication of the signals to be transmitted and the selection of the best signal available at the connection termination. The two (identical) signals are routed over two different path segments (Sub-Network Connections, SNCs). SNCP is supported for all cross-connection levels (VC-3, VC-4, VC-4-4c, VC-4-16c).

DNI towards MS-SPRings, i.e. the redundant connection between a SNCP protected path and a MS-SPRing without using additional capacity in this MS-SPRing, is also supported. The SNCP can now be activated and de-activated in-service, this is advantageous when network changes require a change of the physical way of pathes.

Redundant Cross-Connect and Delay Management Function

The core of the system functionality, the Cross-connect circuit pack (SWITCH/STS576 or SWITCH/STS768), is duplicated. In this way a reliable interconnection of the CC-function and the interface circuit packs is achieved. On the aggregate side, also the delay management unit (PPROC/STS192 or PPROC/STS384) is duplicated.

Redundant Timing Generator

In addition the Timing Generator circuit packs (TMG) are duplicated. This will provide the necessary timing redundancy.

Redundant Electrical STM-1

In order to complete equipment redundancy, the electrical interface circuit packs can be provided with redundancy as well. STM-1(e) circuit packs can be 1:N (N=max. 16) equipment protected.

In the event of failure in any circuit of an interface circuit pack, all traffic carried by this pack is switched to the protecting circuit pack.

Duplicated Power Feed

Power feed is duplicated throughout the system and can take its power from both supply lines (from the duplicated power feeds). Each circuit pack has its own DC/DC converter (distributed powering).

□

Performance Monitoring

Overview

Performance Monitoring provides the user with the facility to systematically track the quality of a particular transport entity. This is done by means of continuous collection and analysis of the data derived from defined measurement points.

Definitions

The following definitions explain expressions which are important for performance monitoring.

Anomaly An anomaly is a discrepancy between the actual and the desired characteristic of a system component.

Defect A defect is the limited interruption of the ability of a system component to perform a required function.

Block A block is a set of consecutive bits associated with the path/section. Each bit belongs to one and only one block. Consecutive bits may not be contiguous in time.

Errored block An errored block is a block in which one or more bits are in error.

Errored second An errored second (for in-service measurements) is a one-second interval with one or more errored blocks or at least one anomaly.

Severely errored second A severely errored second (for in-service measurements) is a one-second interval which contains a configurable amount of errored blocks (default: 30 %) or at least one defect.

Background block error An errored block not occurring as part of a severely errored second is a background block error.

Unavailable seconds Unavailable seconds determine the period of time during which a path is in the unavailable state. A period of unavailable time begins at the onset of ten consecutive severely errored second events. These ten seconds are considered to be part of unavailable time. A new period of available time begins at the onset of ten consecutive non severely errored second events. These ten seconds are considered to be part of available time.

Basic Measurement Parameters

The following basic parameters are used for performance monitoring:

- Near-end parameters, related to the receive direction:
  - Near-End Errored Seconds (NES)
  - Near-End Severely Errored Seconds (NSES)

- Near-End Unavailable Seconds (NUAS)
- Near-End Background Block Errors (NBBE)

- Far-end parameters, related to the transmit direction:
  - Far-End Errored Seconds (FES)
  - Far-End Severely Errored Seconds (FSES)
  - Far-End Unavailable Seconds (FUAS)
  - Far-End Background Block Errors (FBBE)

Enabling performance measurement points

Performance measurement points can be enabled via the Element Manager WaveStar® SNMS and via the WaveStar® CIT. Please refer to the ***WaveStar® TDM 10G (STM-64) User Operations Guide***.

The following table gives an overview on the performance monitoring counter types that can be configured for certain termination points:

Table 5-1 Measurement Parameters for the WaveStar® TDM 10G (STM-64)

Counter type	MS	RS	HO-VC Path
NES	✓	✓	✓
NSES	✓	✓	✓
NUAS	✓	✓	✓
NBBE	✓	✓	✓
FES	✓		✓
FSES	✓		✓
FUAS	✓		✓
FBBE	✓		✓

Performance Monitoring on the Gigabit Ethernet Card

Ethernet Performance Monitoring in SDH network elements is kept as closely related to SDH performance monitoring as possible. This means that the concepts of binning and thresholding are completely reused. This also implies a deviation from SNMP MIB counter like behaviour where counters are continuously updated and not stored into bins. One of the differences with SDH performance monitoring is the fact that higher values for counters not always imply worse behaviour.

There are two levels of Ethernet Performance Monitoring possible:

- Monitoring per port
- Monitoring per port per traffic class. This option monitors all packets of all customers that belong to a specific traffic class

The following gives an overview of the Ethernet Performance Parameters. These parameters are presented in 15 minute and 24 hour reports and thresholding is applicableEthernet parameters, related to the transmit direction:

- Outgoing number of Mbytes (EONB)
- Dropped frames - errors (EDFE)
- Incoming number of Mbytes (EINB)

Data Storage

All data is stored in the current bin. The managed NE has a current data register (current bin) for 15 minutes and 24 hours. Once a termination point for measurements has been configured, you are able to get a snapshot view of the data gathered at any time (default).

Historic Bins

The network element keeps a store of the historic 15 minute and 24 hour bins.

Table 5-2 Number of Historic Bins

Interval	Number of historic bins	Total storage time
15 minute	32	8 hours
24 hours	1	1 day

Data Retrieval

Performance Data can be polled via the WaveStar® SNMS and via the WaveStar® CIT.

Reports

Via the WaveStar® SNMS the user is able to create reports from history data stored in the database of the network management system.

Zero Suppression

Performance data sets with counter value zero, i.e. no errors occured, will not be stored in the perfomance data log.

Thresholds

Via the WaveStar® CIT or WaveStar® SNMS, threshold values for the performance parameters can be defined. Furthermore, profiles for the Threshold Crossing Alert (TCA) values for a set of parameters can be set up.

TCA alarming (on 15 min bins)

Normally the NE reports each TCA as a single event (a transient condition event). By default the NE continues to behave this way. The user however, has the option to change the reporting of TCAs. The user can provision the NE to make it treat and report a TCA as a standing condition meaning; a standing condition event followed by a clear event.

Performance Alarms

If the counter value of a performance parameter exceeds the threshold, an alarm can be generated and displayed on the WaveStar® SNMS and CIT.

Fault Localization

Performance alarms only give a hint that the signal quality at a certain measurement point is degraded. They can be used as a help for fault localization. The severity of such an alarm is strongly dependent on the application of your network. Often it can be helpful to define a very low threshold value in order to realize a signal degradation at a very early stage.

Clearing

The clearing of the alarms is done automatically at the end of the first complete interval during which no threshold crossing occurred.

☐

Reports

Overview

This topic contains information about the

- Active alarms and status report
- Performance monitoring report
- History report
- Report on circuit pack, slot, port and switch states
- Version/equipment list
- Synchronization report

Active Alarms and Status Reports

The WaveStar® TDM 10G provides an on-demand report that shows all the active alarm and status conditions. The WaveStar® TDM 10G automatically displays the local alarm and status report on the local or remote WaveStar® CIT. The report can be configured by WaveStar® CIT to show the following alarm levels and alarm conditions: either

- Critical (CR)
- Major (MJ)
- Minor (MN)
- Not Alarmed (status) (NA)

or

- Prompt
- Deferred
- Info

The source address and description of each alarm condition (for example, controller failure and incoming signal failure) are included in the report along with the date and time detected. The report also indicates whether or not the alarm is service-affecting. Multiple options are available to sort alarm data (for example, in order of severity).

Performance Monitoring Report

The WaveStar® TDM 10G provides reports that contain the values of all performance monitoring registers requested at the time the report. The start time of each register's recording period is also included. The reports provide all performance monitoring data that was recorded in a series of 15-minute and 24-hour storage registers.

Performance Parameters Report

The WaveStar® TDM 10G provides another report that contains a summary of all performance parameters that have crossed their provisioned 15-minute or 24-hour thresholds within the history of the 15-minute and 24-hour registers.

(A series of 32 previous and one current 15-minute register is provided for each parameter, allowing for up to 8 hours and 15 minutes (495 minutes) of history in 15-minute registers. Also, one current and one previous 24-hour register is provided, allowing for up to 2 days (48 hours) of history in 24-hour registers.)

History Report

A history report displays the past 500 events. An event is any change in the WaveStar® TDM 10G that may affect its performance (for example, a failure) or change its operation status (for example, loopback setup). This summary contains time stamps showing when each condition was detected and when it has cleared. The WaveStar® CIT events contain a time stamp showing when the command was entered.

Time Stamp

The day bin time stamp at the top of the reports reflects the last time the 24-hour performance monitoring counts were initialized, even if the resulting “day” is longer or shorter than 24 hours. The report shows corrupted data as a question mark (?) for all non-24-hour day bin collection intervals, including those exceeding 24 hours.

Report on Pack, Slot, Port and Switch States

This on-demand report displays

- Circuit pack, transmission port, and timing port state information
- Protection group switch states.

Version/Equipment List

The version/equipment list report is an on-demand report that lists all

- Provisioned or pre-provisioned circuit packs
- Circuit packs that are present.

Synchronization Report

The synchronization report is an on-demand report that lists the system synchronization status.

□

Maintenance Condition

Definition

The system state of Maintenance Condition is a special state that the system is placed into for securing the integrity of the system's cross-connect maps and database in times of non-volatile memory (NVM) corruption, or when maintenance activities need to be performed on the NVM for purposes of installing a new software generic on the system, or restoring the database from a previously backed up version. Any changes to NE originated data during the Maintenance Condition is made in the controller RAM of the processor that owns the data and is not made in the corresponding associated object or NVM.

□

Orderwire and User Channel

Overview This section provides information about orderwire and user channel.

Description Orderwire (OW) provides voice communications for maintenance personnel to perform facility maintenance. The WaveStar® TDM 10G provides two pairs of 64 kbit/s (X19 for E1 and E2) G.703 orderwire (OW) interfaces and one pair of 64 kbit/s V.11 interfaces for the User Channel (X20 for F1) per shelf. These interfaces are connected to the aggregates. E1 and F1 are part of the Regenerator Section overhead and E2 is part of the Multiplex Section Overhead.

Each pair includes

- Regenerator Section (local) Orderwire
- Multiplex Section (express) Orderwire.

Access The ADJCTL/DCCEI (LEY301) circuit pack interfaces the orderwire and user channel connectors on the rear of the shelf (on the User Byte I/O Panel).

Equipment Interconnection Standard external orderwire equipment (e.g.WaveStar® EOW) can be connected to the orderwire interfaces on the User Byte I/O Panel.

□

Provisioning

Overview

Purpose

This section contains information about the following features:

- Local or remote provisioning
- Preprovisioning circuit packs
- Circuit pack replacement provisioning
- Original value provisioning

Definition

Provisioning refers to assigning values to parameters used for specific functions by network elements. The values of the provisioned parameters determine many operating characteristics of a network element.

Local or Remote Provisioning

The WaveStar® TDM 10G software allows local and remote provisioning of all user-provisionable parameters. The provisionable parameters and values (current and original) are maintained in the nonvolatile memory of the controller circuit pack.

Preprovisioning Circuit Packs

To simplify circuit pack installation, parameters can be provisioned before inserting the corresponding circuit pack. The appropriate parameters are automatically downloaded when the corresponding circuit pack is installed. All system parameters and values (current and original) are retrievable on demand regardless of the means used for provisioning.

Circuit Pack Replacement Provisioning

Replacement of a failed circuit pack is simplified by the WaveStar® TDM 10G automatic provisioning of the original circuit pack values. The controller circuit packs maintain a provisioning map of the current provisioning values. When a transmission and/or a timing circuit pack is replaced, the controller automatically downloads the previous provisioning parameters to the new circuit pack.

Original Value Provisioning

Installation provisioning is minimized with factory-preset values. Each provisionable parameter is assigned an original value at the factory. The provisionable parameters are automatically set to their original values during installation.

There are two complete sets of data (parameters and their values) located in the nonvolatile memory of the controller circuit pack under normal conditions:

- The first set contains the system parameters and their original values (values assigned to a parameter at the factory).
- The second set contains the system parameters and their current values (values currently being used by the system).

Please note that the original values assigned at the factory cannot be changed. However, the current values can be overridden through local or remote provisioning.

Provisionable SS Bits

This feature allows users to provision the value of the bits 5 and 6, the SS bits, that are transmitted in the first H1 pointer byte of an VC-c signal. Present SONET (Telcordia) and SDH (ITU-T) standards require that these bits be ignored by the receiving equipment, however, some older embedded SONET and SDH equipment may not ignore these bits.

Provisioning the SS bits to "00" (overwrite enabled) can allow interworking with older embedded SONET equipment. Provisioning the SS bits to "10" (overwrite disabled) can allow interworking with older embedded SDH equipment.

The SS bits are provisionable on a per shelf basis.

NOTE: When a WaveStar® TDM 10G (STM-64) system is upgraded from a previous software release to the next software release, the value of some key parameters will be retained. With R4, the SS bits are set to transmit "00", to ensure interworking with older embedded base SONET equipment.

References

For more information about provisioning parameters and original values using the WaveStar® CIT, refer to the WaveStar® TDM 10G User Operations Guide.

Contents

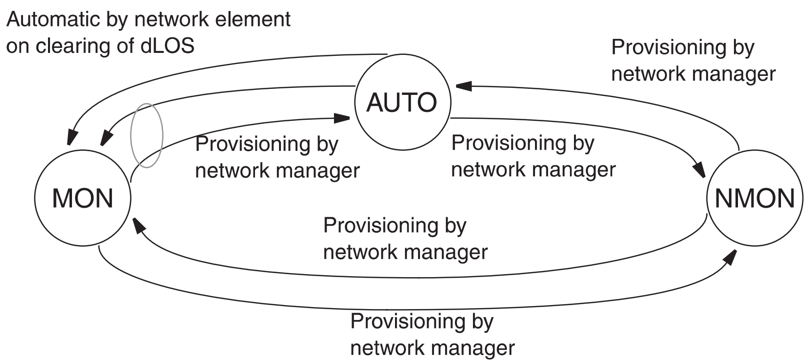
Port Monitoring Modes

Overview This section describes the different port monitoring modes in the WaveStar® TDM 10G.

Definition Port monitoring modes represent the monitoring state for each port in the system at any given time. Each port monitoring mode has its own characteristics for signal failure alarms and PM (performance monitoring) data collection. Transitions between modes occur due to events such as applying a good signal and WaveStar® CIT commands. The detection of a fault does not affect the state of the port monitoring mode.

Port Modes The port modes in the WaveStar® TDM 10G are

- Automatic (AUTO): AUTO refers to a port that is available for automatic provisioning. A port changes from the AUTO mode to the MON mode if a good signal is detected. The original port monitoring mode value is AUTO. When the port monitoring mode is AUTO, the port is not alarmed.
- Monitored (MON): MON refers to a port that is fully monitored and alarmed.
- Not monitored (NMON): NMON refers to a port that is not monitored and does not change to the MON state even if a good signal is detected. Any port modes can be user-provisioned independently to the NMON state at any time, regardless of the auto-provisioned mode of the terminating interface slot. This port mode is used to suppress alarms.



□

Trail Termination Point Modes

Overview

This section describes the trail termination point modes in the WaveStar® TDM 10G.

Definition

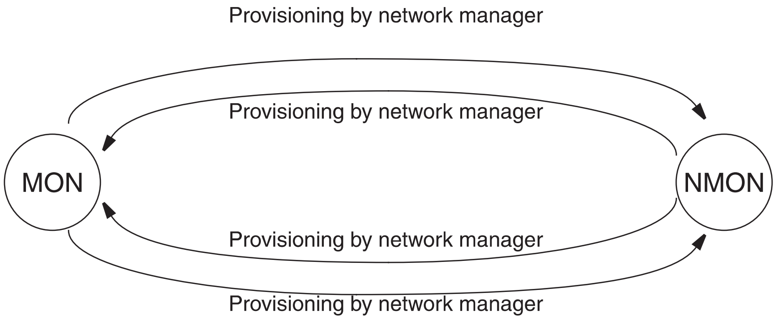
To prevent alarms from being raised and failures being reported during trail provisioning actions, trail termination functions have the ability to enable and disable fault cause declarations.

Modes

The trail termination point modes in the WaveStar® TDM 10G are

- Monitored (MON): MON refers to a trail termination point that is fully monitored and alarmed.
- Not monitored (NMON): NMON refers to a trail termination point that is not monitored. This trail termination point mode is used to suppress alarms.

Transition between the two modes is possible as follows:



□

6 System Planning and Engineering

Overview

Purpose

This chapter provides general System Planning and Engineering information for the WaveStar® TDM 10G.

Contents

General Planning Information

Overview

This section provides general planning information for WaveStar® TDM 10G.

Planning Considerations

When planning your network, you should consider the

- Power planning
- Cooling Equipment
- Transmission capacity
- Port location rules
- Synchronization
- Floor plan layout
- Equipment interconnection.

Engineering and Installation Services Group

Lucent Technologies maintains an Engineering and Installation Services group to assist you in planning and engineering a new system. The Engineering and Installation Services group is a highly skilled force of support personnel dedicated to providing customers with quality engineering and installation services. These specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services.

For more information about the Engineering and Installation Services group, refer to Chapter 8, “Product Support”.

□

Power Planning

Overview

This section provides general power planning information for the WaveStar® TDM 10G.

Power Feeders

Each WaveStar® TDM 10G shelf uses four -48.0V/-60V power feeders, two for the low-speed part and two for the high-speed part (A and B each). Redundant power feeders are used to ensure maximum system reliability.

They are filtered and protected by circuit breakers at the input to the shelf. These should be sized to carry the maximum shelf power consumption (cf. Chapter 10). The two -48V/-60V supplies are then filtered by the Power Filter Units (PFU) to meet the ETSI requirements. After that, the supplies are distributed separately to each circuit pack, where they are filtered again and fused before being converted to the circuit pack working voltages.

References

For more information about power, refer to Chapter 4, “Product Description” and Chapter 10, “Technical Specifications”.

□

Cooling Equipment

Overview

This section provides general cooling equipment information for the WaveStar® TDM 10G.

Fan Units

Cooling is done by fans. Fans draw air in through a filter beneath the fan unit and force it through the shelf from bottom to top. In the Main Shelf one fan unit is located above the upper row of boards and another below the lower one. These two fan units work according to the push-pull principle, i.e., the lower fan unit pushes the air into the shelf, the upper one pulls it out.

The Extension Shelf has one fan unit below the boards.

Heat Baffles

Furthermore, heat baffles have to be mounted beneath each shelf to prevent the fan unit from drawing in the exhaust air from the shelf beneath it.

If you mount the shelf at the top of a bay, install a heat baffle directly below it. If you mount the shelf at the center or bottom of a bay, install a heat baffle directly above ***and*** below it. Allow no gaps between the baffle mounted below the WaveStar® TDM 10G shelf and any equipment mounted directly below the baffle. Observing this rule eliminates the possibility of hot air exhausted from the equipment below the baffle entering the baffle.

It is also recommended to mount a heat baffle beneath the rack connection panel. At least there has to be left 75 mm of space between the rack connection panel and the shelf mounted below if no heat baffle is used there.

References

For more information about cooling, refer to Chapter 4, “Product Description”.

□

Transmission Capacity

Overview

This section provides general information about transmission capacity for the WaveStar® TDM 10G.

Capacity

The WaveStar® TDM 10G shelf provides 64xSTM-1 capacity. This allows you to equip the shelf with any mixture of STM-1 (optical and electrical), STM-4, and STM-16 tributary port units.

An extension shelf can support an additional capacity for inter-shelf connections of up to 64xSTM-1 capacity. An Extension Shelf is required e.g. if more than 8 STM-1(o) port units are to be 1+1 MSP protected. Cross-connections between inputs and outputs in different shelves are limited by the inter-shelf connection capacity.

Growth Considerations

The system can be used as an Add/Drop multiplexer or as a Terminal multiplexer, each using only one subrack. If additional tributary interfaces are required, the system can be expanded by an extension shelf.

If you anticipate using extension shelves in the future, you should equip the WaveStar® TDM 10G Main Shelf so that the total of all traffic that is to be routed to and from the Main Shelf does not exceed 64 (with SWITCH/STS576 and PPROC/STS192) or 128 (with SWITCH/STS768 and PPROC/STS384) STM-1 equivalents. Refer to Table 6-1, "STM-1 Equivalents per Port Unit" (6-5).

Port Unit Capacities

The following table lists the transmission capacity required for each port unit.

Table 6-1 STM-1 Equivalents per Port Unit

Port Unit	STM-1 Equivalents
STM1E/4	4
OC3/STM1 SH	8
OC3/STM1 LH	4
OC12/STM4	8
OC48/STM16	16
GE1/SX2	16
GE1/LX2	16

References

For more information about transmission capacity, refer to Chapter 4, "Product Description".

□

Port Location Rules

Overview

This section provides recommendations about using port units and port unit circuit pack slots efficiently.

OC48/STM16 Port Units

If OC48/STM16 port units are used be aware that each of them requires two port unit slots and that MS-SPRing works ’only’ between neighbouring STM16 units.

STM1E/4 Port Units

STM1E/4 port units should be filled from the right side of the shelf (beginning with slot “(1-1) 16”) to the left. When you use 1:N electrical tributary port protection, the slot “(1-1)eprn” must contain an STM1E/4 port unit and the slot “(1-1)eprotnsw” must contain an EPS-64 circuit pack.

If the slot (1–1)16 is configured for an optical port unit (STM-1(o), STM-4, STM-16), no 1:N equipment protection of the STM-1(e) port units is possible.

If 1:N equipment protection of the STM-1(e) port units is configured, it is not possible to use slot (1–1)16 for optical port units.

Optical Port Unit Protection

In the case of optical port protection it is recommended to place the working port unit and the protection port unit side by side for ease of maintenance.

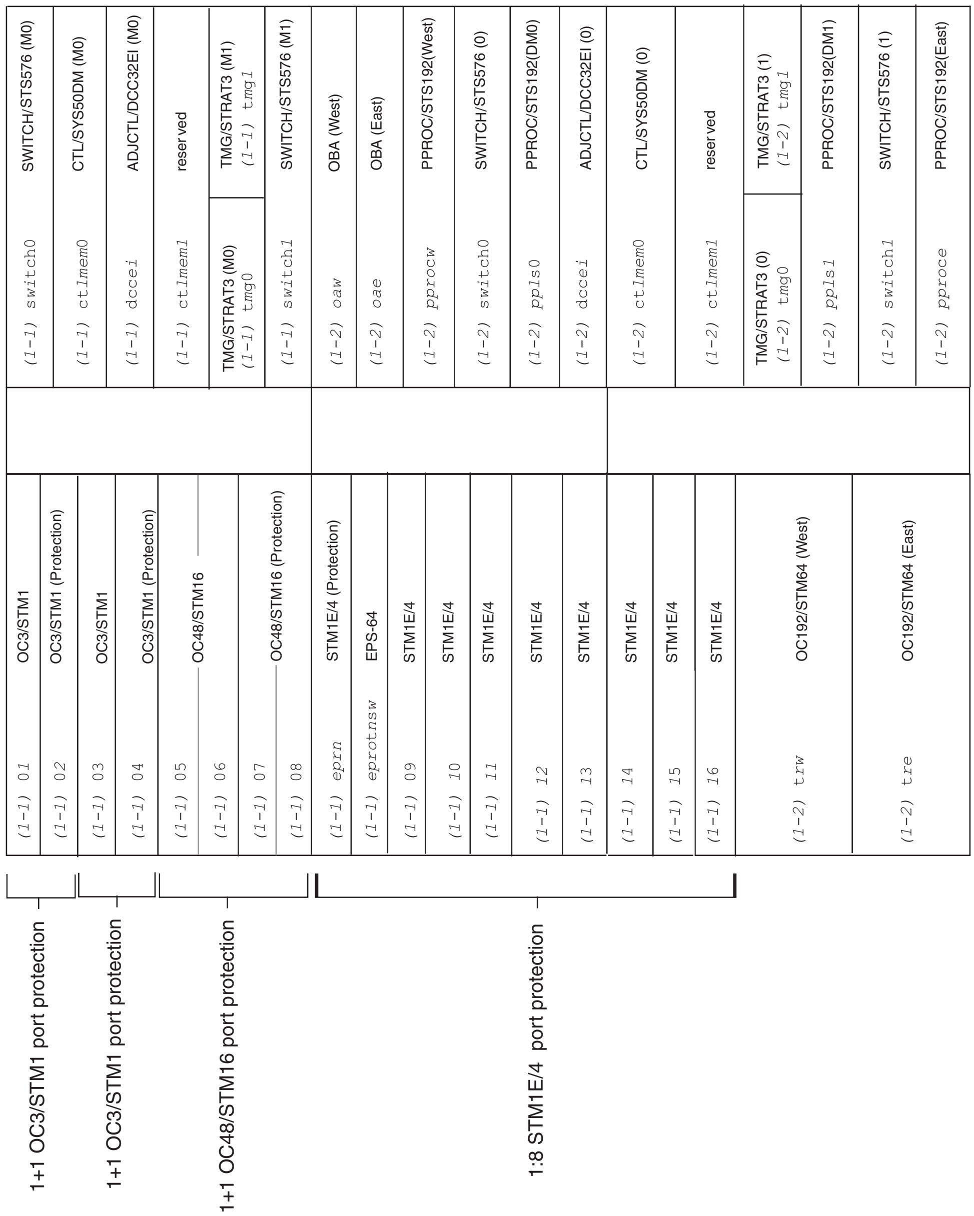
References

For more information about port location rules and shelf configuration, refer to Chapter 4, “Product Description”.

Protection Group Example

The following figure illustrates the recommended grouping of protected ports.

Figure 6-1 Port Protection Groups



Synchronization

Overview

This section describes the synchronization behaviour available in WaveStar® TDM 10G.

Shelf Synchronization

WaveStar® TDM 10G is primarily timed from duplex TMG/STRAT3 circuit packs. Each of these circuit packs is normally synchronized to an external reference signal (2.048 MHz or 2.048 Mbit/s) which must be based on a Stratum 3 clock or better. Then both TMG/STRAT3 packs distribute timing to all circuit packs in the shelf.

References

For more information about synchronization, refer to Chapter 4, “Product Description”.

□

Floor Plan Layout

Overview

This section gives information about the space needed to mount WaveStar® TDM 10G shelves and racks.

Rack Dimensions

The racks require an area of 600 mm x 600 mm (width x depth). This area represents the absolute system limits which must not be exceeded in the operating state by protruding elements such as switches or plugs. The standard height is 2.0 m for a Seismic rack and 2.2 m or 2.6 m for an ETSI rack.

Required Rack Heights

Depending on the desired configuration, the appropriate rack height must be chosen. The following table gives information about this (this only affects the mechanical view).

Table 6-2 Required Rack Height

Number of Main Shelves	Number of Extension Shelves	Number of Rack Connection Panels	Required Rack Height
1	1	1	2.2 m
2	-	1	2.6 m

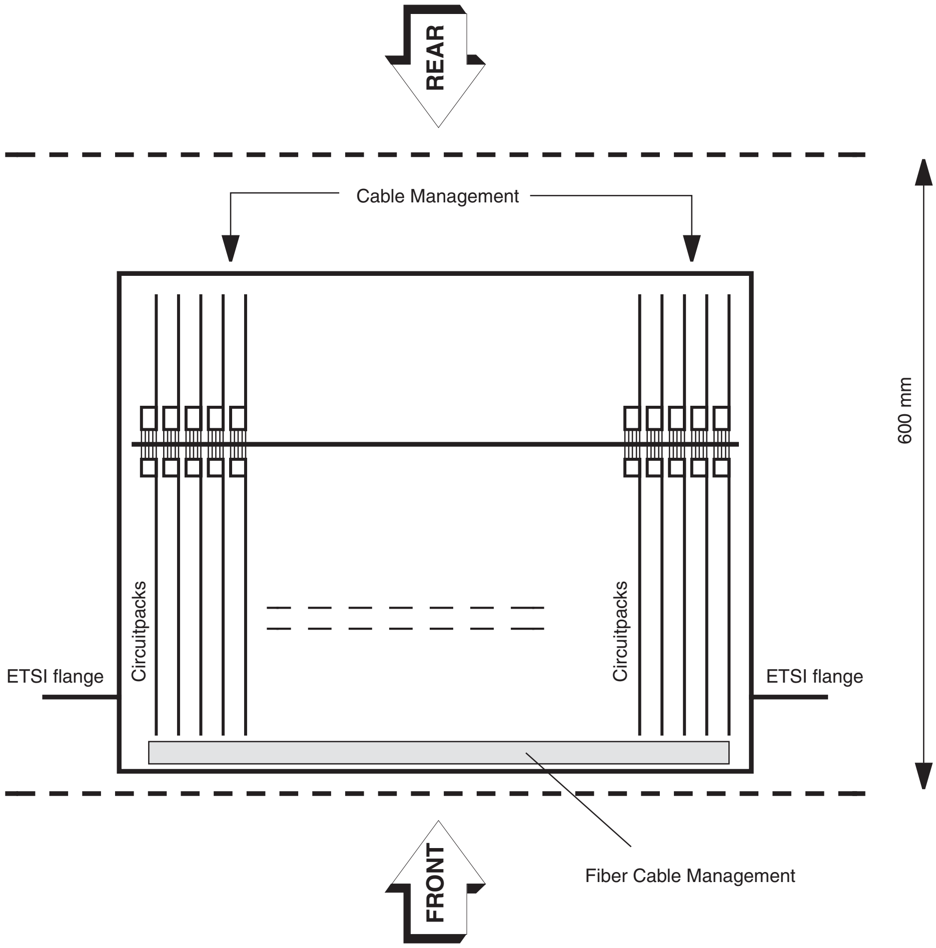
Shelf Dimensions

The shelf area of the ***Main Shelf*** is 1000 mm x 500 mm x 438 mm (height x width x depth). The shelf area of the ***Extension Shelf*** is 600 mm x 500 mm x 438 mm (height x width x depth). Additionally, the height of the heat baffles mounted beneath the shelves (75 mm) has to be taken into account.

Front and Rear Access

The following figure illustrates the space required for front and rear access to the system. Front access is required for operations activities and rearrangements of the tributary port units. Rear access is required for shelf additions and for upgrades that require cable rearrangements.

Figure 6-2 Front and Rear Access



□

Equipment Interconnection

Overview

This section describes equipment interconnection in WaveStar® TDM 10G.

Interbay Cabling

The connection between the shelves is done via the so-called growth interfaces which include data (TXI), timing and control signals.

Optical Connectors

The port units provide optical connections through faceplate-mounted connectors.

LBOs

If required, WaveStar® TDM 10G provides optical attenuation using LBOs (Lightguide Build-Outs) on the optical port units.

LC-type optical attenuators are required for these port units:

- OC3/STM1/1.3SR8 (LEY23)
- OC192/STM64/WDM9580–9190 (LEY201–240)
- OC48/STM16/WDM9585–9190 (LEY101–180).

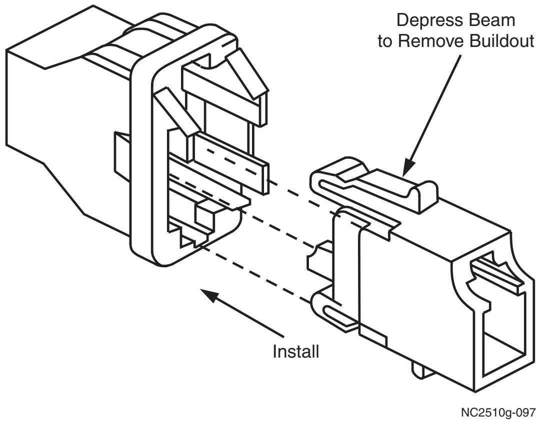
All other port units are capable of operating with the following three connector types:

- ST-type
- FC-type
- SC-type.

Important! The LEY23, LEY101-180, and LEY 201-240 port units are factory equipped with 0-dB LC-type connectors. Only with special patchcords a conversion can be made to different connector types. All optical other interfaces are factory equipped with 0-dB SC-type connectors. The optical attenuation and connector type for other port units can be changed by replacing the LBO.

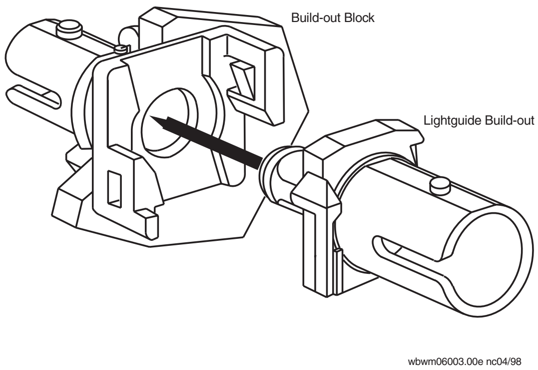
LC-Type LBO

The figure below illustrates the universal build-out block with one of the two kinds of LC-type LBOs.



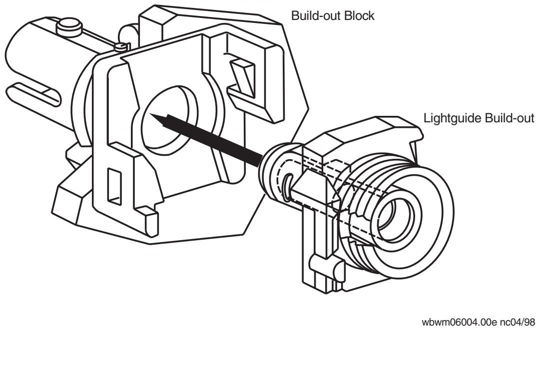
ST-Type LBO

The figure below illustrates the universal build-out block with an ST-type LBO.



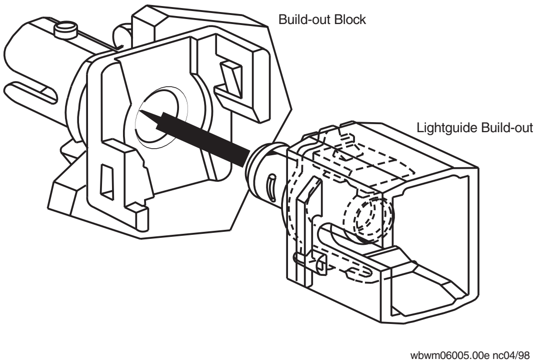
FC-Type LBO

The figure below illustrates the universal build-out block with an FC-type LBO.



SC-Type LBO

The figure below illustrates the universal build-out block with an SC-type LBO.



Electrical Connectors

Cable connections to the STM1EE4/4 I/O interface panels use Sub-D-connectors (3p, 9p, 15p and 25p).

□

7 Ordering

Overview

Purpose

This chapter provides information about circuit pack sparing information for WaveStar® TDM 10G and guidelines and a procedure to determine the number of spares needed at each location. Also, general guidelines for ordering for the WaveStar® TDM 10G are provided.

Contents

Ordering Information

Overview The WaveStar® TDM 10G has been carefully engineered and all equipment kitted to simplify the ordering process. STM-64 is CE marked and UL certified. The ordering can be done via the ordering guide. This guide provides all the information nessesary to order a complete WaveStar® TDM 10G including all desired circuit packs.

Contact Please contact your Account Executive for all questions concerning ordering of the WaveStar® TDM 10G.

□

Sparing Information

Overview

This section provides circuit pack sparing information for WaveStar® TDM 10G.

Please note that the number of spares for each code must be determined and maintained separately, based on the in-service population of the code at each location.

Lead time

Lead time, also known as turnaround time, is defined as the elapsed time between a known circuit pack/port unit failure at a given service location and the arrival of a new (or repaired) circuit pack/port unit at the location where spare circuit packs are stocked to maintain a spare circuit pack level consistent with the circuit pack population in service.

Lead time should not be confused with mean time to repair (≤ 2 hours), which is the elapsed time between a known in-service circuit pack failure and when a spare circuit pack replacement is put into service.

☐

Sparing Graph

Overview

This section provides guidelines and a procedure to determine the number of spares needed at each location. The number of spares for each circuit pack or port unit code must be determined and maintained separately, based on that code's in-service population at each given location.

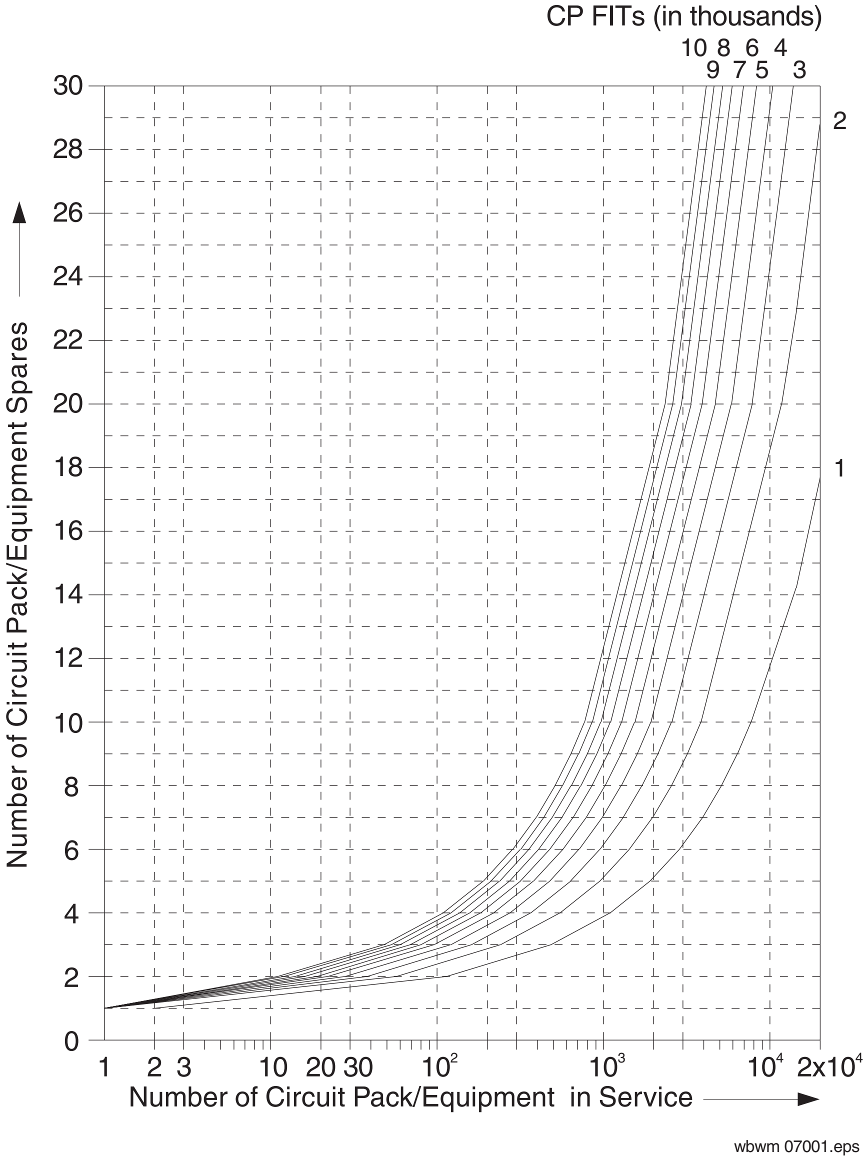
Before you begin

In case you would like to obtain more details on sparing, e.g. for different lead times, please contact your Account Executive.

Sparing Graph

Use the following figure to determine the number of spares necessary for all the circuit packs, port units and pieces of common equipment used in WaveStar® TDM 10G.

Figure 7-1 Sparing Graph for a 10-Day Lead Time



Using the Sparing Graph

Use the following procedure to determine how many spare circuit packs, port units, or other pieces of equipment are required for each code at each location to maintain 99.9% service continuity, given a 10-day lead time.

1 Locate the failure rate for the unit under consideration using Table 9-1, “Circuit Pack Failure Rates” (9-6), or Table 9-2, “Equipment Failure Rates” (9-7) in Chapter 9, “Quality and Reliability”.

2 Refer to the Figure 7-1, “Sparing Graph for a 10-Day Lead Time” (7-5) and select the curve that represents the nearest failure rate.

3 Follow the curve until it intersects the vertical line that represents the number of units in service at the given location.

4 Refer to the horizontal line immediately above the intersection. The number associated with this line is the minimum number of spares recommended for that location.

5 Repeat Step 1 to Step 4 for each circuit pack, port unit, and type of equipment listed in Table 9-1, “Circuit Pack Failure Rates” (9-6) and Table 9-2, “Equipment Failure Rates” (9-7) in Chapter 9, “Quality and Reliability”.

END OF STEPS

Example of using the graph

If there are 100 TMG/STRAT3 units (failure rate of 3800) in service at a given location and your lead time is 10 days, then you should order and stock 3 spare TMG/STRAT3 units for that location.

□

8 Product Support

Overview

Purpose This chapter provides information about the support for the WaveStar® TDM 10G.

Contents

Engineering and Installation Services

Overview

This section describes the engineering and installation services available to support WaveStar® TDM 10G.

Engineering and Installation Services Group

The Engineering and Installation Services group has a highly skilled force of support personnel dedicated to providing customers with quality engineering and installation services. These specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services.

Services provided

The services include

- Analyzing your equipment requests
- Preparing detailed specifications for manufacturing and installation
- Creating and maintaining job records
- Installing equipment
- Testing and turning over working systems

Tailored services

When you purchase Lucent engineering and installation services, your system order is integrated into a complete working system tailored to your office conditions and preferences.

Providing for all your needs

The Engineering and Installation Services group provides for all your needs, including provisions for

- Cabling
- Lighting
- Power equipment
- Connections to local and/or remote alarms.

Reference

For more information about specialized engineering and installation services, engineering consultations, and/or database preparation, please contact your local Account Executive.

□

Technical Support

Overview

This section describes the technical support available for WaveStar® TDM 10G.

Technical Support Services

Lucent Technologies provides the following Technical Support Services:

- Remote Technical Support (RTS) – remote technical support to troubleshoot and resolve system problems.
- On-site Technical Support (OTS) – on-site assistance with operational issues and remedial maintenance.
- Repair and Replacement (R&R) – technical support services for device repair/return or parts replacement.
- Lucent Online Customer Support – online access to information and services that can help resolve technical support requests.

NOTE: Technical Support Services are available 24 hours a day, 7 days a week.

When additional technical assistance is needed, use the appropriate contact information in the table below.

Customer location	Initial Lucent Technologies contact location
Inside the United States and Canada	Technical Support Services can be reached at **1-866-LUCENT8** (866-582-3688): ***Prompt#1***.
Outside the United States	Technical Support Services can be reached at **+1-630-224-4672**: ***Prompt#2***.
Web-Site	For additional information regarding Worldwide Services, refer to the Lucent Technologies' web-site at **http://www.lucent.com/products** – Click on **Browse Catalog** – Click on **Worldwide Services Products** – Select the desired service

Training

Overview

The Information Products & Training (IP&T) organization offers a formal training package to complement your product needs.

On-site training

On-site training is available for all WaveStar® TDM 10G training courses.

Registering for a course or arranging an on-site training session

You can enroll in a training class at one of the Lucent corporate training centers or arrange an on-site training session at your facility via the following URL:

https://www.lucent-product-training.com/SabaWeb

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Training Courses

Overview

This section describes the WaveStar® TDM 10G (STM-64) training courses.

SDH Optical Networking Products Overview

This introductory course (TR9204) provides an operational overview of Lucent Technologies SDH optical networking products. The course explains a variety of applications of these products and develops networking scenarios using these products. This course can be customized to the needs of individual customers.

Audience

This course is designed for telecommunications professionals, engineers, project managers, account executives, and other sales personnel who need to understand the basic functionality of Lucent Technologies Synchronous Digital Hierarchy (SDH) optical networking products in a network.

Objectives

This course is designed to enable students to

- Get an overview of Lucent Technologies' Synchronous Digital Hierarchy (SDH) optical networking products
- Understand all applications and features.

Prerequisites

Students should be familiar with basic SDH or SONET principles.

Media

A combination of instructor lectures and written exercises.

Duration

Approx. 3 days.

Applications, Architecture, and Planning: Instructor Based

The WaveStar® TDM 10G Applications, Architecture, and Planning Course (TR5976) provides a detailed introduction to WaveStar® TDM 10G, covering equipment functions and requirements, system capabilities, network topologies, and network planning.

Audience

Network planners and engineers; Lucent sales and marketing personnel, product managers, technical consultants and account representatives.

Course Length

2 days.

Applications, Architecture, and Planning: Computer Based

The WaveStar® TDM 10G Applications, Architecture, and Planning Course is also available as a comprehensive Computer Based Training (CBT) on CD-ROM (TR5976M). The course provides a detailed introduction to WaveStar® TDM 10G, covering equipment functions and requirements, system capabilities, network topologies, and network planning.

Audience

Network planners and engineers; Lucent sales and marketing personnel, product managers, technical consultants and account representatives.

Operations and Maintenance

The WaveStar® TDM 10G Operations and Maintenance Course (TR5977) includes detailed descriptions of initial turnup and day-to-day operations and maintenance tasks, as well as emphasis on developing skills using the WaveStar® TDM 10G User Operations Guide and the WaveStar® TDM 10G Alarm Messages and Trouble Clearing Guide. The course covers the physical equipment and using the new GUI-based CIT to provision equipment, make cross-connects, perform administrative functions, run diagnostic tests, and do manual protection switching.

Audience

Technicians, installers, maintenance engineers, technical support personnel, product evaluators, and anyone desiring operations and maintenance information for WaveStar® TDM 10G.

Course Length

3 days.

Installation and Test

The WaveStar® TDM 10G Installation and Test Course (LW2478) includes step-by step guidance to system installation and setup. It also includes information needed for pre-installation site planning and post-installation acceptance testing. The course is based on the contents of the WaveStar® TDM 10G Installation Manual.

Audience

Installers, maintenance engineers, technical support personnel.

Course Length

2 days.

SubNetwork Management System

The SNMS course (Application TDM 10G (STM-64)) (TR4510) provides instruction on use of the WaveStar® SNMS workstation or X-terminals using a Java™ platform for provisioning, maintenance, and administration of SDH access and transport networks populated with state-of-the-art equipment.

Audience

Operations personnel and their supervisors who will use the WaveStar®SubNetwork Management System (SNMS) to provision and coordinate maintenance of SDH network equipment and circuits. In general, the course will be helpful to people, such as engineering personnel and network operations and maintenance personnel, who will use the WaveStar® SNMS to obtain information about SDH networks they plan or administer.

Course Length

4 days.

9 Quality and Reliability

Overview

Purpose This chapter provides information about the quality and reliability of the WaveStar® TDM 10G.

Contents

Quality

Overview

Purpose This section describes Lucent's Commitment to Quality and Reliability and how quality is ensured.

Contents

Lucent's Commitment to Quality and Reliability

Overview

Lucent Technologies is extremely committed to providing our customers with products of the highest level of quality and reliability in the industry. WaveStar® TDM 10G is a prime example of this commitment.

Quality policy

Lucent Technologies is committed to achieving sustained business excellence by integrating quality principles and methods into all we do at every level of our company to

- Anticipate and meet customer needs and exceed their expectations, every time
- Relentlessly improve how we work – to deliver the world's best and most innovative communications solutions – faster and more cost-effectively than our competitors

Reliability in the product life-cycle

Each stage of the life cycle of WaveStar® TDM 10G relies on people and processes that contribute to the highest product quality and reliability possible. The reliability of a product begins at the earliest planning stage and continues into

- Product architecture
- Design and simulation
- Documentation
- Prototyping testing during development
- Design change control
- Manufacturing and product testing (including 100% screening)
- Product quality assurance
- Product field performance
- Product field return management

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Ensuring Quality

Overview

This section describes the critical elements that ensure product quality and reliability within

- Product development
- Manufacturing

Critical elements of product development

The product development group's strict adherence to the following critical elements ensures the product's reliability

- Design standards
- Design and test practices
- Comprehensive qualification programs
- System-level reliability integration
- Reliability audits and predictions
- Development of quality assurance standards for manufactured products

Critical elements of manufacturing

Note: Independent Quality Representatives are also present at manufacturing locations to ensure shipped product quality.

The manufacturing and field deployment groups' strict adherence to the following critical elements ensures the product's reliability

- Pre-manufacturing
- Qualification
- Accelerated product testing
- Product screening
- Production quality tracking
- Failure mode analysis
- Feedback and corrective actions

□

Reliability Specifications

Overview

Purpose

This section describes how reliability is specified.

Contents

Failure Rates

Overview

This section provides failure rates for WaveStar® TDM 10G. All data is based on Bellcore's Method I, Reliability Prediction Procedure for Electronic Equipment, Issue 6, December 1997.

Circuit pack failure rates

The following table provides steady-state circuit pack failure rates, specified as Failures in Time (FIT), for WaveStar® TDM 10G. Please note that the SWITCH/STS576, SWITCH/STS768 and the TMG/STRAT3 circuit packs are by default 1+1 equipment protected which increases the reliability significantly. The same applies to other protection schemes.

Table 9-1 Circuit Pack Failure Rates

Circuit Pack	Failure Rate (FIT)
OC192/STM64/1.5IR1	8500
OC192/STM64/1.5IRS1	8500
OC192/STM64/WDM9580-9190	8500
OC192/STM64/POU9590-9210	8500
OC48/STM16/1.3LR1	9450
OC48/STM16/1.3SR1	9900
OC48/STM16/1.5LR1	9450
OC48/STM16/DWDM01-16	9450
OC48/STM16/WDM9585-9190	7500
OC48/STM16/POU9590–9210 (LEY80AE-95AE)	7500
OC12/STM4/1.3LR2	3900
OC12/STM4/1.3SR2	3900
OC12/STM4/1.5LR2	3900
OC3/STM1/1.3LR4	4900
OC3/STM1/1.3SR4	4900
OC3/STM1/1.3SR8	10500
OBA10G/1.5LR1	6500
OBPA10G/1.5VR1	6500
STM1E/4	6700
EPS-64	8200
GE1/SX2	5600

Table 9-1 Circuit Pack Failure Rates (continued)

Circuit Pack	Failure Rate (FIT)
GE1/LX2	5600
SWITCH/STS576	4200
SWITCH/STS768	3500
PPROC/STS192	4800
PPROC/STS384	3300
CTL/SYS50DM	5100
ADJCTL/DCCEI	7100
TMG/STRAT3	3800

Additional failure rates

The following table provides steady-state failure rates for WaveStar® TDM 10G equipment.

Table 9-2 Equipment Failure Rates

Equipment	Failure Rate (FIT)
Power Filter	40
User Panel	110
Fan Unit	1500
TMG I/O Panel	37.9(subject to change)
TMG-EX I/O Panel	32.2
CTL I/O Panel	12.5
CTL-EX I/O Panel	10.9
LAN I/O Panel	47.6 (in Main Shelf) 19.0 (in Extension Shelf)
Alarm I/O Panel	51.2 (subject to change)
STM1EE4/4 I/O Panel	4.4

□

Unavailability Specifications

Overview

This section provides the port unit and system unavailability specifications for WaveStar® TDM 10G. All data is based on the circuit pack failure rates that are calculated according to Bellcore's Method I, Reliability Prediction Procedure for Electronic Equipment, Issue 6, December 1997.

Port unit unavailability

The following table provides hardware unavailability estimates for the optical and electrical port units in WaveStar® TDM 10G.

Table 9-3 Port Unit Unavailability (Hardware only)

Port Unit	Unavailability
OC3/STM1/1.3SR4	0.00013 min/year
OC48/STM16/1.3LR1	0.00020 min/year
OC48/STM16/1.5LR1	0.00020 min/year
OC48/STM16/DWDM01 through OC48/STM16/DWDM16	0.00020 min/year
OC192/STM64/1.5SR1	0.000502 min/year

System unavailability

For appropriate estimates for your individual application please contact your Account Executive.

Operations System Unavailability

The unavailability of the interface to an operation system does not exceed a long term average of 28 minutes per year. For the purpose of reliability prediction and analysis, 50% of this requirement (14 minutes per year) is allocated to downtime resulting from equipment hardware failure. The remaining 50% (14 minutes per year) is allocated to downtime from all other causes, such as software or procedural errors.

Silent failure unavailability

The WaveStar® TDM 10G system is designed to minimize system unavailability due to silent failures. Equipment failures in the system that may result in a loss of service of protection trigger office alarms or generate autonomous messages.

□

General Specifications

Overview

This section provides general reliability specifications for WaveStar® TDM 10G.

Mean time between maintenance activities

The Mean Time Between Maintenance Activities for the WaveStar® TDM 10G shelf is 12 months.

Mean time to repair

The mean time to repair for WaveStar® TDM 10G is assumed to be 4 hours. This figure includes dispatch, diagnostic, and repair time.

Infant mortality factor

Note: The steady state failure rate is equal to the failure rate of the system.

The number of failures that a product experiences during the first year of service after turn-up may be greater than the number of subsequent annual steady state failures. This is the early life or infant mortality period. The ratio of the first year failure rate to the steady state failure rate is termed the infant mortality factor (IMF).

The infant mortality factor (IMF) for WaveStar® TDM 10G is ≤ 2.5. Therefore, the first year failure rate (or infant mortality rate [IMR]) is 2.5 times the steady state failure rate.

Product design life

The product design life for WaveStar® TDM 10G is 15 years except for the fan units. The fan unit design life is 12 years.

Maintainability specifications

Note: The fan filter, located below the fan unit in the shelf, must be replaced once every 6 months to ensure the proper operation of the fan units.

WaveStar® TDM 10G does not require periodic electronic equipment maintenance activities. Continuous performance monitoring enables the system to detect conditions before they become service-affecting.

□

10 Technical Specifications

Overview

Purpose

This chapter provides the technical specifications for WaveStar® TDM 10G. This data is necessary for planning the use of a WaveStar® TDM 10G network element in an existing or new network.

References

For information about the following reliability specifications, refer to Chapter 9, “Quality and Reliability”:

- Port unit unavailability
- System unavailability
- Circuit pack FIT rates
- Mean time between maintenance activities.

For detailed specifications of the optical and electrical port units, refer to Appendix B, “Port Unit Data Sheets”.

Contents

Interfaces

Standards Compliance

WaveStar® TDM 10G (STM-64) is compliant with the ITU-T Recommendations:

Equipment	G.781, G.782, G.783, G.784, G.813
Physical interface	G.957 & G.691 for optics and G.703 for electrical interfaces
Performance requirements	G.823, G.825, G.826
Mapping Structure	STM-n - AUG-4 - VC-4-4c STM-n - AUG-4 - AU-4 - VC-4 STM-n - AUG-3 - AU-3 STM-n - AUG4 - VC4-16c

Optical and Electrical Interfaces

The detailed specifications of the optical and electrical interfaces can be found in Appendix B, "Port Unit Data Sheets" .

Data Interfaces

The following table lists the data interfaces:

Standard External clock interfaces	Input/Output station clock interfaces: 2048 kHz (G.703.10) or 2048 kbit/s (G.703.6), 75 Ω or 120 Ω
Orderwire	X19 (for E1), E2 bytes as 64 kbit/s data channel at G.703. E1 is part of the Regenerator Section overhead and E2 is part of the Multiplex Section overhead.
User Channel	X20 (for F1) byte as 64 kbit/s data channel at V.11. F1 is part of the Regenerator Section overhead.

Bandwidth management

Specifications The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to bandwidth management:

- System capacity (Cross-connections):
  128 STM-1 equivalents between the tributary area of the Main Shelf or within an Extension Shelf.
  64 STM-1 equivalents between the low-speed part of the Main Shelf and the Extension Shelf
- System capacity (Add/Drops):
  64 STM-1 equivalents between the high-speed part of the Main Shelf and each of the low-speed shelves (including one Extension Shelf)
  64 STM-1 equivalents between the low-speed part of the Main Shelf and the Extension Shelf
  128 STM-1 equivalents between the high-speed part of the Main Shelf and the Extension Shelf
- Complete VC-4 (and VC-3) Cross-connecting
- Uni & Bi-directional Cross-connecting
- 1:2 Broadcast connections type VC-4
- VC-4-4c Concatenation and VC-4-16c Concatenation
- Uni-directional Drop & Continue (e.g. for Dual Node Interworking)
- Higher Order Cross-connect size 256 x 256 VC-4
- Bridging and rolling commands for in-service rearrangement of circuits
- Low-speed hairpin cross-connections, i.e. between any tributary ports without using ring capacity
- Support of virtual concatenation (VC-4–kv, k=1...7) for mapping into Ethernet frame

□

Performance requirements

Specifications

The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to performance requirements:

Jitter on STM-N interfaces	G.813, G.825
Jitter on PDH interfaces	G.823, G.783
Error Performance	G.826
Performance monitoring	G.784, G.826

Performance Monitoring

Specifications The following performance monitoring points are supported by the WaveStar® TDM 10G (STM-64):

Trail Termination Points	Equipment
MS-1	Multiplex Section of the STM-1 interfaces
MS-16	Multiplex Section of the 2.5-Gbit/s interfaces
MS-64	Multiplex Section of the 10-Gbit/s interfaces
RS-1	Regenerator Section of the STM-1 interfaces
RS-16	Regenerator Section of the 2.5-Gbit/s interfaces
RS-64	Regenerator Section of the 10-Gbit/s interfaces

Historic Bins The network element keeps a store of the historic 15-minute and 24-hour bins.

Table 10-1 Number of Historic Bins

Interval	Number of historic bins	Total storage time
15 minute	32	8 hours
24 hours	1	1 day

Supervision and alarms

Specifications

The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to supervision and alarms:

- Plug-in circuit pack indication: red fault and green service/active LED per circuit pack
- System Controller indicators/buttons:
  - User Panel LED indicators: Prompt, Deferred and Info alarm, Abnormal, Near-End Activity, Far-End Activity, Power On, Alarm Cut-off (ACO)
  - Push-buttons: ACO button to acknowledge office alarms, LED test button
- CIT connector for connecting the CIT to the system LAN
- Floating station alarm interface outputs
- Miscellaneous discretes
- Q-LAN interface to connect to EMS or other Network Elements.

□

Protection and Redundancy

Overview The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to protection and redundancy.

Tributary Level Redundancy 1:N equipment protection on STM-1(e) (N = max. 16)

1+1 equipment protection on Cross-connect circuit pack and Timing circuit pack.

Dual Node Interworking (DNI) Dual Node Interworking (DNI) can be used between two MS SPRings and supports VC-4, VC-3, VC-4-4c Concatenation and VC-4-16c Concatenation.

MSP 1+1 MSP on optical STM-1 and STM-16 tributary interface signals.

MS-SPRing MS SPRing is used in two fiber ring Add/Drop applications or as selective MS-SPRing.

2F MS-SPRing NUT

2F MS-SPRing NUT is used to exclude timeslots from the MS-SPRing protection The non-preemtable protection access feature (NUT) is implemented on STM-64 and on STM-16 protection groups.

SNCP Sub-Network Connection Protection (SNCP) can be configured on VC-3, VC-4, VC-4-4c or VC-4-16c signal level. The SNCP is based on non-intrusive monitoring of the sub-network connection (SNC/N).

Other specifications The following specifications apply to WaveStar® TDM 10G (STM-64) too:

- Cascading of protection schemes in one Network Element
- Maximum of 50 ms switching time for all protection mechanisms.

□

Timing and Synchronization

Overview

The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to timing and synchronization.

Oscillator

The oscillator has the following specifications:

Oscillator	Specification
Built-in oscillator Stratum-3	Accuracy 4.6 ppm acc. to G.813 option 1, Stability 0.37 ppm/ first 24 hours

Timing modes

The timing modes are specified as follows:

Timing mode	Specification
Free running mode	Accuracy 20 ppm over 15 years
Hold-over mode	Accuracy 4.6 ppm of the frequency of the last source in two weeks
Locked mode with reference to	- one of the external sync. inputs - one of the STM-64/STM-16 inputs
Automatic ref. signal switching	compliant with ETSI ETS 300 417–6
Support of Sync. Status Marker (SSM)	STM-16 and STM-64 interfaces

OAM and P

Specifications The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to operation, administration, maintenance, and provisioning:

- Testing
  - Installation self-test (System level, cabling)
  - LAN interface self test, LED self test
  - Test loops for interface signals
- Recovery
  Auto recovery after input power failure
- Local O&M via faceplate LEDs, buttons on User Panel, CIT interface
- Centralised O&M via Q interface, DCC link
- SW-downloading via Q interface, DCC link
- Alarms
  - Categories for indication of alarm severity
  - Station alarm interfaces
- Miscellaneous Discretes
- Self-diagnostics
- Local workstation (WaveStar® CIT)
- Auto-provisioning by the insertion of a circuit pack.

□

Network management

Specifications

The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to network management:

- Fully manageable by WaveStar® SNMS
- Integration into path management WaveStar® NMS
- Access to Embedded Communication Channels
- Via in-station Q-LAN interface: TL1 message protocol / 10BaseT interface
- WaveStar® CIT for small network management: CIT interface / 10BaseT interface
- Access via TCP/IP.

□

Physical Design

Specifications The following specifications apply to WaveStar® TDM 10G (STM-64) with regard to physical design:

Subrack dimensions	Main Shelf: 1000 x 500 x 438 mm (H x W x D) Extension Shelf: 600 x 500 x 438 mm in accordance with ETSI Recommendation ETS 300 119-4 for wide racks
Weight	Main Shelf (fully equipped): approx. 110 kg, Extension Shelf (fully equipped): approx. 60 kg
Rack Types	ETSI (D700) rack
Connectors-Optical	Lucent universal optical connector (ST/SC/FC) on the STM-1 (4 port), STM-4, STM-16, STM-64 and Gigabit Ethernet interfaces. LC connectors on OLS400G colored interfaces. Duplex LC connectors on STM-1 (8 port) interfaces.
Connectors-Electrical	SUB-D on Alarm, Timing, User Byte IF, 1.6/5.6 on electrical STM-1 IF, Western RJ45 on LAN interfaces
Station power input (Battery)	-48 V DC and -60 V DC (Range: -40.5 ... -72 VDC)
Fuse (main power distribution)	63 A for each supply line
Min. cross-section of the power supply lines	16 mm^2 / 6 AWG
Min. cross-section of the rack grounding cable	16 mm^2 / 6 AWG
Min. cross-section of the shelf grounding cable	4.65 mm^2 / 10 AWG, stranded

Power Consumption	1230 W for a typical configuration (2 x STM-64, 2 x STM-16, 32 x STM-1o). For power consumption of the individual units, please refer to "Power Consumption" (10-14)

Transmission Fibers

WaveStar® TDM 10G uses the following transmission fibers:

- Standard single-mode (non-dispersion shifted) fiber
- TrueWave™ non-zero dispersion shifted fiber.

□

Power Consumption

Specifications The following specifications apply to WaveStar® TDM 10G with regard to power consumption of the individual parts/circuit packs:

Part	Power Consumption [W]
Main Shelf incl. all common units (CTL/SYS50DM, ADJCTL/DCCEI, PPROC/STS192(384), SWITCH/STS576(768), TMG/STRAT3)	592
Extension Shelf incl. all common units (CTL/SYS50DM, ADJCTL/DCCEI, SWITCH/STS576, TMG/STRAT3)	247.5
OC192/STM64 port unit	94
OC192/STM64 port unit (DWDM comp.)	104.5
Optical Booster Amplifier (OBA)	14.7
OC48/STM16 port unit	34
OC48/STM16 port unit (DWDM comp.)	40
OC12/STM4 port unit	21.2
OC3/STM1 opt. port unit	19.4
STM1 el. port unit (incl. I/O panel)	27.5
GE1 port units	40
EPS-64	23
TMG I/O Panel	2

□

Environmental conditions

Environment Compliant with EN300 019-1-3 for Class 3.1 Environment "Stationary use at weather protected locations":

	Temperature range	Humidity
Normal operation	+5˚C to +40˚C	up to 85%
Short term operation	0˚C to +50˚C	up to 80% (conditions last at most 72 hours per year during at most 15 days)
Storage	-25˚C to +55˚C	up to 100%

EMC WaveStar® TDM 10G (STM-64) meets the emissions requirement as per FCC 47 CFR part 15 Subpart B for class A computing device.

WaveStar® TDM 10G (STM-64) is compliant with EN 61000:" EMC requirements for Public Telecommunication Network Equipment":

Radiated emission	EN 61000
Conducted emission	EN 61000
Electrostatic discharge	EN 61000
Radiated immunity	EN 61000
Conducted immunity: • Electrical fast transients • Surges • Continuous wave	 • EN 61000 • EN 61000 • EN 61000
Compliant with LVD	EN 60950
CE Certification	CE compliant with European Directive 89/336/EEC

Transmission requirements

Transmitter/Receiver types

Depending on the distance, different transmitter/receiver types are required. The following table gives an overview of the STM-64 port units needed.

Distance [km]	STM-64 Port Unit	in conjunction with
0 – 40	LEY97	—
40 – 60	LEY69	—
60 – 80	LEY69 or LEY97	SEN3 (OBA10G/1.5LR1)
	(valid for single mode ***and*** dispersion shifted fibres)	
80 – 120 (single mode fibres)	LEY228	SEN4 (OBPA10G/1.5VR1) and the following DCM boxes: – DCM 40km (precompensation) – DCM 50km (postcompensation)
80 – 120 (dispersion shifted fibres)	LEY228	SEN4 (OBPA10G/1.5VR1) and one LBO on the LEY228 receiver to have incoming signal level between –21 dBm and –13 dBm
120 – 500	LEY228	1–5 cascaded Ditech amplifiers and DCM boxes

□

11 Circuit pack description

Overview

Purpose

This chapter provides a detailed functional description of the WaveStar® TDM 10G (STM64) circuit packs and port units.

Objectives

This chapter provides information to perform the following:

1. Describe the major functions of each circuit pack.
2. Describe the major functions of each port unit.

Circuit pack and software compatibility

The following table provides a cross-reference of the circuit packs to the compatible software release version.

Table 11-1 Circuit pack and software compatibility

Apparatus code	Name	Compatible software release R5
LEY1, LEY301	ADJCTL/DCCEI circuit pack	X
LEY10B	CTL/SYS50DM circuit pack	X
LEY13, 190	OC12/STM4 LR Port Unit	X
LEY14	OC12/STM4 SR Port Unit	X
LEY15	OC3/STM1 LR port unit	X
LEY16	OC3/STM1 SR port unit (4 ports)	X
LEY23	OC3/STM1 SR port unit (8 ports)	X

Table 11-1 Circuit pack and software compatibility (continued)

Apparatus code	Name	Compatible software release R5
LEY7, LEY8, LEY182	OC48/STM16 port unit	X
LEY50...LEY65	OC48/STM16 port unit (OLS80 comp.)	X
LEY80...LEY95	OC48/STM16/POU9590 - POU9210 Port Unit	X
LEY101...180	OC48/STM16 port unit (OLS400 comp.)	X
LEY69, LEY97	OC192/STM64 port unit	X
LEY201...LEY240	OC192/STM64 port unit (DWDM comp.)	X
LEY284...LEY299	OC192/STM64 port unit (passive optics)	X
LEY309	Gigabit Ethernet 1000BASE-SX the non-LPT casds have suffix AE, the LPT cards have suffix BE	X
LEY310	Gigabit Ethernet 1000BASE-LX the non-LPT casds have suffix AE, the LPT cards have suffix BE	X
SEN3	Optical Booster Amplifier 10G	X
SEN4	Optical Booster and Pre-Amplifier 10G	X
LEY44	STM1E/4	X
LEY42	EPS-64 Circuit Pack	X
LEY3	PPROC/STS192 circuit pack	X
LEY47	PPROC/STS384 circuit pack	X
LEY4	SWITCH/STS576 circuit pack	X
LEY73	SWITCH/STS768 circuit pack	X
LLY2B	TMG/STRAT3 circuit pack	X

Related information

For related information see:

- WaveStar® TDM 10G (STM64) User Operations Guide
- WaveStar® TDM 10G (STM64) Alarm Messages and TroubleClearing Guide
- WaveStar® TDM 10G (STM64) Installation Manual
- WaveStar® TDM 10G (STM64) TL1 Reference Manual
- WaveStar® SNMS Provisioning Guide (Application TDM 10G (STM-64))

Contents

ADJCTL/DCCEI circuit pack (LEY1)

Overview

Purpose

The Adjunct Control/Data Communications Channel External Interface (ADJCTL/DCCEI) circuit pack provides access to the transport overhead bytes. The overhead bytes include the data communications channel (DCC) bytes and user bytes. The ADJCTL/DCCEI circuit pack also provides external user interfaces for the system. The DCC and external interface functions are independent of each other.

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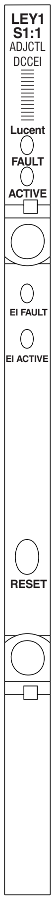
ADJCTL/DCCEI circuit pack faceplate

Faceplate diagram

The following diagram illustrates the ADJCTL/DCCEI circuit pack faceplate.



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Faceplate indicators

The ADJCTL/DCCEI circuit pack has a red FAULT light-emitting diode (LED), a red EI FAULT LED, a green ACTIVE LED, and a green EI ACTIVE LED on its faceplate. Please note that the EI FAULT and EI ACTIVE LEDs are controlled by the CTL/SYS50DM circuit packs.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected or the circuit pack loses one power feeder.
EI FAULT LED (red)	Lights continuously when a failure is detected in the external interface (EI) part of the circuit pack.

LED	Function
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.
EI ACTIVE LED (green)	Lights when the external interface (EI) part of the circuit pack is active/in-service.

Faceplate push-button switch

The ADJCTL/DCCEI circuit pack has a RESET push-button switch recessed on its faceplate. When the RESET push-button switch is pressed, the ADJCTL/DCCEI circuit pack performs a circuit pack reset.

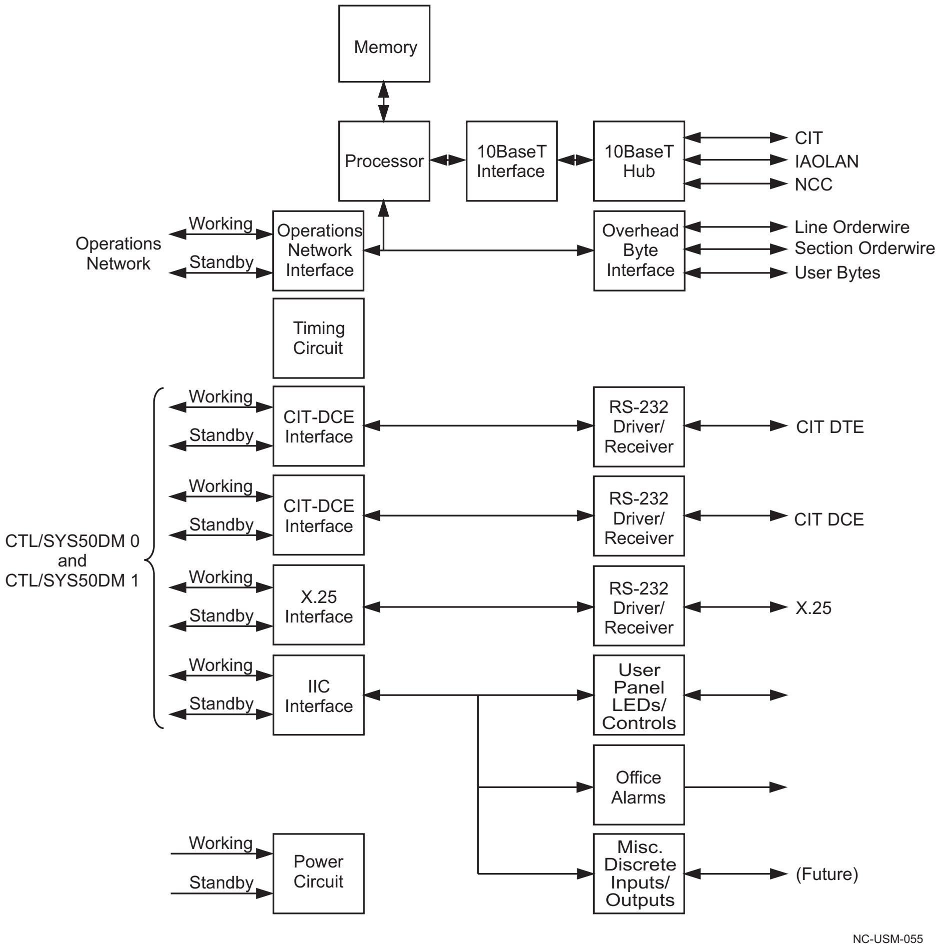
□

ADJCTL/DCCEI circuit pack functions

Overview The ADJCTL/DCCEI circuit pack assembles and disassembles the embedded information for the transport overhead bytes. These overhead bytes include section and line data communications bytes, section and line orderwire bytes, and user bytes. The ADJCTL/DCCEI circuit pack also provides external user interfaces.

Functional block diagram The following figure shows a functional block diagram of the ADJCTL/DCCEI circuit pack.

Figure 11-1 ADJCTL/DCCEI circuit pack functional block diagram



Control circuitry The processor controls and monitors the operation of the circuit pack. The processor also performs protocol processing of the open systems interconnection (OSI) 7-layer stack for the 10BaseT interface. The processor also manages communication with the CTL/SYS50DM circuit pack via the operations network.

Memory circuitry

The memory circuitry consists of

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the CTL/SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of 32 megabytes of dynamic random access memory (DRAM). The operating memory is used to store executable code/data.
- Nonvolatile memory
  The nonvolatile memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the circuit pack history such as the ***CLEI*** code and type/version information.

Interface circuitry

The interface circuitry consists of

- 10BaseT interface
  The 10BaseT interface provides access to the intraoffice LAN (10 Mb/s Ethernet LAN) via the10BaseT four-port hub. The 10BaseT interface performs protocol processing for physical layer 1 of the OSI 7-layer stack for the intraoffice LAN (IAOLAN) data.
  In the receive direction, the 10BaseT interface accepts IAOLAN data from the10BaseT four-port hub. The IAOLAN data is routed to the processor for OSI protocol processing.
  In the transmit direction, the 10BaseT interface accepts the IAOLAN data from the processor and transmits the information to the 10BaseT four-port hub.
- Operations network interface
  The operations network interface provides access to the CTL/SYS50DM circuit packs and transmission port units via the operations network. For more information about the operations network, refer to Chapter 4, Control Architecture.
- Overhead byte interface

The overhead byte interface accepts the data communications channel (DCC) bytes from the operations network or the intraoffice LAN (IAOLAN) and the following overhead bytes from the backplane of the shelf:

- RSOH orderwire byte E1
- MSOH orderwire byte E2
- User byte F1

The overhead byte interface multiplexes this information and sends it via the operations network to the transmission port units for transmission over the optical transmission line. This information provides end-to-end communications and maintenance.

In the receive direction, the transmission port units transmit the overhead bytes via the operations network to the overhead byte interface. The overhead byte interface then demultiplexes the DCC and overhead bytes and makes them available for use.

- Inter-integrated circuit interface

  The inter-integrated circuit (IIC) interface is a communication link between the ADJCTL/DCCEI circuit pack and the CTL/SYS50DM circuit packs. The inter-integrated circuit interface allows the CTL/SYS50DM circuit pack to control the user panel, office alarms, and miscellaneous discrete user interfaces.

The following table shows the DCC and overhead bytes that are provided by the ADJCTL/DCCEI circuit pack.

Table 11-2 Overhead bytes

Name	Overhead byte	Data rate	Access
Orderwire	E1	64 kb/s	Backplane
Orderwire	E2	64 kb/s	Backplane
User	F1	64 kb/s	Backplane
DCC	D1-D3	192 kb/s	IAOLAN
DCC	D4-D12	576 kb/s	IAOLAN

Timing circuitry

A free-running 6.48-MHz oscillator provides a reference signal for the timing circuit. The timing circuit multiplies the 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. The 155.52-MHz timing signal is used to generate all other output timing signals.

User interface circuitry

The user interface circuitry consists of

- Four-Port 10BaseT hub

The four-port 10Base-T hub provides one internal port for the system and three external user ports. The three external user ports are for the:

- Craft interface terminal (CIT)
- Intraoffice LAN (IAOLAN)
- Network communications controller (NCC).

- CIT DTE
  The CIT DTE interface is configured as data terminating equipment (DTE) to allow a permanent connection to a modem. The CIT DTE interface allows dial-up access to a personal computer (PC) running the WaveStar® CIT software. The CIT DTE interface supports data rates up to 19200 baud.
- CIT DCE
  The CIT DCE interface is configured as data circuit equipment (DCE) for direct craft interface terminal (CIT) access. The CIT DCE interface allows direct access to a PC running WaveStar® CIT software. The CIT DCE interface supports data rates up to 19200 baud.
- X.25
  The X.25 interface supports X.25 protocol and the Transaction Language 1 (TL1) message language. The X.25 interface is used to report alarm and status conditions and performance-monitoring data to the Bellcore network monitoring and analysis (NMA) system and the Lucent Technologies integrated transport management subnetwork controller (SNMS) systems using an EIA-232-D port operating at 1200 to 56,000 baud.
- User panel LEDs and controls
  The ADJCTL/DCCEI circuit pack provides the outputs to light the following LEDs on the user panel:
  - Critical (CR) alarm
  - Major (MJ) alarm
  - Minor (MN) alarm
  - Abnormal (ABN) status
  - Near-end activity (NE ACTY)
  - Far-end activity (FE ACTY)
  - Power on (PWR ON).

  The ADJCTL/DCCEI circuit pack also accepts the alarm cut-off (ACO) and LED test (LED TEST) inputs from the user panel. For more information about the user panel, refer to Chapter 3, Operations Interfaces.
- Office alarms

The ADJCTL/DCCEI circuit pack provides relays to interface with a central office alarm grid. The relays are controlled by the CTL/SYS50DM circuit packs. Relays are provided for audible and visible alarms for the following:

- Critical
- Major
- Minor.

The normally closed contacts for the critical and major relays provide the alarm closure if power fails. For more information about the office alarms interface, refer to Chapter 3, Operations Interfaces.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V and +3.3 V used on the circuit pack.

The ADJCTL/DCCEI circuit pack monitors the two –48 V power sources. If the ADJCTL/DCCEI circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The ADJCTL/DCCEI circuit pack performs the following control and interface functions:

- Interfaces with the 10BaseT interface to send and receive IAOLAN data
- Interfaces with the CTL/SYS50DM circuit pack via the operations network interface to send and receive system messages
- Processes and routes messages between the 10BaseT and operations network interfaces using the open system interconnection (OSI) protocol
- Provides communications between the transmission port units and the CTL/SYS50DM circuit packs using the operations network
- Provides the following external user interfaces:
  - CIT DCE interface for direct local access to the system operating at up to 19200 baud
  - CIT DTE interface for remote dial-up access to the system operating at up to 19200 baud
  - X.25 interface for advanced provisioning, performance monitoring, administration, and maintenance activities operating at 1200 to 56,000 baud
  - Office alarms

  - User panel LEDs and controls
  - User-settable miscellaneous discrete interface that provides environmental inputs and control outputs.
- Provides internal fault detection and interfaces with the CTL/SYS50DM circuit pack
- Stores inventory information (for example, CLEI code and serial number)
- Controls the circuit pack faceplate FAULT and ACTIVE LEDs.

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CTL/SYS50DM circuit pack (LEY10B)

Overview

Purpose

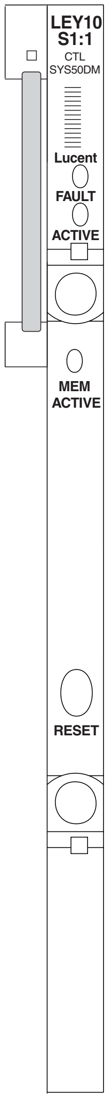
The Control/System 50DM (CTL/SYS50DM) circuit pack provides the system control and memory functions.

□

CTL/SYS50DM circuit pack (LEY10B) faceplate

Faceplate diagram

The following diagram illustrates the CTL/SYS50DM circuit pack (LEY10B) faceplate.



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Faceplate indicators

The CTL/SYS50DM circuit pack has a red FAULT LED, a green ACTIVE LED, and a green MEM ACTIVE LED on its faceplate.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected.

LED	Function
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.
MEM ACTIVE LED (green)	Lights when the flash disk memory is accessed.

Faceplate push-button switch

The CTL/SYS50DM circuit pack has a RESET push-button switch recessed on its faceplate. When the RESET push-button switch is pressed, the CTL/SYS50DM circuit pack performs a circuit pack reset.

□

CTL/SYS50DM circuit pack functions

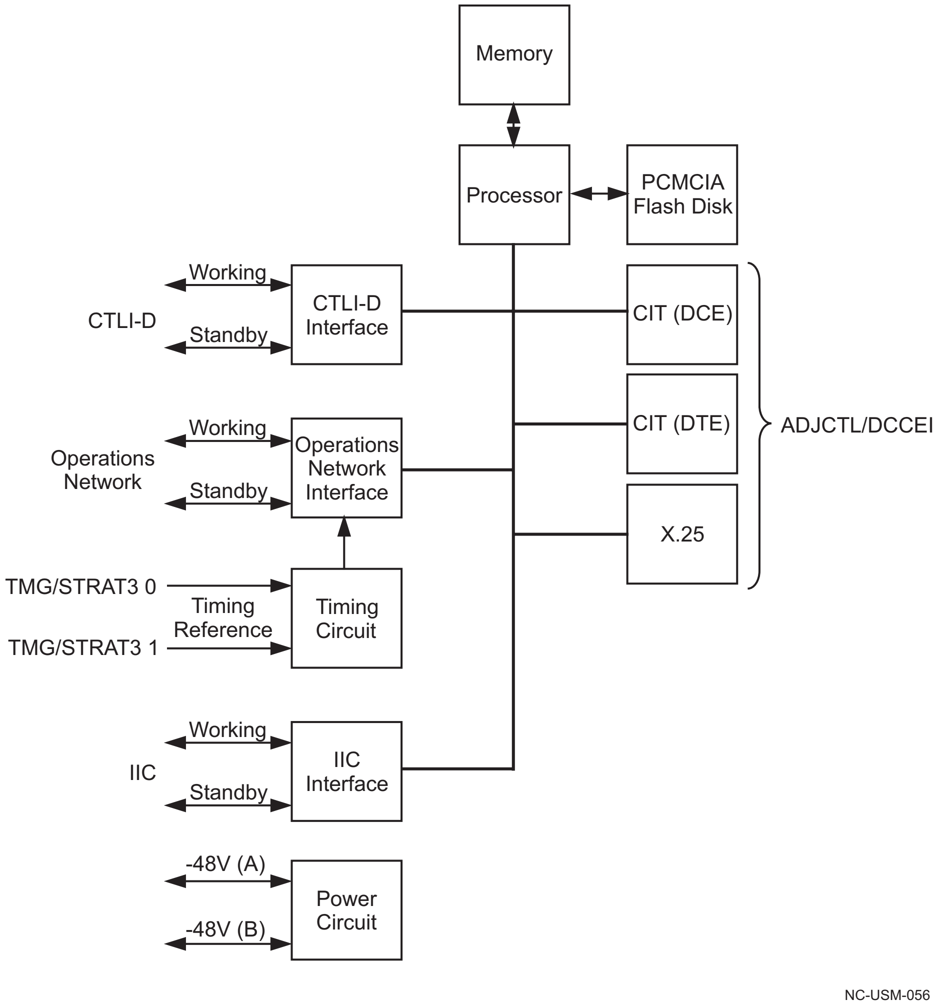
Overview

The CTL/SYS50DM circuit pack provides control and memory functions for the system. It performs shelf-level computations and performance monitoring. It also provides the serial user interfaces.

Functional block diagram

The following figure shows a functional block diagram of the CTL/SYS50DM circuit pack.

Figure 11-2 CTL/SYS50DM circuit pack functional block diagram



Control circuitry

The processor controls and monitors the operation of the circuit pack. The processor also manages communication with other circuit packs via the operations network, control interface for devices, and inter-integrated circuit bus.

Memory circuitry

The memory circuitry consists of

- The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the secondary operating memory into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software. Start-up memory
- Operating memory
  The operating memory consists of up to 32 megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Secondary operating memory
  The secondary operating memory is used to store copies of the executable code and data. The secondary operating memory consists of one personal computer memory card international association (PCMCIA) flash disk card. The flash disk card supports up to 175 megabytes of memory. The flash disk cards are removable and can be accessed from the circuit pack faceplate.
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the circuit pack history such as the CLEI code and type/version information.

Interface circuitry

The interface circuitry consists of

- Operations network interface
  The operations network interface provides access to the ADJCTL/DCCEI transmission port units via the operations network. For more information about the operations network, refer to Chapter 5, Control Architecture.
- Control interface for devices (CTLI-D) interface
  The CTLI-D interface provides access to the external interface function of the TMG/STRAT3 and SWITCH/STS576 circuit packs via the CTLI-D bus.
- Inter-integrated circuit interface
  The inter-integrated circuit interface provides access to the external interface function of the ADJCTL/DCCEI circuit pack via the inter-integrated circuit bus.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the TMG/STRAT3 circuit packs. The timing circuit multiplies the 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

User interface circuitry

The user interface circuitry consists of

- CIT DTE
  The CIT DTE interface is configured as data terminating equipment (DTE) to allow a permanent connection to a modem. The CIT DTE interface allows dial-up access to a PC running the WaveStar® CIT software. The CIT DTE interface supports data rates up to 19200 baud.
- CIT DCE
  The CITDCE interface is configured as data circuit equipment (DCE) for direct WaveStar® craft interface terminal (CIT) access. The CIT DCE interface allows direct access to a PC running WaveStar® CIT software. The CIT DCE interface supports data rates up to 19200 baud.
- X.25
  The X.25 interface supports X.25 protocol and the Transaction Language 1 (TL1) message language. The X.25 interface is used to report alarm and status conditions and performance-monitoring data to the Bellcore network monitoring and analysis (NMA) system and the Lucent Technologies integrated transport management subnetwork controller (ITM-SNC) systems using an EIA-232-D port operating at 1200 to 56,000 baud. The X.25 interface is provided via the ADJCTL/DCCEI circuit pack.

Protection circuitry

Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The CTL/SYS50DM circuit pack monitors these timing reference signals and can select the working or standby timing reference signal.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V and +3.3 V used on the circuit pack.

The CTL/SYS50DM circuit pack monitors the two –48 V power sources. If the CTL/SYS50D circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The CTL/SYS50DM circuit pack performs control and interface functions:

Control functions

The CTL/SYS50DM circuit pack performs the following control and maintenance functions:

- Stores the operating copy of the system executable code and data
- Provides a removable PCMCIA flash disk memory card
- Performs shelf maintenance computations and performance monitoring
- Automatically resets the system during powerup
- Performs self-audits
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the circuit pack faceplate EI FAULT LED on the ADJCTL/DCCEI circuit pack
- Controls the circuit pack faceplate FAULT LED on the SWITCH/STS576 and TMG/STRAT3 circuit pack
- Controls the circuit pack FAULT, ACTIVE, and MEM ACTIVE LEDs on the circuit pack faceplate.

Interface functions

The CTL/SYS50DM circuit pack performs the following interface functions:

- Communications with other circuit packs using the operations network
- Communications with other circuit packs using the control interface for devices (CTLI-D) bus
- Communications with other circuit packs using the inter-integrated circuit (IIC) bus
- CIT DCE interface via the ADJCTL/DCCEI circuit pack for direct local access to the system operating at up to 19200 baud
- CIT DTE interface via the ADJCTL/DCCEI circuit pack for remote dial-up access to the system operating at up to 19200 baud
- X.25 interface via the ADJCTL/DCCEI circuit pack for advanced provisioning, performance monitoring, administration, and maintenance activities operating at 1200 to 56,000 baud.

□

Gigabit Ethernet Port Units (LEY309, LEY 310)

Overview

Purpose

The Gigabit Ethernet (GE1/SX2) port unit provides an interface between two 1000Base-SX optical Ethernet ports and internal synchronous transmission interface signals (TXI). The non-LPT units have suffix AE, the LPT units have suffix BE.

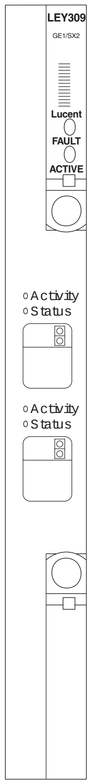
The Gigabit Ethernet (GE1/LX2) port unit provides an interface between two 1000Base-LX optical Ethernet ports and internal synchronous transmission interface signals (TXI).

□

GE1 Port Unit Faceplate

Faceplate diagram

The following diagram illustrates the GE1 port unit faceplate.



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Faceplate LEDs

The GE1/SX2 and GE1/LX2 port units provide the following faceplate LEDs.

LED	Color	Function
FAULT	Red	Continuously lighted when a port unit failure is detected or the port unit loses one power feeder. Flashes on and off when an incoming signal failure is detected.
ACTIVE	Green	Lighted when the port unit is active/in-service.
ACTIVITY	Green	Lighted when the Ethernet port is transmitting or receiving data.
STATUS	Green	Lighted when the Ethernet link is up.

□

GE1 Port Unit Functions

General description of operation

The GE1/SX2 port unit terminates up to two bidirectional 1000BASE-SX optical Ethernet ports. The GE1/LX2 port unit terminates up to two bidirectional 1000BASE-LX optical Ethernet ports.

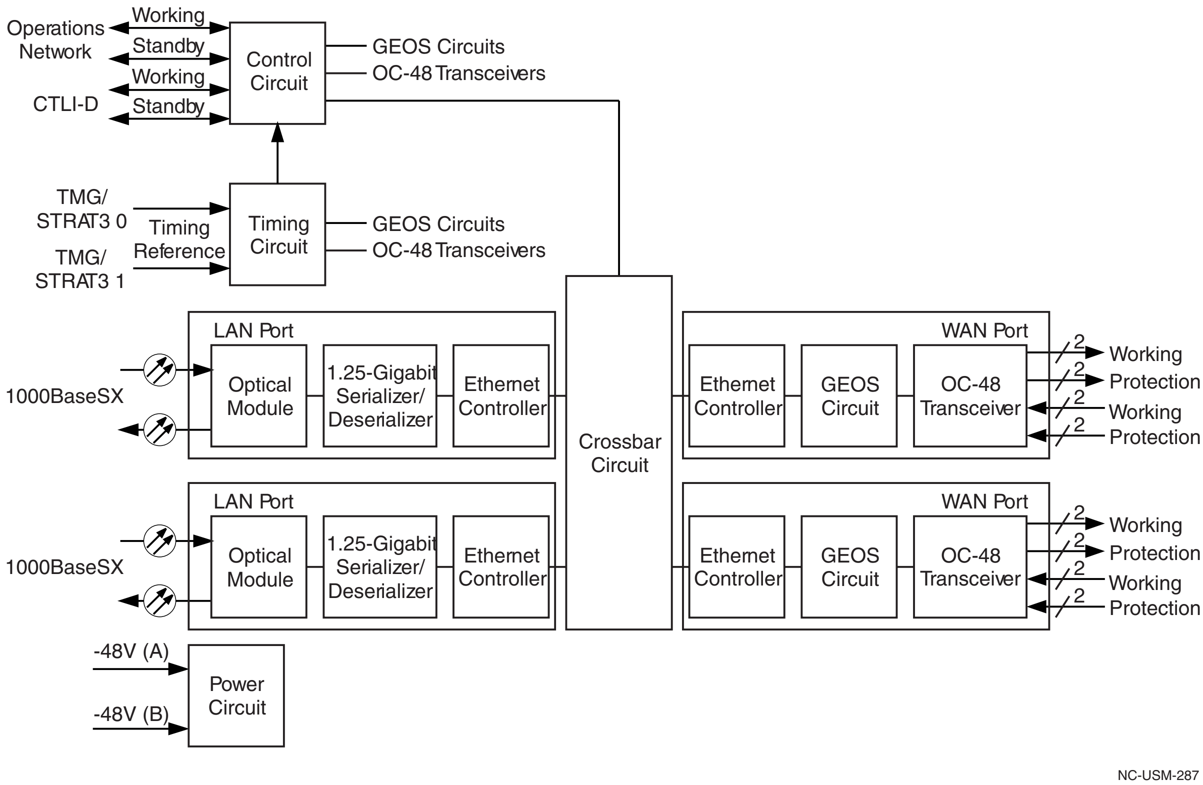
Each optical Ethernet signal is converted to a serial 1.25 Gb/s electrical signal. The serial 1.25 Gb/s electrical Ethernet signals are demultiplexed to parallel data and processed for SDH transport. The data is then converted to internal transmission interface (TXI) signals (622.08 Mb/s) and transmitted to the 576x576 (SWITCH/STS576) or 768x768 (SWITCH/STS768) STS-1 switch circuit packs.

In the transmit direction, the SWITCH/STS576 (or SWITCH/STS768) circuit packs send TXI signals to the GE1/SX2 or GE1/LX2 port unit. The GE1/SX2 or GE1/LX2 port unit selects and converts the 622.08 Mb/s TXI signals to parallel Ethernet data. The parallel data is multiplexed to a serial 1.25 Gb/s electrical signal and converted to an optical Gigabit Ethernet signal (1000BASE-SX or 1000BASE-LX) for transmission.

The GE1/SX2 or GE1/LX2 port units also interfaces with the shelf Control/System 50DM (CTL/SYS50DM) circuit pack.

Functional block diagram

The following figure shows a functional block diagram of the GE1/SX2 port unit. The block diagram of the GE1/LX2 port unit is identical. The only difference is that at the LAN port a 1000BASE-LX signal is processed.



Control circuitry

The processor is the lowest level processor in the system control hierarchy. The processor controls and monitors the operation of the port unit. The processor also manages communication with other circuit packs via the operations network and the control interface for devices (CTLI-D) interfaces.

Memory circuitry

The GE1/SX2 and GE1/LX2 port units provide the following memory functions.

Start-up memory

The start-up memory consists of four megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup or reset condition, or when initializing new software.

Operating memory

The operating memory consists of up to 16 megabytes of synchronous dynamic random access memory (SDRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).

Nonvolatile inventory memory

The nonvolatile inventory memory consists of 1024 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The GE1/SX2 and GE1/LX2 port units provide the following transmission functions.

Receive direction: LAN port

Each LAN port of the GE1/SX2 port unit accepts one incoming 1000BASE-SX optical Ethernet signal. Each LAN port of the GE1/LX2 port unit accepts one incoming 1000BASE-LX optical Ethernet signal.

Fiber access to the GE1/SX2 or GE1/LX2 port units is via fixed duplex SC-type buildout blocks on the port unit faceplates.

The optical module converts an optical Ethernet signal (1000BASE-SX or 1000BASE-LX) to a 1.25-Gb/s electrical Ethernet signal. Clock and data recovery are also provided.

The 1.25-gigabit serializer/deserializer converts the serial 1.25-Gb/s electrical signal to parallel data.

The Ethernet controller in the LAN port processes the Ethernet data and transmits the Ethernet data via a crossbar circuit to the Ethernet controller in the WAN port.

Receive direction: WAN port

The Ethernet controller in the WAN port processes the Ethernet data received from the LAN port and transmits the Ethernet data to a GEOS circuit.

The Gigabit Ethernet over SDH (GEOS) circuit encapsulates the Ethernet data for SDH transport via virtually concatenated VC-4 signals (VC-4-xv; x=1...7). The SDH path overhead and pointer bytes are also inserted. The VC-4 signals are converted to internal transmission interface (TXI) signals and sent to the OC-48 transceiver.

The OC-48 transceiver circuit transmits up to two TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and two TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

Transmit direction: WAN port

In the transmit direction, each OC-48 transceiver circuit receives up to two TXI signals from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and two TXI signals from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The OC-48 transceiver circuit selects the working TXI signals and sends them to the GEOS circuit.

The GEOS circuit converts the TXI signals to virtually concatenated VC-4 signals. The SDH overhead bytes and Ethernet data are removed from the VC-4 signals.

The Ethernet controller in the WAN port processes the Ethernet data and transmits the Ethernet data via a crossbar circuit to the Ethernet controller in the LAN port.

Transmit direction: LAN port

The Ethernet controller in the LAN port processes the Ethernet data received from the WAN port and transmits the Ethernet data to the serializer/deserializer circuit.

The 1.25-gigabit serializer/deserializer converts the parallel Ethernet data to a serial 1.25-Gbit/s electrical signal and sends it to the optical module.

The optical module converts electrical 1.25-Gbit/s Ethernet signal to an optical 1000BASE-SX or 1000BASE-LX Ethernet signal for transmission.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used. The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. The timing circuit also provides internal 77.76-MHz and 8-KHz timing signals. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The Gigabit Ethernet port units provide the following protection functions.

Switch fabric protection

Switch fabric protection is performed by selecting the working or protection TXI signals from the shelf SWITCH/STS576 (or SWITCH/STS768) circuit packs. The Gigabit Ethernet port units monitor these TXI signals and can select the working or protection TXI signal. The CTL/SYS50DM circuit pack can inhibit this autonomous selection and make its own selection.

Timing reference signal protection

Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The Gigabit Ethernet port units monitor these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The Gigabit Ethernet port units provide the following fault detection functions.

Monitoring and testing

The control circuit monitors all the activities on the port unit. The GE1/SX2 and GE1/LX2 port units have an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed whenever a Gigabit Ethernet port unit is inserted in a slot or reset.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V, +3.3 V, +2.5 V, and +1.8 V used on the port unit.

The Gigabit Ethernet port units monitor the two power sources. If the port units detect a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The GE1/SX2 and GE1/LX2 port units perform the following functions.

Receive functions

The GE1/SX2 and GE1/LX2 port units perform the following receive functions:

- Receive up to two 1000BASE-SX or 1000BASE-LX optical Ethernet signals
- Recovers clock from each signal
- Converts the optical 1000BASE-SX or 1000BASE-LX signal to an electrical 1.25-Gb/s signal
- Converts the serial 1.25-Gb/s signal to 10-bit parallel Ethernet data
- Encapsulates Ethernet data in virtually concatenated VC-4 signals (VC-4-xv; x=1...7)
- Inserts VC-4 path overhead and pointer bytes

- Converts the VC-4 signals to 622.08 Mb/s TXI signals
- Sends the 622.08 Mb/s TXI signals to each SWITCH/STS576 (or SWITCH/STS768) circuit pack.

Transmit functions

The GE1/SX2 and GE1/LX2 port units perform the following transmit functions:

- Receives working and protection 622.08 Mb/s TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs and selects the working TXI signals
- Converts the 622.08 Mb/s TXI signals to VC-4 signals
- Extracts SDH path overhead and pointer bytes from the VC-4 signals
- Extracts the Ethernet data from the VC-4 signals
- Converts the 10-bit parallel Ethernet data to a serial 1.25-Gb/s signal
- Converts the electrical 1.25-Gb/s signal to an optical 1000BASE-SX or 1000BASE-LX Ethernet signal for transmission.

Timing and control functions

The GE1/SX2 and GE1/LX2 port units performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network
- Provides nearside internal loopbacks and farside facility loopbacks
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the circuit pack faceplate FAULT, ACTIVE, ACTIVITY, and STATUS LEDs.

□

STM1E/4 port unit (LEY44)

Overview

Purpose

The STM-1 4-port interface (STM1E/4) port unit provides a low speed interface for four electrical STM-1 signals.

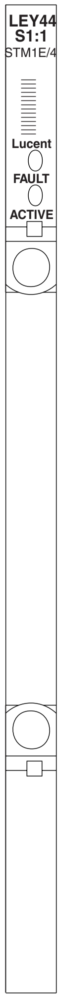
Furthermore, the hardware is prepared to support 1:N electrical protection switching. This also requires the EPS-64 (Electrical Protection Switch) circuit pack.

□

STM1E/4 port unit faceplate

Faceplate diagram

The following diagram illustrates the STM1E/4 port unit faceplate.



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Faceplate indicators

The STM1E/4 port unit has a red FAULT LED and a green ACTIVE LED on its faceplate.

> **Important!** The EI FAULT and EI ACTIVE LEDs are controlled by the CTL/SYS50DM circuit packs.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a port unit failure is detected or the port unit loses one power feeder. The red FAULT LED flashes on and off when an incoming STM-1 signal failure from the STM-1EE4/4 I/O Panel is detected.

LED	Function
ACTIVE LED (green)	Lights when the port unit is active/in-service.

□

STM1E/4 port unit functions

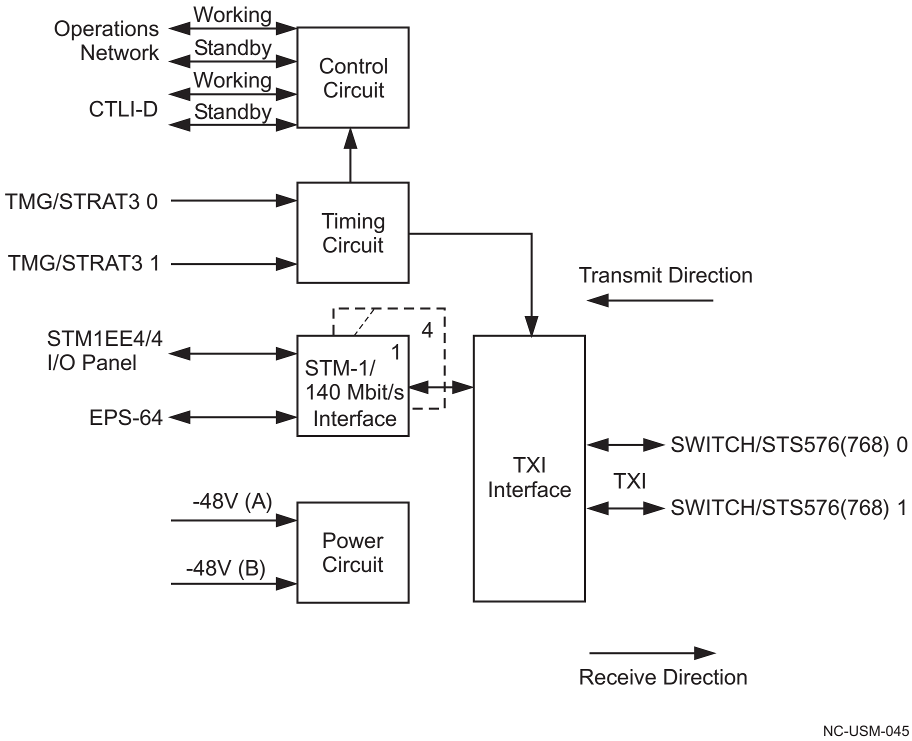
Overview

The STM1E/4 circuit pack has four bidirectional line interface ports that may carry electrical STM1 signals. Each port connects to one external interface to support normal working mode. Each port also connects to one internal interface to the EPS-64 circuit pack to support protection. On the system side of the pack the STM1E/4 pack connects to the switch fabric (SWITCH/STS576 or SWITCH/STS768). The circuit pack performs the necessary conversions and processes to convert four STM1 signals into twelve STS-1 bit streams and multiplex the STS-1 bit streams into the TXI signal (622.08 Mbit/s). The STM1E/4 port unit also interfaces with the shelf Control/System 50DM (CTL/SYS50DM) circuit pack.

Functional block diagram

The following figure shows a functional block diagram of the STM1E/4 port unit.

Figure 11-3 STM1E/4 port unit functional block diagram



Control circuitry

The processor controls and monitors the operation of the circuit pack. The processor also manages communication with other circuit packs via the operations network and control interface for devices (CTLI-D) interfaces.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of up to four megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The transmission circuitry is divided into

- Receive direction
  In the receive direction the CMI coded signal is converted to NRZ code. The signal is split into 2 similar level signals with one side going to the interface circuitry for processing and eventual multiplexing to the TXI bus and the other side feeding a high speed solid state switch. In the normal (no protection needed) power up state of the switch, the signal is terminated into a 75 Ω impedance and not output to the EPS-64 protection unit. To ensure that there is minimal leakage of the signal to the EPS-64, one of the contacts of the solid state switch provides an ac ground signal to the output. When a protection switch is made, the contacts on the receive DSX In port transfers the signal from the 75 Ω termination to the EPS-64 unit.
- Transmit direction
  In the transmit direction, the SWITCH/STS576 (or SWITCH/STS768) circuit packs sends two 622.08 Mbit/s TXI signals to the TXI interface. The TXI interface selects one TXI signal and recovers timing. The selected TXI signal is descrambled and demultiplexed into twelve VC-3 signals. Each STS-1 signal goes through STS-1 pointer processing, and the STS-1 path overhead is removed and processed. The TXI interface sends four STM-1 signals and a 155 MHz clock to the

STM-1 interface.The STM-1 interface provides four CMI-coded STM-1 signals to the STM1EE4/4 I/O panel. The STM-1 interface selects the signals from the TXI interface or the EPS-64 circuit pack (for protection) and outputs them to the STM1EE4/4 I/O panel.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The protection circuitry consists of

- STM1E/4 port unit protection
  Optional 1:N (N≤16) revertive STM1E/4 port unit protection is provided. A protection bus is implemented with on-board relays on the STM-1 side and with selectors at the TXI level on the SWITCH/STS576 (or SWITCH/STS768) circuit packs. The Electrical Protection Switch (EPS-64) circuit pack provides power to these relays and controls their operation. If the +5 volt power on the STM1E/4 port unit fails, the relays are still operational and controlled by the EPS-64 and CTL/SYS50DM circuit packs. Shorting contacts are provided in the STM1E/4 port unit backplane connector so that when the port unit is

removed, the STM-1 cables short through to the EPS-64 circuit pack for routing to the protecting STM1E/4 port unit. When the STM1E/4 port unit is reinserted, the relays are in the protection state until the CTL/SYS50DM circuit pack determines that the port unit is good.

- Switch fabric protection
  Switch fabric protection is performed by selecting the working or standby TXI signals from the shelf SWITCH/STS576 (or SWITCH/STS768) circuit packs. The STM1E/4 port unit monitors these TXI signals and can select the working or standby TXI signal. The CTL/SYS50DM circuit pack can inhibit this autonomous selection and make its own selection.
- Timing reference signal protection
  Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The STM1E/4 port unit monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The fault detection circuitry is divided into

- Monitoring and testing
  The control circuit monitors all the activities on the port unit. The STM1E/4 port unit has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed whenever the STM1E/4 port unit is inserted in a slot or reset.
- Loopbacks
  The STM1E/4 port unit provides a near-side facility lookback and a far-side facility loopback for each STM-1 signal. The loopbacks are implemented by the STM-1 interface. The STM-1 interface bridges the STM-1 signaI from the TXI interface (transmitted towards the STM1EE4/4 I/O panel) back into the TXI interface (far-side facility loopback). The STM-1 interface also bridges the STM-1 signaI from the STM1EE4/4 I/O panel (transmitted towards the TXI interface) back to the STM1EE4/4 I/O panel (near-side facility loopback). These loopbacks are implemented in response to WaveStar® CIT commands (via the CTL/SYS50DM circuit pack) and controlled by control circuit.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR’d, fused, and filtered. Modular

DC-to-DC converters produce +5 V and +3.3 V used on the port unit. The EPS-64 circuit pack supplies power to the input and output protection relays on the STM1E/4 port unit.

The STM1E/4 port unit monitors the two –48 V power sources. If the STM1E/4 port unit detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The STM1E/4 port unit performs the following functions:

Receive functions

The STM1E/4 port unit performs the following receive functions:

- Receives four electrical STM-1 signals from a STM1EE4/4 I/O Panel.
- Recovers clock from each STM-1 signal
- Converts the four STM-1 signals to twelve STS-1 (51.84 Mbit/s) bit streams
- Inserts STS-1 path overhead and pointer bytes
- Multiplexes twelve STS-1 signals to a 622.08 Mbit/s TXI signal
- Sends a 622.08 Mbit/s TXI signal to each SWITCH/STS576 (or SWITCH/STS768) circuit pack.

Transmit functions

The STM1E/4 port unit performs the following transmit functions:

- Receives two 622.08 Mb/s TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs and selects one TXI signal
- Demultiplexes the selected 622.08 Mbit/s TXI signal into twelve STS-1 signals
- Converts the twelve STS-1 (51.84 Mbit/s) bit streams into four STM-1 signals
- Provides four STM-1 signals to a STM1EE4/4 I/O Panel.

Timing and control functions

The STM1E/4 port unit performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Provides relays for low speed protection switching
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network

- Provides a near-side facility loopback and far-side facility loopback for each STM-1 signal (not yet supported by software)
- Stores inventory information (for example, the CLEI code and serial number)
- Controls the circuit pack faceplate FAULT and ACTIVE LEDs

□

EPS-64 Circuit Pack (LEY42)

Overview

Purpose

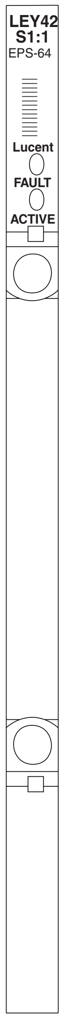
The Electrical Protection Switch (EPS-64) circuit pack is a relay switch circuit pack used to build a low speed protection bus in the transmit and receive directions for the STM1E/4 port units.

☐

EPS-64 circuit pack faceplate

Faceplate diagram

The following diagram illustrates the EPS-64 circuit pack faceplate.



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Faceplate indicators

The EPS-64 circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a cicuit pack failure is detected or the port unit loses one power feeder.
ACTIVE LED (green)	Lights when the port unit is active/in-service.

□

EPS-64 circuit pack functions

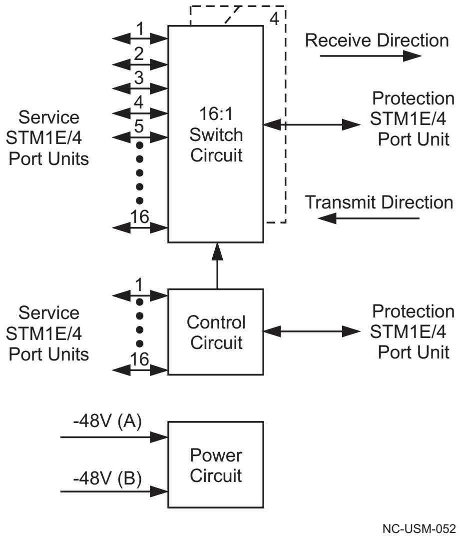
Overview

The EPS-64 circuit pack is responsible for implementing the STM1E/4 1:16 Protection Switch function in the WaveStar® TDM 10G (STM-64). In one direction it acts as a STM1E/4 selector i.e. it selects which STM1E/4 pack will be protected by the protection circuit pack and in the other direction it acts as a director i.e. it directs the STM1E signals to the correct protected STM1E/4 pack.

Functional block diagram

The following figure shows a functional block diagram of the EPS-64 circuit pack.

Figure 11-4 EPS-64 circuit pack functional block diagram



Control circuitry

The EPS-64 circuit pack has no on-board processor. The control circuit interfaces with the service STM1E/4 port units and the protection STM1E/4 port unit. All control information comes from the protection STM1E/4 port unit. The protection STM1E/4 port unit receives commands from the CTL/SYS50DM circuit packs via the operations network. For more information about the operation network, refer to Chapter 4, Control Architecture.

The EPS-64 circuit pack also controls the protection switching relays on the service STM1E/4 port units.

Memory circuitry

The memory circuitry consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the circuit pack history such as the CLEI code and type/version information.

Transmission interface

The transmission interface of the EPS-64 circuit pack performs the STM1E/4 director function and the STM1E/4 selector function. The transmission rate of the STM1E signal through the EPS-64 is 155.52 Mb/s, (+/- 20 ppm).

- STM1E/4 selector function
  The EPS-64 circuit pack implements the 1:16 protection scheme. The EPS-64 circuit pack has 4 (16:1) switch circuits that will select and send the 4 STM1E/4 signals from a "failed" STM1E/4 pack to the STM1E/4 protection pack.
  In normal system operation, i.e. no protection switch required, there will be no active STM1E signals to and from the EPS-64 circuit pack. All the signals coming from the 16 STM1E/4 packs will be individually grounded on the working STM1E/4 packs. Also, the control information (discussed in the control section) from the protection STM1E/4 pack will be decoded to keep all the switches in the open position so that there is no signal path formed.
  When a protection switch is required, only the 4 STM1E/4 signals from the "failed" STM1E/4 pack will be sent to the EPS-64 pack. Also, the protection STM1E/4 pack will send a code to the EPS-64 pack to close the relevant switches and setup the protection path (control scheme is discussed in the control section).
- STM1E/4 director function
  The EPS-64 circuit pack implements the director function using 4 (1:16) switch circuits. These switch circuits will select which of the 16 STM1E/4 packs or slots (through shorting contacts) will receive the 4 STM1E signals coming from the protection STM1E/4 pack.
  Again, in normal operation, i.e. no protection switch required, there will be no active STM1E signals to and from the EPS-64 circuit pack. All the signals coming from the Protection STM1E/4 pack will be open circuited on the protection STM1E/4 pack. Also, the control information (discussed in the control section) from the protection STM1E/4 pack will be decoded to keep all the switches in the open position so that there is no signal path formed.
  When a protection switch is in operation, the 4 STM1E signals from the protection STM1E/4 pack will be routed to the STM1E/4 slot that needed protection. This path is setup by decoding information from the protection STM1E/4 pack.

Switch implementation

The 1:16 and 16:1 switches are implemented identically using pin diodes. The difference between the 1:16 switch and the 16:1 switch is the direction in which the STM1E/4 signal flows.

Control interface

The control interface of the EPS-64 circuit pack consists of interaction between the protection STM1E/4 pack and the 16 STM1E/4 packs. All control information to the EPS-64 pack comes from the protection STM1E/4 pack which receives its command via the ONI interface from the System Controller.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Fault detection circuitry

The control circuit monitors all the activities on the port unit. The EPS-64 port unit has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or a reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V used on the port unit.

Furthermore, the EPS-64 pack provides a 15V secondary power source to the up to 16 working STM1E/4 packs to power the pin diode circuitry in order to guarantee service continuity during STM1E/4 pack insertion or power failure.

The EPS-64 circuit pack monitors the two –48 V power sources. If the EPS-64 circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The EPS-64 circuit pack performs the following functions:

Switch functions

The EPS-64 circuit pack performs the following switch functions:

- Receives four STM1E signals from a failed STM1E/4 port unit and switches the four STM1E signals to the protection STM1E/4 port unit
- Receives four STM1E signals from the protection STM1E/4 port unit and switches the four STM1E signals to the correct service STM1E/4 port unit and to the STM1EE4/4 I/O panel.

Control functions

The EPS-64 circuit pack performs the following control functions:

- Controls and powers the protection switching relays on the service STM1E/4 port units
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit pack via the protection STM1E/4 port unit
- Stores inventory information (for example, the CLEI code and serial number)

□

OC3/STM1 port unit (LEY15, LEY16, LEY23)

Overview

Purpose

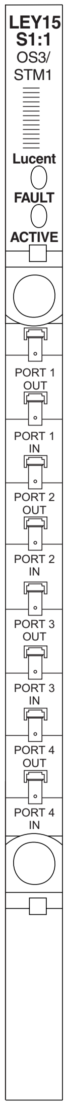
The OC3/STM1 port unit provides an interface between four (LEY15, LEY16) or eight (LEY23) OC-3/STM-1 signals and two internal transmission signals. The LEY15 (four ports) OC3/STM1 1.3LR4 port unit supports standard 1310 nm long reach applications (up to 51 kilometers). The LEY16 (four ports) and LEY23 (eight ports) OC3/STM1 1.3SR4(8) port units support low power 1310 nm short reach applications.

□

OC3/STM1 port unit faceplate

Faceplate diagram

The following diagram illustrates the OC3/STM1 port unit faceplate (four ports).



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Faceplate indicators

The OC3/STM1 port unit has a red FAULT LED and a green ACTIVE LED on its faceplate.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a port unit failure is detected or the port unit loses one power feeder. The red FAULT LED flashes on and off when an incoming OC-3/STM-1 signal failure from the lightguide cross-connect panel (or equivalent) is detected.
ACTIVE LED (green)	Lights when the port unit is active/in-service.

□

OC3/STM1 port unit functions

Overview

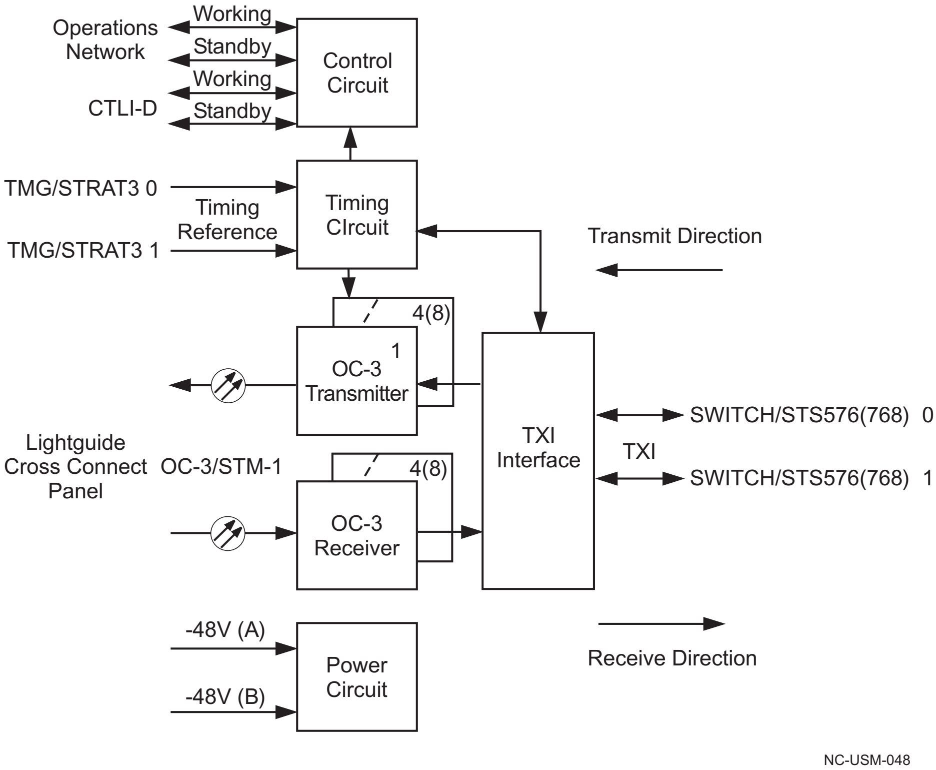
The OC3/STM1 port unit terminates four (eight for LEY23) bidirectional OC-3/STM-1 lines. Each OC-3/STM-1 signal is converted to an electrical STS-3/VC-4 signal. The four (eight) STS-3/VC-4 signals are demultiplexed into 12 (24) VC-3 signals and converted to one (two) 622.08 Mb/s internal transmission interface (TXI) signal(s). The TXI signal supports up to 12 multiplexed VC-3 signals. The TXI signal is sent to the shelf 576x576 (SWITCH/STS576) or 768x768 (SWITCH/STS768) STS-1 switch circuit packs.

In the transmit direction, the SWITCH/STS576 (or SWITCH/STS768) circuit packs send two working TXI signals to the OC3/STM1 port unit. The OC3/STM1 port unit converts the working 622.08 Mb/s TXI signal(s) into 12 (24) VC-3 signals. The VC-3 signals are multiplexed into four (eight) STS-3/VC-4 signals and converted to OC-3/STM-1 signals for transmission. The OC3/STM1 port unit also interfaces with the shelf Control/System 50DM (CTL/SYS50DM) circuit packs.

Functional block diagram

The following figure shows a functional block diagram of the OC3/STM1 port unit.

Figure 11-5 OC3/STM1 port unit functional block diagram



Control circuitry

The processor controls and monitors the operation of the port unit. The processor also manages communication with other circuit packs via the operations network and control interface for devices (CTLI-D) interfaces. For more information about the operations network and CTLI-D, refer to Chapter 6, Control, Transmission, and Synchronization Interfaces.

The control circuitry also transmits/receives transport overhead bytes to/from the ADJCTL/DCCEI circuit pack via the operations network.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 256 kilobytes of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of up to four megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The transmission circuitry is divided into

- Receive direction
  In the receive direction, each OC-3/STM-1 receiver circuit accepts one incoming OC-3/STM-1 optical signal. The OC-3/STM-1 optical signals are converted into STS-3/VC-4 electrical signals and the line clock and data is recovered. The STS-3/VC-4 data and clock signals are sent to the TXI interface. The TXI interface demultiplexes the 4 STS-3/VC-4 signals into 12 VC-3 signals and processes the transport and path overhead bytes. After the overhead bytes are processed, the VC-3 signals

are converted into one TXI signal. The TXI interface circuit retimes the TXI signal, adjusts the pointers, and sends one TXI signal to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one TXI signal to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

- Transmit direction
  In the transmit direction, the TXI interface circuit receives one (two) TXI signal(s) from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one (two) TXI signal(s) from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The TXI interface circuit selects the TXI signal and demultiplexes it into 12 VC-3 signals. The VC-3 signals are multiplexed into four STS-3/VC-4 signals and transport and path overhead bytes are inserted. The STS-3/VC-4 signals are then sent to the OC-3 transmitter circuits.
  Each OC-3/STM-1 transmitter circuit converts the STS-3/VC-4 signal into an optical 155.55 Mb/s OC-3/STM-1 signal for transmission.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The protection circuitry consists of

- Switch fabric protection
  In the receive direction, the OC3/STM1 port unit fans out one (two) TXI signal(s) to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one (two) TXI signal(s) to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. In the transmit direction, the OC3/STM1 port unit receives one (two) TXI signal(s) from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one (two) TXI signal(s)

from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The OC3/STM1 port unit selects one (two) TXI signal(s) as active and the other (two) TXI signal(s) as standby. If the active TXI signal fails, the OC3/STM1Stratum 3 port unit selects the standby TXI signal.

- Timing reference signal protection
  Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The OC3/STM1 port unit monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The control circuit monitors all the activities on the port unit. The OC3/STM1 port unit has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or a reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V and +3.3 V used on the port unit.

The OC3/STM1 port unit monitors the two –48 V power sources. If the OC3/STM1 port unit detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The OC3/STM1 port unit performs the following functions:

Receive functions

The OC3/STM1 port unit performs the following receive functions:

- Receives four (eight) optical 155.55 Mb/s OC-3/STM-1 signals
- Converts each OC-3/STM-1 signal to an electrical STS-3/VC-4 signal
- Extracts and processes the transport and path overhead access bytes
- Converts the four (eight) STS-3/VC-4 signals into one (two) 622.08 Mb/s TXI signal(s)
- Sends one (two) TXI signal(s) to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one (two) TXI signal(s) to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

Transmit functions

The OC3/STM1 port unit performs the following transmit functions:

- Receives two (four) 622.08 Mb/s TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs and selects one (two) TXI signal(s)
- Processes and inserts the transport and path overhead access bytes
- Converts the 622.08 Mb/s TXI signal(s) into four (eight) STS-3/VC-4 signals
- Converts each STS-3/VC-4 signal to an optical 155.55 Mbit/s OC-3/STM-1 signal for transmission.

Timing and control functions

The OC3/STM1 port unit performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs
- Selects the working or standby TXI signal from the SWITCH/STS576 (or SWITCH/STS768) circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the port unit faceplate FAULT and ACTIVE LEDs.

□

OC12/STM4 port unit (LEY13, LEY14, LEY190)

Overview

Purpose

The OC12/STM4 interface (OC12/STM4) port unit provides an interface between two OC-12/STM-4 signals and two internal transmission signals.

Supported OC12/STM4 port units

The following table shows the supported OC12/STM4 port units.

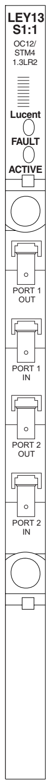
Name	Code	Description
OC12/STM4/ 1.5LR2	LEY190	Supports standard 1.5-µm long-reach applications
OC12/STM4/ 1.3LR2	LEY13	Supports standard 1.3-µm long-reach applications
OC12/STM4/ 1.3SR2	LEY14	Supports standard 1.3-µm short-reach applications (up to 15 kilometers)

□

OC12/STM4 faceplate

Faceplate diagram

The following diagram illustrates the OC12/STM4 port unit faceplate.



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Faceplate LEDs

The OC12/STM4 port unit provides the following faceplate LEDs.

LED	Color	Function
FAULT	Red	Continuously lighted when a port unit failure is detected or the port unit loses one power feeder. Flashes on and off when an incoming STM-4 signal failure from the lightguide cross-connect panel (or equivalent) is detected.
ACTIVE	Green	Lighted when the port unit is active/in-service.

OC12/STM4 port unit functions

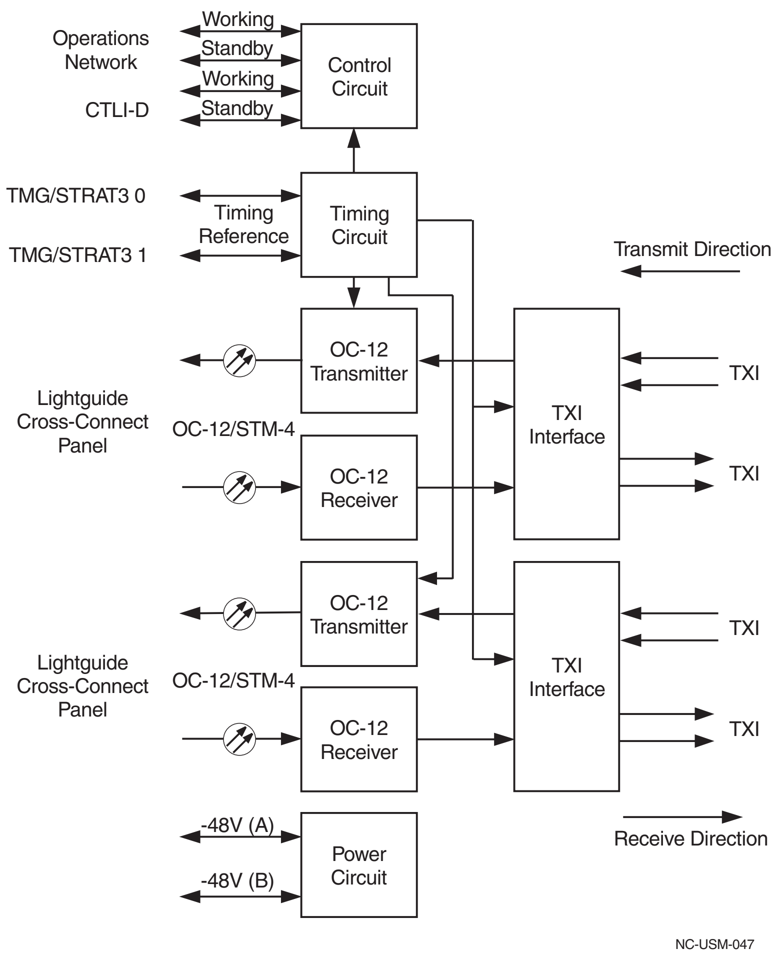
General description of operation

The OC12/STM4 port unit terminates two bidirectional OC-12/STM-4 lines. Each optical STM-4 signal is converted to an electrical STM-4 signal. The STM-4 signal is demultiplexed into 12 VC-3 signals and converted to a 622.08 Mb/s internal transmission interface (TXI) signal. The TXI signal supports up to 12 multiplexed VC-3 signals. The TXI signal is sent to the shelf 192x192 STM-1 Switch (SWITCH/STS576) circuit packs.

In the transmit direction, the SWITCH/STS576 circuit packs send two working TXI signals to the OC12/STM4 port unit. The OC12/STM4 port unit converts each working 622.08 Mb/s TXI signal into 12 VC-3 signals. The VC-3 signals are multiplexed into an STM-4 signal and converted to an optical signal for transmission. The OC12/STM4 port unit also interfaces with the shelf Control/System 50DM (CTL/SYS50DM) circuit packs.

Functional block diagram

The following figure shows a functional block diagram of the OC12/STM4 port unit.



Control circuitry

The processor is a lowest level processor in the system control hierarchy. The processor controls and monitors the operation of the port unit. The processor also manages communication with other circuit packs via the operations network and control interface for devices (CTLI-D) interfaces.

The control circuitry also transmits/receives transport overhead bytes to/from the ADJCTL/DCCEI circuit pack via the operations network.

Memory circuitry

The OC12/STM4 port unit provides the following memory functions.

Start-up memory

The start-up memory consists of 256 kilobytes of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup or reset condition, or when initializing new software.

Operating memory

The operating memory consists of up to 16 megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).

Nonvolatile inventory memory

The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The OC12/STM4 port unit provides the following transmission functions.

Receive direction

In the receive direction, each STM-4 receiver circuit accepts one incoming STM-4 optical signal. The STM-4 optical signal is converted into an STM-4 electrical signal and the line clock and data is recovered. The STM-4 data and clock signals are sent to the TXI interface.

The TXI interface demultiplexes the STM-4 signal into 12 VC-3 signals and processes the transport and path overhead bytes. After the overhead bytes are processed, the VC-3 signals are converted into one TXI signal. The TXI interface circuit retimes the TXI signal, adjusts the pointers, and sends one TXI signal to the SWITCH/STS576 0 (or

SWITCH/STS768 0) circuit pack and one TXI signal to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

Transmit direction

In the transmit direction, each TXI interface circuit receives one TXI signal from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one TXI signal from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The TXI interface circuit selects the TXI signal and demultiplexes it into 12 VC-3 signals. The VC-3 signals are multiplexed into one STM-4 signal and transport and path overhead bytes are inserted. The STM-4 signal is then sent to the STM-4 transmitter circuit.

The STM-4 transmitter circuit converts the electrical signal into an optical 622.08 Mbit/s signal for transmission.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used. The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The OC12/STM4 port unit provides the following protection functions.

Switch fabric protection

In the receive direction, the OC12/STM4 port unit fans out two TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and two TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. In the transmit direction, the OC12/STM4 port unit receives two TXI signals from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and two TXI signals from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The OC12/STM4 port unit selects two TXI signals as active and the remaining two TXI signals are standby. If an active TXI signal fails, the OC12/STM4 port unit selects the associated standby TXI signal.

Timing reference signal protection

Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The OC12/STM4 port unit monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The OC12/STM4 port unit provides the following fault detection functions.

Monitoring and testing

The control circuit monitors all the activities on the port unit. The OC12/STM4 port unit has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or reset condition, or when initializing new software.

Loopbacks

The OC12/STM4 port unit supports nearside and farside facility loopbacks. Nearside facility loopbacks allow an incoming OC-12 line to be looped back in the port unit to the output of the same line. Farside facility loopbacks allow an outgoing OC-12 line to looped back in the port unit to the switch fabric and the outgoing line in the opposite direction.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR’d, fused, and filtered. Modular DC-to-DC converters produce +5 V and +3.3 V used on the port unit.

The OC12/STM4 port unit monitors the two power sources. If the OC12/STM4 port unit detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The OC12/STM4 port unit performs the following functions.

Receive functions

The OC12/STM4 port unit performs the following receive functions:

- Receives two optical 622.08 Mb/s OC-12/STM-4 signals
- Converts each OC-12/STM-4 signal to an electrical STS-12 signal
- Extracts and processes the transport and path overhead access bytes
- Converts each STS-12 signal into one 622.08 Mb/s TXI signal
- Sends one TXI signal to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and one TXI signal to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

Transmit functions

The OC12/STM4 port unit performs the following transmit functions:

- Receives four 622.08 Mb/s TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs and selects two TXI signals
- Processes and inserts the transport and path overhead access bytes
- Converts each 622.08 Mb/s TXI signal to an STS-12 signal
- Converts the STS-12 signal to an optical 622.08 Mb/s OC-12/STM-4 signal for transmission.

Timing and control functions

The OC12/STM4 port unit performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network
- Provides nearside and farside facility loopbacks
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the port unit faceplate FAULT and ACTIVE LEDs.

□

OC48/STM16 port unit (LEY7, LEY8 and LEY50-LEY65)

Overview

Purpose

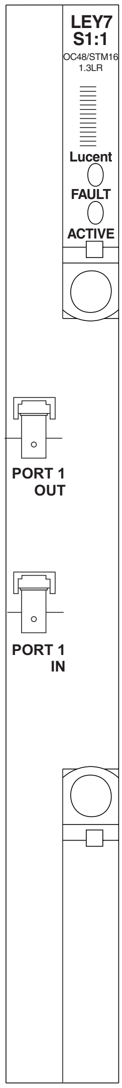
The OC48/STM16 interface (OC48/STM16) port unit provides an interface between an OC-48/STM-16 signal and four internal transmission signals. The LEY7 OC48/STM16 1.3LR1 port unit supports 1.3-m long reach applications. The LEY8 OC48/STM16 1.5LR1 port unit supports 1.5-m long reach applications. The LEY50-LEY65 OC48/STM16 port units support applications with dense wavelength division multiplexing systems.

□

OC48/STM16 port unit faceplate

Faceplate diagram

The following diagram illustrates the OC48/STM16 port unit faceplate.



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Faceplate indicators

The OC48/STM16 port unit has a red FAULT LED and a green ACTIVE LED on its faceplate.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a port unit failure is detected or the port unit loses one power feeder. The red FAULT LED flashes on and off when an incoming OC-48/STM-16 signal failure from the lightguide cross-connect panel (or equivalent) is detected.
ACTIVE LED (green)	Lights when the port unit is active/in-service.

□

OC48/STM16 port unit functions

Overview

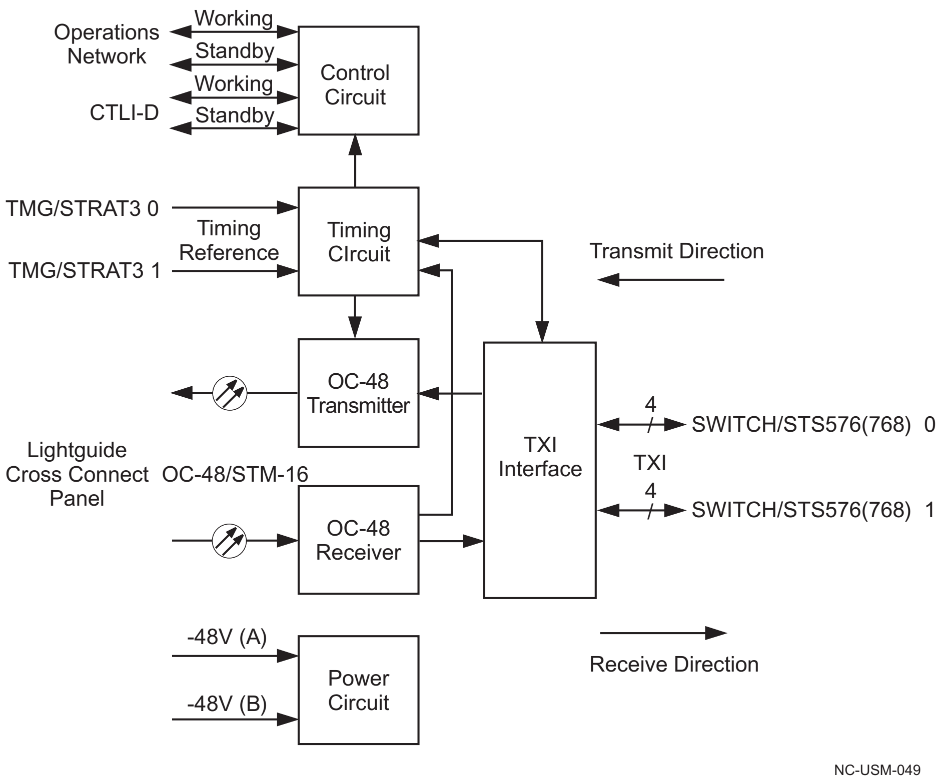
The OC48/STM16 port unit terminates one bidirectional OC-48/STM-16 line. The OC-48/STM-16 signal is converted to an electrical STS-48 signal. The STS-48 signal is demultiplexed into four 622.08 Mb/s internal transmission interface (TXI) signals. Each TXI signal supports up to 12 multiplexed VC-3 signals. The TXI signals are sent to the shelf 576x576 (SWITCH/STS576) or 768x768 (SWITCH/STS768) STS-1 switch circuit packs.

In the opposite direction, the SWITCH/STS576 (or SWITCH/STS768) circuit packs send eight TXI signals to the OC48/STM16 port unit. The OC48/STM16 port unit selects and converts four 622.08 Mb/s TXI signal into one STS-48 signal. The STS-48 signal is converted to an OC-48/STM-16 signal for transmission. The OC48/STM16 port unit also interfaces with the shelf Control/System 50DM (CTL/SYS50DM) circuit pack.

Functional block diagram

The following figure shows a functional block diagram of the OC48/STM16 port unit.

Figure 11-6 OC48/STM16 port unit functional block diagram



Control circuitry

The processor controls and monitors the operation of the port unit. The processor also manages communication with other circuit packs via the operations network and control interface for devices (CTLI-D) interfaces.

The control circuitry also transmits/receives transport overhead bytes to/from the ADJCTL/DCCEI circuit pack via the operations network.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of up to four megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The transmission circuitry is divided into

- Receive direction
  In the receive direction, the OC-48 receiver circuit accepts one incoming OC-48/STM-16 optical signal. The OC-48/STM-16 optical signal is converted into an STS-48 electrical signal and the line clock and data is recovered. The STS-48 signal is demultiplexed into sixteen 155.52 Mb/s signals and sent to the overhead byte processor. After the overhead bytes are processed, the STS-48 signal is converted into four TXI signals and sent to

the TXI interface circuit. The TXI interface circuit retimes the TXI signals, adjusts the pointers, and sends four TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and four TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

- Transmit direction
  In the transmit direction, the TXI interface circuit receives four TXI signals from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and four TXI signals from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The TXI interface circuit selects four TXI signals and sends them to the OC-48 transmitter circuit. The OC-48 transmitter circuit sends the four TXI signals to overhead byte processor. The four TXI signals are converted into an STS-48 signal and the overhead bytes are inserted. The STS-48 signal is converted into an optical 2.488 Gb/s OC-48/STM-16 signal for transmission.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The protection circuitry consists of

- Switch fabric protection
  In the receive direction, the OC48/STM16 port unit fans out four TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and four TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. In the transmit direction, the OC48/STM16 port unit receives four TXI signals from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and

four TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The OC48/STM16 selects the one group of four TXI signals as active and the other group as standby. If the active group fails, the OC48/STM16 port unit selects the standby group of TXI signals.

- Timing reference signal protection
  Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The OC48/STM16 port unit monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The control circuit monitors all the activities on the port unit. The OC48/STM16 port unit has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V, +3.3 V, –3.3 V, and –5.2 V used on the port unit.

The OC48/STM16 port unit monitors the two –48 V power sources. If the OC48/STM16 port unit detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The OC48/STM16 port unit performs the following functions:

Receive functions

The OC48/STM16 port unit performs the following receive functions:

- Receives one optical 2.448 Mb/s OC-48/STM-16 signal
- Converts the OC-48/STM-16 signal to an electrical STS-48 signal
- Extracts and processes the overhead access bytes
- Demultiplexes the STS-48 signal into four 622.08 Mb/s TXI signals
- Sends four TXI signals to SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and four TXI signals to SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

Transmit functions

The OC48/STM16 port unit performs the following transmit functions:

- Receives eight 622.08 Mb/s TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs and selects four TXI signals
- Processes and inserts overhead access bytes
- Multiplexes four 622.08 Mb/s TXI signals to an STS-48 signal
- Converts the STS-48 signal to an optical 2.448 Mb/s OC-48/STM-16 signal for transmission.

Timing and control functions

The OC48/STM16 port unit performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs
- Selects the working or standby TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs
- Provides a 25.92-MHz reference signal to TMG/STRAT3 circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the port unit faceplate FAULT and ACTIVE LEDs.

□

OC48/STM16 port unit (LEY182)

Overview

Purpose

This section provides detailed information concerning all OC48/STM16 port units available for use with the WaveStar® TDM 10G (STM64).

□

OC48/STM16 port unit functions

Overview

This data sheet contains technical specifications for the OC48/STM16/1.3VSR1 (very short-reach) port units that are used in WaveStar® TDM 10G (STM64).

Capacity

Each OC48/STM16/1.3VSR1 port unit supports one bidirectional (one receive and one transmit) OC-48 formatted optical signal. The capacity may be translated to 48 STS-1 equivalents or 32,256 two-way voice circuits per port unit.

OC-48 access

The table below describes OC-48 capabilities

Specification	Description
Interface	very short-reach (1-2 km) interface
Growth Increment	One OC-48 per port unit
Line Code	Scrambled NRZ

Protection switching

The table below describes protection switching information per high speed line.

Specification	Description
Switching Bit Error Rate (BER)	10-3 to 10-9 (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER >10-3 line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/1.3VSR1 port unit, is Class IIIB in the FDA/CDRH Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/1.3VSR1 port units is 300 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC48/STM16/1.3VSR1 port units.

Specification	Description
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–14.0 dB

Maximum discrete reflectance	–14.0 dB

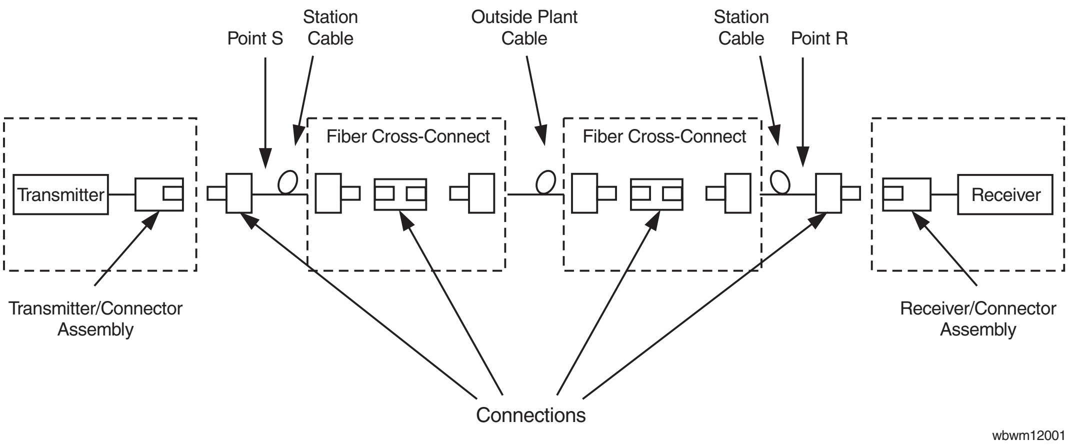
Transmissie specification

The table below provides transmission specifications for the OC48/STM16/1.3VSR1 port units.

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gb/s Output: 2.488 Gb/s
Transmitter Wavelengths	Minimum: 1280 nm Maximum: 1335 nm
Spectral Width	3.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser

Optical system interfaces

The figure below illustrates the optical path between the transmitter and the receiver.



Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the OC48/STM16/1.3VSR1 port units.

Parameter	OC48/STM16/ 1.3VSR1 Port Unit (a)
Maximum Transmitter Output Power (PTmax) (b)	-1.0 dBm
Minimum Transmitter Output Power (PTmin) (c)	-6.0 dBm
Maximum Received Power (PRmax)(d)	-1.0 dBm
Receiver Sensitivity (PRmin) (c) (d)	-14.0 dBm
Minimum System Gain (S-R)	5.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget (e)	0.0 dB
Maximum Loss Budget(f)	4.0 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar TDM 2.5G/10G (2-Fiber) complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber. (b) Transmit and receive points are referenced as points S and R in Figure B-6. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins. (d) These values are measured at a BER of 1x10(-12). (e) This value assumes that the maximum received power limitations are not exceeded. (f) Loss is dispersion limited and not power limited.

□

OC48/STM16 port unit (LEY101–LEY180)

Overview

Purpose

This section provides detailed information concerning all OC48/STM16/WDM port units available for use with the WaveStar® TDM 10G (STM64).

□

OC48/STM16 port unit functions

Overview This data sheet contains technical specifications for the OC48/STM16/WDM port units that are used in WaveStar® TDM 10G (STM64).

Capacity Each OC48/STM16/WDM port unit supports one bidirectional (one receive and one transmit) OC-48 formatted, ITU-compatible optical signal. The capacity may be translated to 48 STS-1 equivalents or 32,256 two-way voice circuits per port unit.

OC-48 access The table below describes OC-48 capabilities

Specification	Description
Interface	Long-reach (80 km) interface (a)
Growth Increment	One OC-48 per port unit
Line Code	Scrambled NRZ

Notes:

1. (a) This number is tipical value.

Protection switching The table below describes protection switching information per high speed line.

Specification	Description
Switching Bit Error Rate (BER)	10-3 to 10-9 (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER >10-3 line signal failure)

Optical safety Optical safety data on laser-containing port units, such as the OC48/STM16/WDM port unit, is Class I in the FDA/CDRH Classification System.

Optical dispersion The optical dispersion for the OC48/STM16/WDM port units is 1800 ps/nm.

Optical return loss The table below provides the optical return loss for a system using OC48/STM16/WDM port units.

Specification	Description

Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmissie specification

The table below provides transmission specifications for the OC48/STM16/WDM port units.

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gb/s Output: 2.488 Gb/s
Transmitter Wavelengths	Minimum: 1549 nm Maximum: 1560 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser

Optical wavelength

The table below lists the operating wavelengths for the OC48/STM16/WDM port units.

Item Code	Port Unit	Wavelength (nm)
LEY101	OC48/STM16/WDM9585	1530.72
LEY102	OC48/STM16/WDM9580	1531.11
LEY103	OC48/STM16/WDM9575	1531.50
LEY104	OC48/STM16/WDM9570	1531.89
LEY105	OC48/STM16/WDM9565	1532.28
LEY106	OC48/STM16/WDM9560	1532.68
LEY107	OC48/STM16/WDM9555	1533.07
LEY108	OC48/STM16/WDM9550	1533.46
LEY109	OC48/STM16/WDM9545	1533.85
LEY110	OC48/STM16/WDM9540	1534.25

LEY111	OC48/STM16/WDM9535	1534.64
LEY112	OC48/STM16/WDM9530	1535.03
LEY113	OC48/STM16/WDM9525	1535.42
LEY114	OC48/STM16/WDM9520	1535.82
LEY115	OC48/STM16/WDM9515	1536.21
LEY116	OC48/STM16/WDM9510	1536.60
LEY117	OC48/STM16/WDM9505	1537.00
LEY118	OC48/STM16/WDM9500	1537.39
LEY119	OC48/STM16/WDM9495	1537.79
LEY120	OC48/STM16/WDM9490	1538.18
LEY121	OC48/STM16/WDM9485	1538.58
LEY122	OC48/STM16/WDM9480	1538.97
LEY123	OC48/STM16/WDM9475	1539.37
LEY124	OC48/STM16/WDM9470	1539.76
LEY125	OC48/STM16/WDM9465	1540.16
LEY126	OC48/STM16/WDM9460	1540.55
LEY127	OC48/STM16/WDM9455	1540.95
LEY128	OC48/STM16/WDM9450	1541.34
LEY129	OC48/STM16/WDM9445	1541.74
LEY130	OC48/STM16/WDM9440	1542.14
LEY131	OC48/STM16/WDM9435	1542.53
LEY132	OC48/STM16/WDM9430	1542.93
LEY133	OC48/STM16/WDM9425	1543.33
LEY134	OC48/STM16/WDM9420	1543.73
LEY135	OC48/STM16/WDM9415	1544.12
LEY136	OC48/STM16/WDM9410	1544.52
LEY137	OC48/STM16/WDM9405	1544.92
LEY138	OC48/STM16/WDM9400	1545.32
LEY139	OC48/STM16/WDM9395	1545.72
LEY140	OC48/STM16/WDM9390	1546.11
LEY141	OC48/STM16/WDM9385	1546.51
LEY142	OC48/STM16/WDM9380	1546.91
LEY143	OC48/STM16/WDM9375	1547.31
LEY144	OC48/STM16/WDM9370	1547.71

LEY145	OC48/STM16/WDM9365	1548.11
LEY146	OC48/STM16/WDM9360	1548.51
LEY147	OC48/STM16/WDM9355	1548.91
LEY148	OC48/STM16/WDM9350	1549.31
LEY149	OC48/STM16/WDM9345	1549.71
LEY150	OC48/STM16/WDM9340	1550.11
LEY151	OC48/STM16/WDM9335	1550.11
LEY152	OC48/STM16/WDM9330	1550.91
LEY153	OC48/STM16/WDM9325	1551.31
LEY154	OC48/STM16/WDM9320	1551.72
LEY155	OC48/STM16/WDM9315	1552.12
LEY156	OC48/STM16/WDM9310	1552.52
LEY157	OC48/STM16/WDM9305	1552.92
LEY158	OC48/STM16/WDM9300	1553.32
LEY159	OC48/STM16/WDM9295	1553.73
LEY160	OC48/STM16/WDM9290	1554.13
LEY161	OC48/STM16/WDM9285	1554.53
LEY162	OC48/STM16/WDM9280	1554.94
LEY163	OC48/STM16/WDM9275	1555.34
LEY164	OC48/STM16/WDM9270	1555.74
LEY165	OC48/STM16/WDM9265	1556.15
LEY166	OC48/STM16/WDM9260	1556.55
LEY167	OC48/STM16/WDM9255	1556.95
LEY168	OC48/STM16/WDM9250	1557.36
LEY169	OC48/STM16/WDM9245	1557.76
LEY170	OC48/STM16/WDM9240	1558.17
LEY171	OC48/STM16/WDM9235	1558.57
LEY172	OC48/STM16/WDM9230	1558.98
LEY173	OC48/STM16/WDM9225	1559.38
LEY174	OC48/STM16/WDM9220	1559.79
LEY175	OC48/STM16/WDM9215	1560.20
LEY176	OC48/STM16/WDM9210	1560.60
LEY177	OC48/STM16/WDM9205	1561.01
LEY178	OC48/STM16/WDM9200	1561.41

LEY179	OC48/STM16/WDM9195	1561.82
LEY180	OC48/STM16/WDM9190	1562.23

Optical requirements and loss budgets

Because OC48/STM16/WDM9190-9585 port units interface with Metropolis EON, refer to the Metropolis EON Applications and Planning Guide (365-575-300) to calculate loss budgets.

□

OC48/STM16 port unit (LEY80–LEY95)

Overview

Purpose

This section provides detailed information concerning all OC48/STM16/POU port units available for use with the WaveStar TDM 2.5G/10G (2-Fiber).

□

OC48/STM16 port unit functions

Overview

This data sheet contains technical specifications for the OC48/STM16/POU port units that are used in WaveStar TDM 2.5G/10G (2-Fiber).

Capacity

Each OC48/STM16/POU port unit supports one bidirectional (one receive and one transmit) OC-48 formatted, ITU-compatible optical signal. The capacity may be translated to 48 STS-1 equivalents or 32,256 two-way voice circuits per port unit.

OC-48 access

The table below describes OC-48 capabilities

Specification	Description
Interface	Long-reach (80 km) interface(a)
Growth Increment	One OC-48 per port unit
Line Code	Scrambled NRZ

Notes:

1. (a) This number is a typical value.

Protection switching

The table below describes protection switching information per high speed line.

Specification	Description
Switching Bit Error Rate (BER)	10-3 to 10-9 (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER >10-3 line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/POU port units, is Class I in the FDA/CDRH Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/POU port units is 2400 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC48/STM16/POU port units.

Specification	Description

Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specification

The table below provides transmission specifications for the OC48/STM16/POU port units.

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gb/s Output: 2.488 Gb/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1561 nm
Spectral Width	0.2 nm (RMS)
Optical Source	Electro-absorptive Modulated Laser (EML)

Notes:

1. (a) Refer to Table B-40 for a complete list of the operating wavelengths.

Operating wavelength

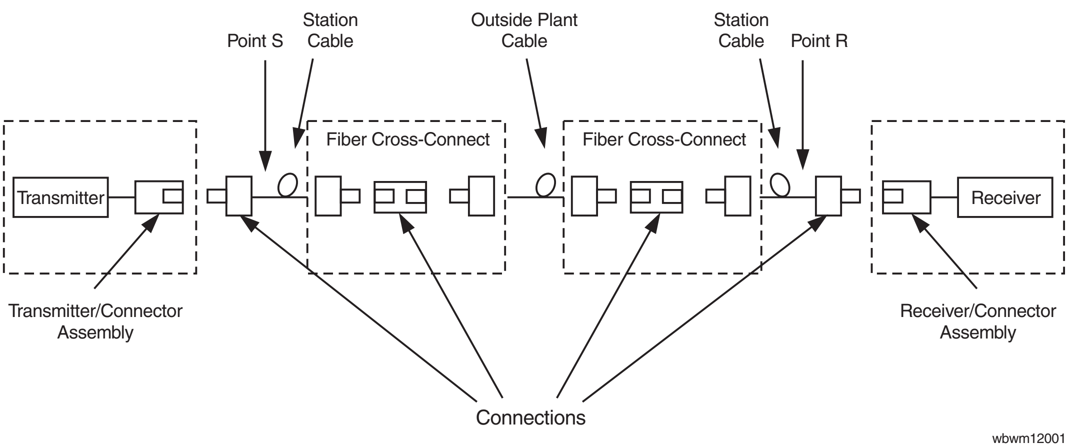
The table below lists the operating wavelengths for the OC48/STM16/POU port units.

Item Code	Port Unit	Channel	Wavelength (nm)
LEY80	OC48/STM16/POU9590	1	1530.33
LEY81	OC48/STM16/POU9570	2	1531.90
LEY82	OC48/STM16/POU9550	3	1533.47
LEY83	OC48/STM16/POU9530	4	1535.04
LEY84	OC48/STM16/POU9490	5	1538.19
LEY85	OC48/STM16/POU9470	6	1539.77

LEY86	OC48/STM16/POU9450	7	1541.35
LEY87	OC48/STM16/POU9430	8	1542.94
LEY88	OC48/STM16/POU9370	9	1547.72
LEY89	OC48/STM16/POU9350	10	1549.32
LEY90	OC48/STM16/POU9330	11	1550.92
LEY91	OC48/STM16/POU9310	12	1552.52
LEY92	OC48/STM16/POU9270	13	1555.75
LEY93	OC48/STM16/POU9250	14	1557.36
LEY94	OC48/STM16/POU9230	15	1558.98
LEY95	OC48/STM16/POU9210	16	1560.61

Optical system interfaces

The figure below illustrates the optical path between the transmitter and the receiver.



Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the OC48/STM16/POU port units.

Parameter	OC48/STM16/ POU Port Unit (a) with 16ch-mux and 16ch-dmux	OC48/STM16/POU Port Unit (a) with 32ch-mux and 32ch-dmux (consists of 16ch-mux/dmux+16ch-muxint/dmuxint)
Maximum Transmitter Output Power (PTmax) (b)	-0.2 dBm	-0.2 dBm

Minimum Transmitter Output Power (PTmin) (c)	-2.8 dBm	-2.8 dBm
Maximum Received Power (PRmax)(d)	-9 dBm	-9 dBm
Receiver Sensitivity (PRmin) (c) (d)	-28.0 dBm	-28.0 dBm
Minimum System Gain (S-R)	25.2 dB	25.2 dB
Optical Path Penalty (PO)	1.0 dB	1.0 dB
Mux/Demux insertion loss	6.4 dB	10.2 dB
Maximum Loss Budget	17.8 dB	14.0 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar TDM 2.5G/10G (2-Fiber) complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber. (b) Transmit and receive points are referenced as points S and R in Figure B-9. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins. (d) These values are measured at a BER of 1x10-12.

□

OC192/STM64 port unit (LEY69, LEY97, LEY201...240)

Overview

Purpose

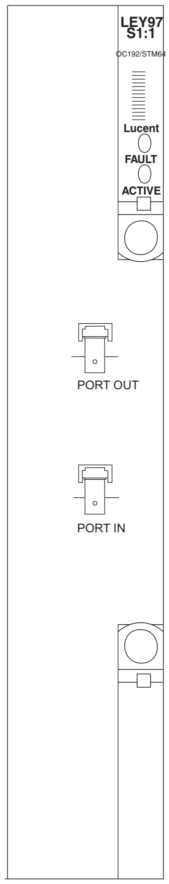
The OC192/STM64 port unit supports one bidirectional (one receive and one transmit) STM-64 formatted optical signal connection to a 2-fiber STM-64 multiplex section shared protection ring (MS-SPRing). The capacity may be translated to 64 STM-1 equivalents or 129,024 2-way voice circuits per fiber. The OC192/STM64 port unit supports standard SDH signals over 1.5 m fiber spans of up to 52 km with Forward Error Correction (FEC) and up to 40 km without FEC. For more details on optical parameters, please refer to Appendix B.

□

OC192/STM64 port unit faceplate

Faceplate diagram

The following diagram illustrates the OC192/STM64 port unit faceplate.



NC10G039

Faceplate indicators

The OC192/STM64 port unit has a red FAULT LED and a green ACTIVE LED on its faceplate.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a port unit failure is detected or the port loses one power feeder. The red FAULT LED flashes on and off when an incoming OC-192/STM-64 signal failure from the lightguide cross-connection panel (or equivalent) is detected.
ACTIVE LED (green)	Lights when the port unit is active/in-service.

OC192/STM64 port unit functions

Overview

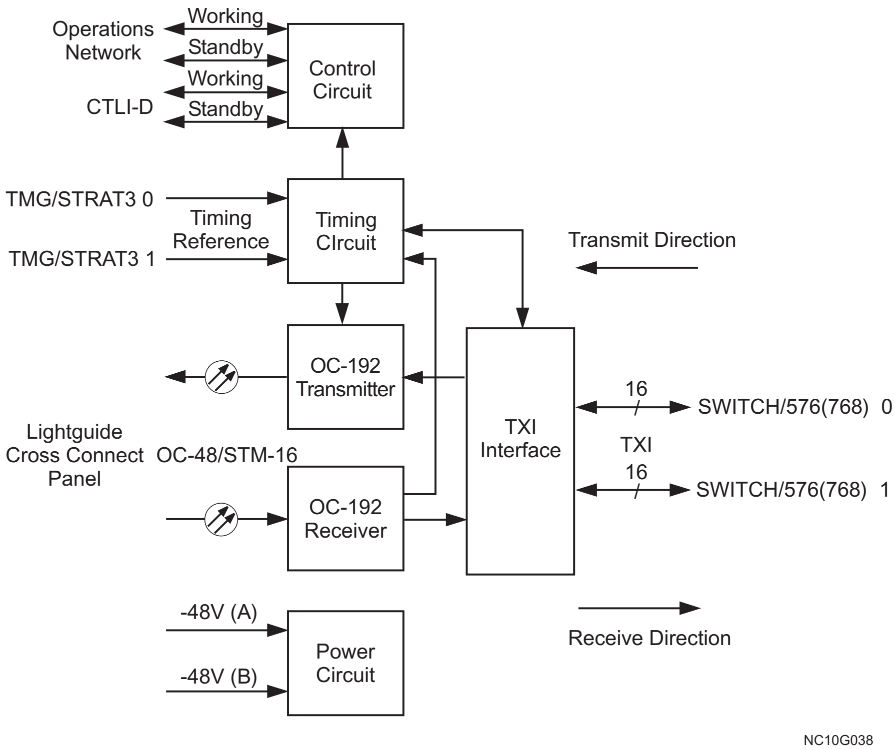
The OC192/STM64 port unit terminates one bidirectional OC-192/STM-64 line. The OC-192/STM-64 optical signal is converted to an electrical STS-192 signal. The STS-192 signal is demultiplexed into 16 STS-1 signals and each is converted to a 622.08 Mb/s internal transmission interface (TXI) signal. Each TXI signal supports up to 12 multiplexed VC-3 signals. The TXI signals are sent to the shelf 576x576 (SWITCH/STS576) or 768x768 (SWITCH/STS768) STS-1 Switch circuit packs.

In the transmit direction, the SWITCH/STS576 (or SWITCH/STS768) circuit packs send 16 working TXI signals to the OC192/STM64 port unit. The OC192/STM64 port unit converts each working 622.08 Mb/s TXI signal into 16 STS-1 signals. The STS-1 signals are multiplexed into one electrical STS-192 signal and converted to an OC-192 optical signal for transmission. The OC192/STM64 port unit also interfaces with the shelf Control/ System 50DM (CTL/SYS50DM) circuit pack.

Functional block diagram

The following figure shows a functional block diagram of the OC192/STM64 port unit.

Figure 11-7 OC192/STM64 port unit functional block diagram



Control circuitry

The processor controls and monitors the operation of the port unit. The processor also manages communication with other circuit packs via the operations network and control interface for devices (CTLI-D) interfaces. The control circuitry also transmits/receives transport overhead bytes to/from the ADJCTL/DCCEI circuit pack via the operations network.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of up to four megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The transmission circuitry is divided into

- Receive direction
  In the receive direction, each OC-192 receiver circuit accepts one incoming OC-192/STM-64 optical signal. The 9.953 Gb/s optical signal is converted into one 9.953 Gb/s electrical STS-192 signal and the line clock and data are recovered. The TXI interface demultiplexes the STS-192 signal into 16 STS-12 signals and processes the transport and path overhead bytes. After the overhead bytes are processed, the 16 STS-12 signals are

converted into TXI signals. The TXI interface circuit retimes the TXI signals, adjusts the pointers, and sends 16 TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and 16 TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

- Transmit direction
  In the transmit direction, each TXI interface circuit receives 16 TXI signals from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and 16 TXI signals from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The TXI interface circuit selects each working TXI signal and demultiplexes it into 16 STS-12 signals. The STS-12 signals are multiplexed into one 9.953 Gb/s STS-192 electrical signal and transport and path overhead bytes are inserted. The STS-192 signal is then sent to the OC-192 transmitter circuit. The OC-192 transmitter circuit converts the STS-192 electrical signal into an optical 9.953 Gb/s OC-192 signal for transmission.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The protection circuitry consists of

- Control complex protection
  Control complex protection is performed by selecting the working or standby operations network and CTLI-D signals. The OC192/STM64 port unit monitors these signals and can select the working or standby signals. The CTL/SYS50DM circuit pack can inhibit this selection and make its own selection.
- Switch fabric protection
  In the receive direction, the OC192/STM64 port unit fans out 16 TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and 16 TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. In the transmit direction, the OC192/STM64 port unit receives 16 TXI signals from the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and 16

TXI signals from the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack. The OC192/STM64 port unit selects 16 TXI signals as active and the remaining 16 TXI signals are standby. If an active TXI signal fails, the OC192/STM64 port unit selects the associated standby TXI signal.

- Timing reference signal protection
  Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The OC192/STM64 port unit monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The control circuit monitors all the activities on the port unit. The OC192/STM64 port unit has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or a reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR’d, fused, and filtered. Modular DC-to-DC converters produce +5 V, +3.3 V, –3.3 V, and –5.2 V used on the port unit.

A soft start feature is provided to control excessive power surges to the -48V supplies upon shelf power-up. A power off feature is provided to allow remote power down of the circuit pack by the active or standby CTL/SYS50D circuit pack.

The OC192/STM64 port unit monitors the two –48 V power sources. If the OC192/STM64 port unit detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Quick reference summary

The OC192/STM64 port unit performs the following functions:

Receive functions

The OC192/STM64 port unit performs the following receive functions:

- Receives one optical 9.953 Gb/s OC-192/STM-64 signal
- Converts each OC-192 signal to one 9.953 Gb/s electrical STS-192 signal
- Extracts and processes the transport and path overhead access bytes

- Converts each STS-192 signal into sixteen 622.08 Mb/s TXI signals
- Sends 16 TXI signals to the SWITCH/STS576 0 (or SWITCH/STS768 0) circuit pack and 16 TXI signals to the SWITCH/STS576 1 (or SWITCH/STS768 1) circuit pack.

Transmit functions

The OC192/STM64 port unit performs the following transmit functions:

- Receives thirty two 622.08 Mb/s TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs and selects 16 TXI signals
- Processes and inserts the transport and path overhead access bytes
- Converts the sixteen 622.08 Mb/s TXI signals to one 9.953 Gb/s electrical STS-192 signal
- Converts the STS-192 signal to an optical 9.953 Gb/s OC-192/STM-64 signal for transmission.

Timing and control functions

The OC192/STM64 port unit performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/ STRAT3 circuit packs
- Selects the working or standby TXI signals from the SWITCH/STS576 (or SWITCH/STS768) circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network
- Stores inventory information (for example, the CLEI code and serial number)
- Controls the port unit faceplate FAULT and ACTIVE LEDs.

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OC192/STM64/POU port unit (LEY284–LEY299)

Overview

Purpose

This section provides detailed information concerning all OC192/STM64/POU passive port units available for use in combination with the Metropolis® passive WDM system.

☐

OC192/STM64/POU port unit functions

Overview

This data sheet contains technical specifications for the OC192/STM64/POU passive port units that are used in WaveStar® TDM 10G (STM64).

Capacity

Each OC192/STM64/POU port unit supports one bidirectional (one receive and one transmit) OC-192 formatted optical signal. The capacity may be translated to 192 STS-1 equivalents or 129,024 two-way voice circuits per port unit.

OC-192 access

The table below describes OC-192 capabilities

Specification	Description
Interface	Short-reach (40 km) interface
Growth Increment	One OC-192 per port unit
Line Code	Scrambled NRZ

Notes:

1. (a) This number is a typical value.

Protection switching

The table below describes protection switching information per high speed line.

Specification	Description
Switching Bit Error Rate (BER)	10-3 to 10-9 (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER >10-3 line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/POU port unit, is Class I in the FDA/CDRH Classification System

Optical dispersion

The optical dispersion for the OC192/STM64/POU port units is 1200 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC192/STM64/POU port units.

Specification	Description

Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specification

The table below provides transmission specifications for the OC192/STM64/POU port units.

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 9.953 Gb/s Output: 9.953 Gb/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1565 nm
Spectral Width	0.07 nm (RMS)
Optical Source	CW(a) Laser with a Mach-Zender Modulator

Notes:

1. (a) Continuous Wave

Operating wavelength

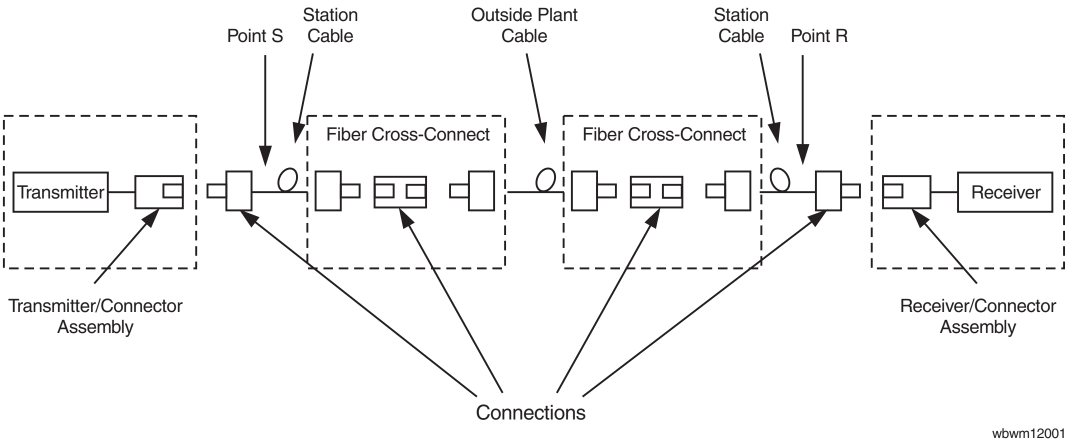
The table below lists the operating wavelengths for the OC192/STM64/POU port units.

Item Code	Port Unit	f (THz)	Wavelength (nm)
LEY284AE	OC192/STM64/ POU9590	195.90	1530.334
LEY285AE	OC192/STM64/ POU9570	195.70	1531.898
LEY286AE	OC192/STM64/ POU9550	195.50	1533.465
LEY287AE	OC192/STM64/ POU9530	195.30	1535.036
LEY288AE	OC192/STM64/ POU9490	194.90	1538.186

Item Code	Port Unit	f (THz)	Wavelength (nm)
LEY289AE	OC192/STM64/ POU9470	194.70	1539.766
LEY290AE	OC192/STM64/ POU9450	194.50	1541.349
LEY291AE	OC192/STM64/ POU9430	194.30	1542.936
LEY292AE	OC192/STM64/ POU9370	193.70	1547.715
LEY293AE	OC192/STM64/ POU9350	193.50	1549.315
LEY294AE	OC192/STM64/ POU9330	193.30	1550.918
LEY295AE	OC192/STM64/ POU9310	193.10	1552.524
LEY296AE	OC192/STM64/ POU9270	192.70	1555.747
LEY297AE	OC192/STM64/ POU9250	192.50	1557.363
LEY298AE	OC192/STM64/ POU9230	192.30	1558.983
LEY299AE	OC192/STM64/ POU9210	192.10	1560.606

Optical system interfaces

The figure below illustrates the optical path between the transmitter and the receiver.



Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the O192/STM64/POU port units.

Parameter	OC192/STM64/ POU Port Unit (a) with 16ch-mux and 16ch-dmux	OC192/STM64/POU Port Unit (a) with 32ch-mux and 32ch-dmux (consists of 16ch-mux/dmux+16ch-muxint/dmuxint)
Maximum Transmitter Output Power (PTmax) (b)	2.0 dBm	2.0 dBm
Minimum Transmitter Output Power (PTmin) (c)	-1.0 dBm	-1.0 dBm
Maximum Received Power (PRmax)(d)	-8.0 dBm	-8.0 dBm
Receiver Sensitivity (PRmin) (c) (d)	-21.0 dBm	-21.0 dBm
Minimum System Gain (S-R)	20.0 dB	20.0 dB
Optical Path Penalty (PO)	2.0 dB	2 dB
Mux/Demux insertion loss	6.4 dB	10.2 dB
Maximum Loss Budget	11.6 dB	7.8 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar TDM 2.5G/10G (2-Fiber) complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber. (b) Transmit and receive points are referenced as points S and R in Figure B-3. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins. (d) These values are measured at a BER of 1x10-12.

□

Optical Booster Amplifier (SEN3)

Overview

Purpose

The Optical Booster Amplifier (OBA) can be used as an option in the WaveStar® TDM 10G (STM-64) network element on the transmit side for amplification of the optical STM-64 signal output from the LEY69 or LEY97 port unit. Thus, fiber spans of up to 80 km can be reached. For more details on optical parameters, please refer to Appendix B.

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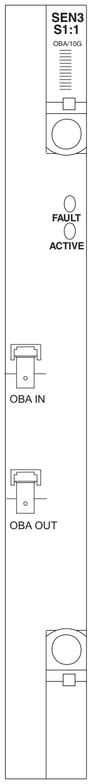
OBA faceplate

Faceplate diagram

The following diagram illustrates the Optical Booster Amplifier faceplate.



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Faceplate indicators

The OBA circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected or the port loses one power feeder. The red FAULT LED flashes on and off when an incoming OC-192/STM-64 signal failure from the lightguide cross-connection panel (or equivalent) is detected.
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.

OBA functions

Overview

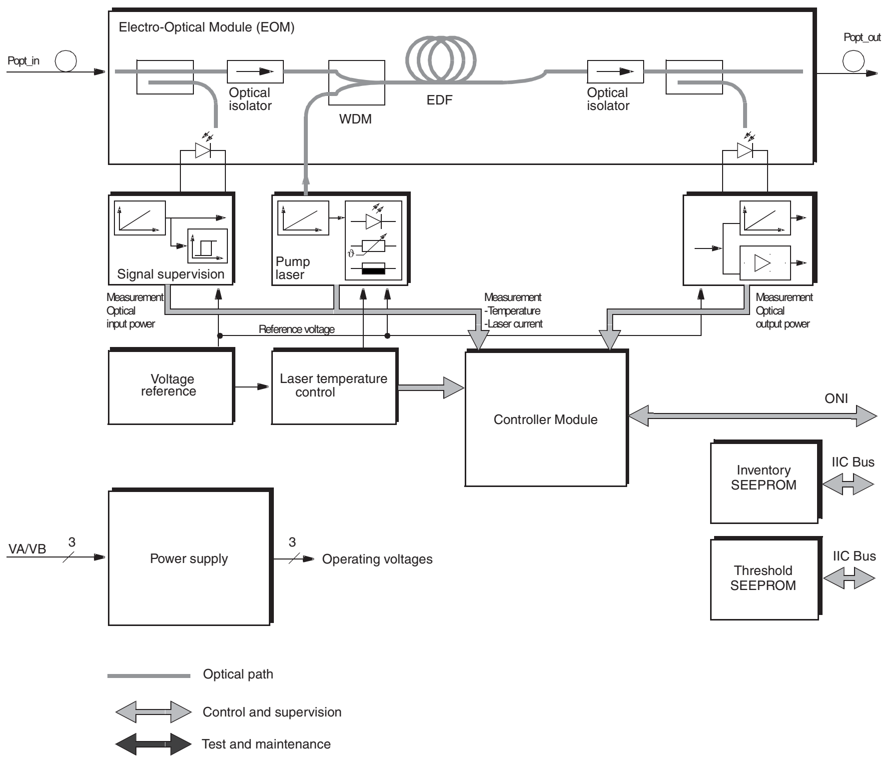
The OBA has the following main tasks:

- Amplification of an optical OC-192/STM-64 signal at 1550 nm
- Supervision of the optical signal and the plug-in unit hardware
  - Detection of Loss of Signal (LOS)
  - Supervision of pump source
  - Provision of a signalling interface to the system controller in the network element.

Functional block diagram

The following figure shows a functional block diagram of the OBA.

Figure 11-8 OBA circuit pack functional block diagram



Control circuitry

The processor controls and monitors the operation of the circuit pack. The processor also manages communication with other circuit packs via the operations network and control interface for devices (CTLI-D) interfaces. For more information about the operations network and CTLI-D, refer to ***Chapter 4, Control Architecture***.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of 16 megabytes of dynamic random access memory (SDRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.
- Nonvolatile threshold memory
  The nonvolatile threshold memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the thresholds for alarm detection on optical and electrical signals.

Transmission circuitry

The transmission circuitry mainly consits of the Electro-Optical Module (EOM). The incoming optical signal (Popt_in) passes directly to the Electro-Optical Module (EOM).

A small part of the detected data signal is tapped off using a non-polarised optical coupler at both the optical signal input and the optical signal output of the EOM. Following optical/electrical conversion using a photodiode, this part of the signal passes via the signal supervision function block to the controller module. The optical signal in the main path is fed via an optical isolator to the actual amplifier. The signal power together with the pump power is fed to the heart of the amplifier, the Erbium-Doped Fibre (EDF), using Wavelength Division Multiplexers (WDM). The EDF amplifies the input signals (1550 nm) due to stimulated emission. The erbium ions provide the active medium, which is excited by radiation of a smaller wavelength. This radiation is provided by one pump laser.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used. The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal which is used by the board controller module. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Pump Laser

Semiconductor lasers are used as pump lasers. Effects on the OBA output power due to temperature and ageing are compensated by a controller. Such a control block that controls the injection current is assigned to the pump laser.

Signal Supervision

The signal supervision blocks amplify the electrical signal provided by the supervision photodiodes in the Electro-Optical Module and pass it as measurements to the A/D converter on the controller module. The current optical input power is calculated from the photodiode current at the input and the current optical output power from the photodiode current at the output.

Laser Temperature

The chip temperature of the semiconductor laser must be maintained within specified limits in operation. The Peltier element built into the laser module is connected to a control circuit for this purpose.

Fault detection circuitry

The control circuit monitors all the activities on the circuit pack. The OBA has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or a reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V, +3.3 V, and –5 V used on the port unit.

The OBA circuit pack monitors the two –48 V power sources. If the OBA detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the port unit faceplate.

Optical Interfaces

Lightguide Buildouts (LBO) are used to provide the optical input and output interface. SC and FC/PC type connectors are allowed.

Quick reference summary

The OBA circuit pack performs the following functions:

- Amplification of an optical OC-192/STM-64 signal at 1550 nm
- Supervision of the optical signal and the plug-in unit hardware
  - Detection of Loss of Signal (LOS)
  - Supervision of pump source
  - Provision of a signalling interface to the system controller in the network element.

□

Optical Booster and Pre-Amplifier (SEN4)

Overview

Purpose

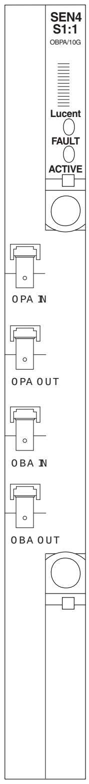
The 10G Optical Booster and Pre-Amplifier (OBPA10G, SEN4) circuit pack optically amplifies one outgoing OC-192/STM-64 signal (9.95328 Gb/s) and optically pre-amplifies one incoming OC-192/STM-64 signal.

□

OBPA Faceplate

Faceplate layout

The following diagram illustrates the Optical Booster and Pre-Amplifier faceplate.



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Faceplate LEDs

The OBPA10G circuit pack provides the following faceplate LEDs.

LED	Color	Function
FAULT	Red	Continuously lighted when a circuit pack failure is detected or the circuit pack loses one power feeder. Flashes on and off when an incoming signal failure is detected.
ACTIVE	Green	Lighted when the circuit pack is active/in-service.

OBPA10G Circuit Pack Functions

General description of operation

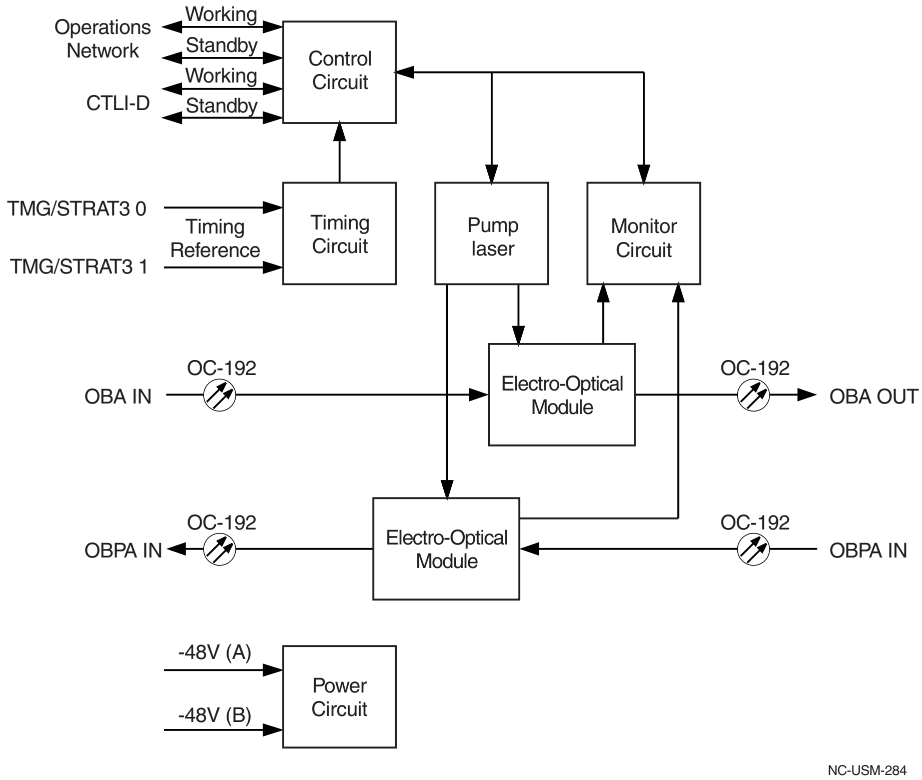
The OBPA10G circuit pack optically amplifies one outgoing OC-192/STM-64 signal. The wavelength of the outgoing OC-192/STM-64 signal (from an OC192/STM64 port unit) must be 1552.52 nanometers. The OC-192/STM-64 signal is optically amplified and retransmitted.

The OBPA10G circuit pack also optically pre-amplifies one incoming OC-192/STM-64 signal. The wavelength of the incoming OC-192/STM-64 signal must be 1552.52 nanometers and the low frequency tone must be 197.557 kHz.

The OBA10G circuit pack also interfaces with the Control/System 50DM (CTL/SYS50DM) circuit pack.

Functional block diagram

The following figure shows a functional block diagram of the OBPA10G circuit pack.



Control circuitry

The processor is the lowest level processor in the system control hierarchy. The processor controls and monitors the operation of the circuit pack. The processor also manages communication with other circuit packs via the operations network and the control interface for devices (CTLI-D) interfaces.

Memory circuitry

The OBPA10G circuit pack provides the following memory functions.

Start-up memory

The start-up memory consists of one megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup or reset condition, or when initializing new software.

Operating memory

The operating memory consists of up to 16 megabytes of synchronous dynamic random access memory (SDRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).

Nonvolatile inventory memory

The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile inventory memory is used to store information about the circuit pack history such as the ***CLEI*** code and type/version information.

Nonvolatile threshold memory

The nonvolatile threshold memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile threshold memory is used to store information about the thresholds used for fault detection.

Transmission circuitry

The OBPA10G circuit pack provides the following transmission functions.

Optical booster amplifier

The OBPA10G circuit pack accepts one 1552.52-nanometer OC-192/STM-64 signal (OBA IN). Fiber access to the OBPA10G circuit pack is via fixed SC-type buildout blocks and a removable ST-type, SC-type, or FC type lightguide buildouts on the circuit pack faceplate. Lightguide buildouts are chosen based on the attenuation desired and the type of connector interface.

Pump lasers provide the power for optical amplification. The incoming OC-192/STM-64 signal passes through erbium-doped fiber. The erbium-doped fiber is also driven with a 980-nm optical signal from the pump laser. The erbium-doped fiber transfers energy from the 980-nm pump laser signal to the OC-192/STM-64 signal and the amplified OC-192/STM-64 signal is retransmitted (OBA OUT).

The OBPA10G circuit pack output is switched off if the circuit pack does not receive an input OC-192/STM-64 signal.

Optical pre-amplifier

The OBPA10G circuit pack accepts one 1552.52-nanometer OC-192/STM-64 signal (OBPA IN). Fiber access to the OBPA10G circuit pack is via fixed SC-type buildout blocks and a removable ST-type, SC-type, or FC type lightguide buildouts on the circuit pack faceplate. Lightguide buildouts are chosen based on the attenuation desired and the type of connector interface.

Pump lasers provide the power for optical amplification. The incoming OC-192/STM-64 signal passes through erbium-doped fiber. The erbium-doped fiber is also driven with a 980-nm optical signal from the pump laser. The erbium-doped fiber transfers energy from the 980-nm pump laser signal to the OC-192/STM-64 signal and the amplified OC-192/STM-64 signal is retransmitted (OBPA OUT).

The OBA10G circuit pack output is switched to a low level to avoid high transient power levels if the circuit pack does not receive an input OC-192/STM-64 signal.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used. The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The OBPA10G circuit pack monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The control circuit monitors all the activities on the circuit pack. The OBPA10G circuit pack has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed whenever the OBPA10G circuit pack is inserted in a slot or reset.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular

DC-to-DC converters produce +5 V, +3.3 V and –5 V used on the circuit pack.

The OBPA10G circuit pack monitors the two power sources. If the OBPA10G circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The OBPA10G circuit pack performs the following functions.

Transmission functions

The OBPA10G circuit pack performs the following transmission functions:

- Optically amplifies one transmit OC-192/STM-64 signal (1552.52 nanometers).
- Optically pre-amplifies one receive OC-192/STM-64 signal (1552.52 nanometers)

Control functions

The OBPA10G circuit pack performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs
- Selects the working or standby operations network and CTLI-D signals
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the operations network
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the circuit pack faceplate FAULT and ACTIVE LEDs.

□

PPROC/STS192 circuit pack (LEY3)

Overview

Purpose The STS-192 Pointer Processor (PPROC/STS192) circuit pack performs the following functions:

- Pointer processing and path monitoring for the incoming 192 STS-1 signals
- Frame delay management between SWITCH/STS576 circuit packs on the High Speed Shelf and the Low Speed Shelf

□

PPROC/STS192 circuit pack faceplate

Faceplate indicators

The PPROC/STS192 circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate. The FAULT and ACTIVE LEDs are controlled by the Control/System 50DM (CTL/SYS50DM) circuit packs.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected, the circuit pack loses one power feeder, or the on-board power converter fails. The red FAULT LED flashes on and off when an incoming signal failure, a loss of timing signal, or a memory fault is detected.
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.

□

PPROC/STS192 circuit pack functions

Overview

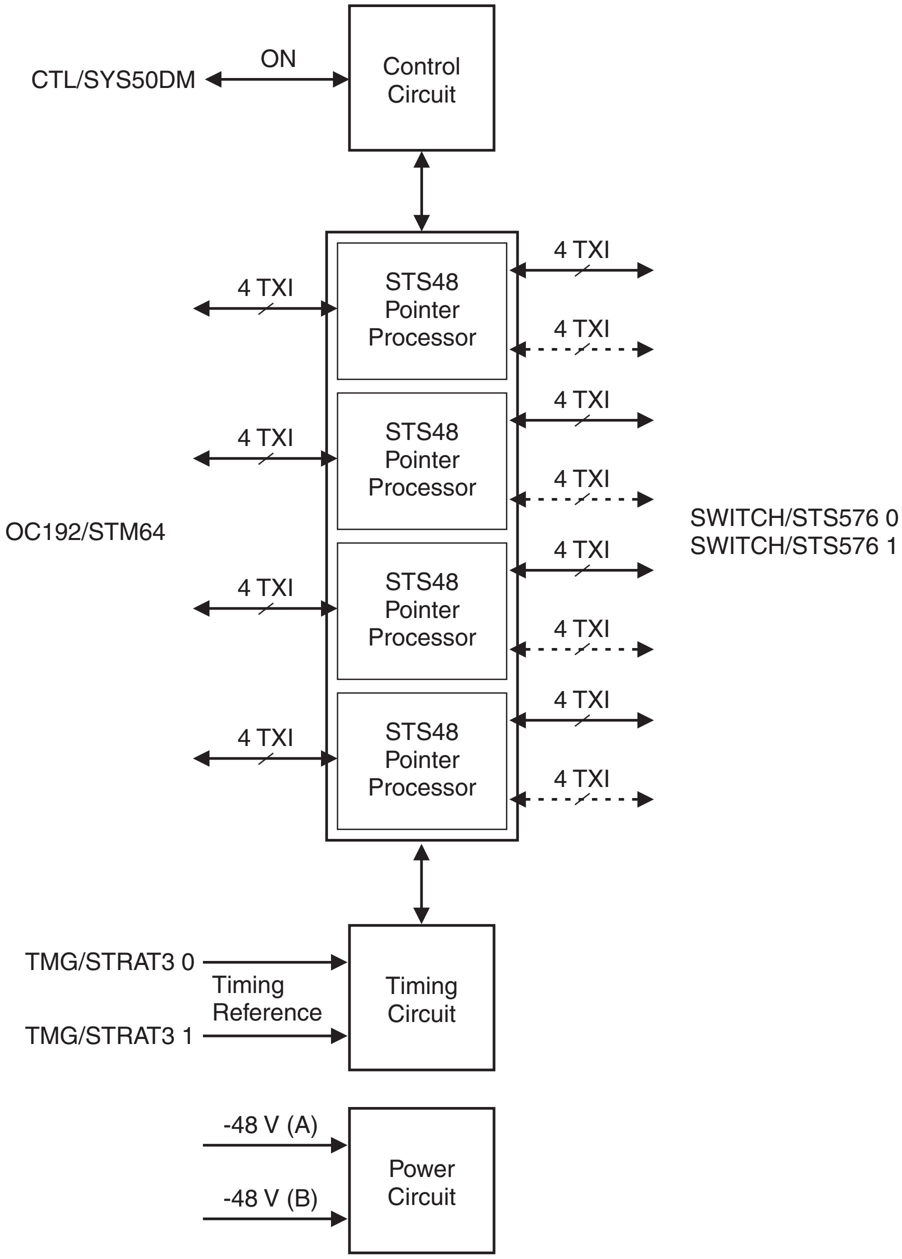
The PPROC/STS192 circuit pack performs the following functions:

- Port unit function:
  The port unit function provides pointer processing and path monitoring on an equivalent of 192 STS-1 signals and delivers system synchronized and frame aligned data for the SWITCH/STS576 circuit pack. There are four bidirectional transmission devices on PPROC/STS192 circuit pack. Each bidirectional transmission device supports 48 STS-1 signals. One PPROC/STS192 circuit pack supports the east OC192/STM64 port unit, and one PPROC/STS192 circuit pack supports the west OC192/STM64 port unit.
- Switch function:
  The switch function provides delay management between the SWITCH/STS576 circuit packs in the high speed and low speed shelves. This is required because different STS-1 signals within the network element take two paths of unequal delay through the network element. The PPROC/STS192 circuit pack adjusts the frame positions of the SWITCH/STS576 circuit pack outputs in the Low Speed Shelf to match the frame positions at the inputs of the SWITCH/STS576 circuit pack in the High Speed Shelf. Two PPROC/STS192 circuit packs are required to support to the redundant SWITCH/STS576 circuit packs.

Functional block diagram

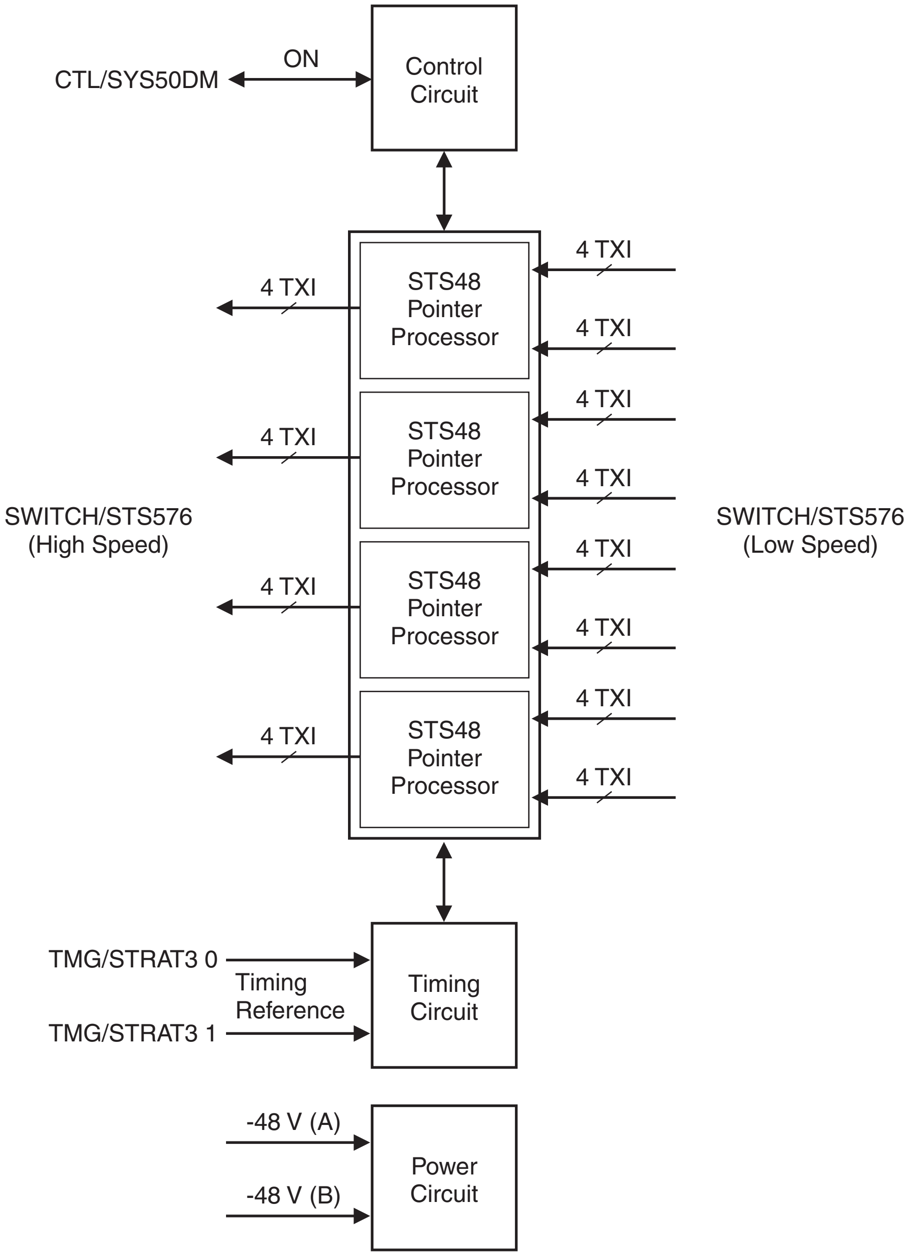
The following figure shows a functional block diagram of the PPROC/STS192 circuit pack port unit function.

Figure 11-9 PPROC/STS192 circuit pack functional block diagram (Port Unit Function)



The following figure shows a functional block diagram of the PPROC/STS192 circuit pack switch function.

Figure 11-10 PPROC/STS192 circuit pack functional block diagram (Switch Function)



Control circuitry

The processor is the lowest level processor in the system control hierarchy. The processor controls and monitors the operation of the circuit pack. The processor also manages communication with other circuit packs via the operations network (ON) and control interface for devices (CTLI-D) interfaces. For more information about the operations network and CTLI-D, refer to Chapter 6, Control Architecture.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of up to eight megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Transmission circuitry

The transmission circuitry is divided into

- Port Unit Function
  In the receive direction, the PPROC/STS192 circuit pack accepts 16 TXI signals (192 STS-1 equivalent signals), a 155.52-MHz clock and a 8-KHz frame timing signal from the associated OC192/STM64 port unit. Each STS48 pointer processor accepts four TXI signals. After passing through the STS48 pointer processor, the data is reformatted into TXI signals and transmitted to the SWITCH/STS576 0 and SWITCH/STS576 1 circuit packs.
  In the transmit direction, the PPROC/STS192 circuit pack receives 16 TXI signals from each SWITCH/STS576 circuit pack and selects one set of TXI signals. The selected TXI signals are passed through to the associated OC192/STM64 port unit. There is no pointer processing performed in the transmit direction.
- Switch Function
  The PPROC/STS192 circuit pack supports up to 16 TXI signals (192 STS-1 equivalent signals) between the SWITCH/STS576 circuit packs on the High Speed and Low Speed Shelves. On the receive side the PPROC/STS192 circuit pack receives 2 sets of 16 TXI signals from the SWITCH/STS576 circuit packs on the Low Speed Shelves and selects one set. The selected TXI signals are routed back to the PPROC/STS192 circuit pack through

backplane traces to the STS48 pointer processor. The TXI signals are processed on an STS-1 basis for frame position adjustment for switching through a static pointer offset. The STS-1 signals are multiplexed to 16 TXI signals and sent to the associated SWITCH/STS576 circuit pack on the High Speed Shelf.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Protection circuitry

The protection circuitry consists of

- Switch fabric protection
  In the receive direction, the PPROC/STS192 circuit pack port function fans out 16 TXI signals to the SWITCH/STS576 0 circuit pack and 16 TXI signals to the SWITCH/STS576 1 circuit pack. In the transmit direction, the PPROC/STS192 circuit pack port function receives 16 TXI signals from the SWITCH/STS576 0 circuit pack and 16 TXI signals from the SWITCH/STS576 1 circuit pack. The PPROC/STS192 circuit pack port function selects 16 TXI signals as active and the remaining 16 TXI signals are standby. If the active SWITCH/STS576 circuit pack fails, the PPROC/STS192 circuit pack port function selects the 16 TXI signals from the standby SWITCH/STS576 circuit pack.
- Timing reference signal protection
  Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The PPROC/STS192 circuit pack monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Fault detection circuitry

The control circuit monitors all the activities on the circuit pack. The PPROC/STS192 circuit pack has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or a reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR’d, fused, and filtered. A modular

DC-to-DC converter produces +5 V and +3.3 V used on the circuit pack.

The PPROC/STS192 circuit pack monitors the two –48 V power sources. If the PPROC/STS192 circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The PPROC/STS192 circuit pack performs the following functions:

Port unit receive functions

The PPROC/STS192 circuit pack performs the following port unit receive functions:

- Receives 16 622.08 Mb/s TXI signals from the associated OC192/STM64 port unit
- Performs pointer processing and synchronization to the system clock
- Monitors the path overhead
- Extracts and processes the TXI overhead bytes
- Sends 16 TXI signals to the SWITCH/STS576 0 circuit pack and 16 TXI signals to the SWITCH/STS576 1 circuit pack

Port unit transmit functions

The PPROC/STS192 circuit pack performs the following port unit receive functions:

- Selects 16 622.08 Mb/s TXI signals from the SWITCH/STS576 0 circuit pack and 16 TXI signals from the SWITCH/STS576 1 circuit pack
- Sends 16 TXI signals to the associated OC192/STM64 port unit

Switch functions

The PPROC/STS192 circuit pack performs the following switch functions:

- Receives 32 622.08 Mb/s TXI signals from the associated SWITCH/STS576 circuit packs on the Low Speed Shelves and selects 16 TXI signals
- Adjust the frame positions of the selected 16 TXI signals (static pointer offset)
- Sends the 16 TXI signals to the associated SWITCH/STS576 circuit pack on the High Speed Shelf

Timing and control functions

The PPROC/STS192 circuit pack performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/ STRAT3 circuit packs
- Selects the working or standby TXI signals from the SWITCH/STS576 circuit packs on the High Speed Shelf (port unit function only)
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit pack using the operations network
- Stores inventory information (for example, the CLEI code and serial number)
- Controls the port unit faceplate FAULT and ACTIVE LEDs

□

PPROC/STS384 circuit pack (LEY47)

Overview

Purpose

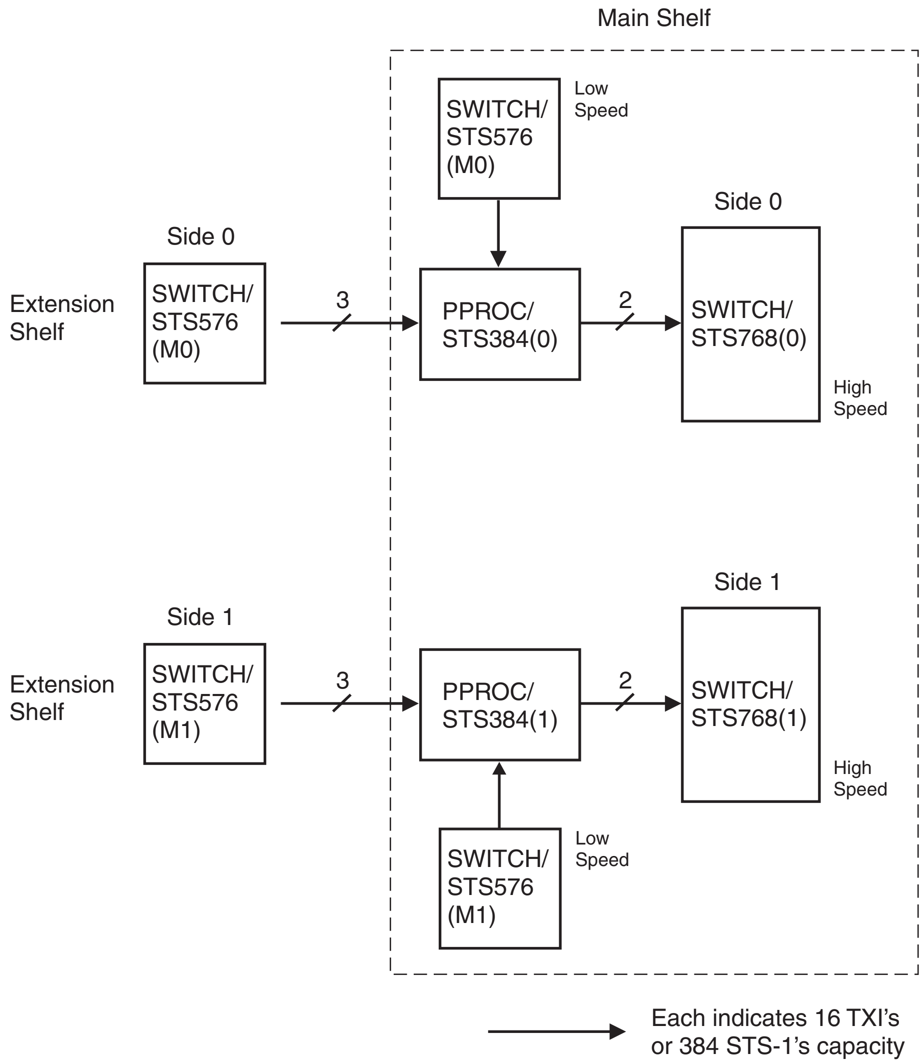
The STS-384 Pointer Processor (PPROC/STS384) circuit pack must always be used in combination with the SWITCH/STS768 circuit pack. The switch capacity can be dublicated if both circuit packs are used. In that case all circuit packs (2x PPROC/STS384 and 2x SWITCH/STS768) have to be plugged in the high-speed part of the Main Shelf (cf. Chapter 4, “Main Shelf” (4-12)).

The PPROC/STS384 circuit pack provides delay management between the SWITCH/STS768 circuit packs in the High Speed Shelf and between the SWITCH/STS576 circuit packs in the Low Speed Shelves. This is required because different VC-3 signals within the network element take two paths of unequal delay through the network element. The PPROC/STS384 circuit pack adjusts the frame positions of the SWITCH/STS576 circuit pack outputs in the Low Speed Shelves to match the frame positions at the inputs of the SWITCH/STS768 circuit packs in the High Speed Shelf.

The PPROC/STS384 circuit pack accepts 4 sets of 16 TXI formatted signals.

The interconnections between the PPROC/STS384 circuit packs and the High Speed SWITCH/STS768 packs and between the PPROC/STS384 circuit packs and the Low Speed SWITCH/STS576 packs are illustrated in the following figure.

Figure


Main Shelf
SWITCH/
STS576
(M0)
Low
Speed
Side 0
Side 0
Extension
Shelf
SWITCH/
STS576
(M0)
3
PPROC/
STS384(0)
2
SWITCH/
STS768(0)
High
Speed
Side 1
Side 1
Extension
Shelf
SWITCH/
STS576
(M1)
3
PPROC/
STS384(1)
2
SWITCH/
STS768(1)
High
Speed
SWITCH/
STS576
(M1)
Low
Speed
Each indicates 16 TXI's
or 384 STS-1's capacity

□

PPROC/STS384 circuit pack faceplate

Faceplate indicators

The PPROC/STS384 circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate. The FAULT and ACTIVE LEDs are controlled by the Control/System 50DM (CTL/SYS50DM) circuit packs.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected, the circuit pack loses one power feeder, or the on-board power converter fails. The red FAULT LED flashes on and off when an incoming signal failure, a loss of timing signal, or a memory fault is detected.
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.

□

PPROC/STS384 circuit pack functions

Overview

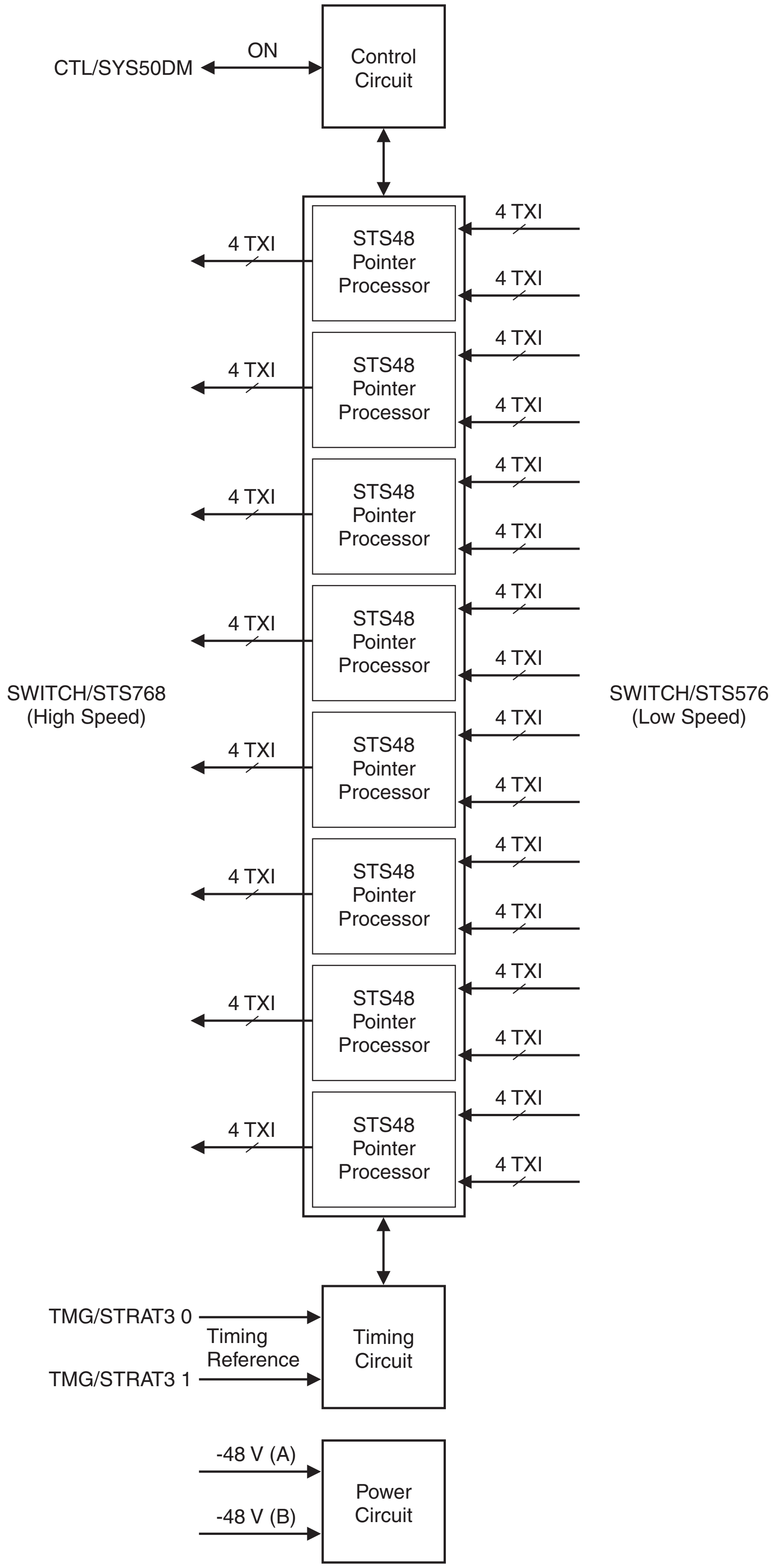
The PPROC/STS384 circuit pack performs the following functions:

- TXI signal integrity monitoring
- TXI frame alignment of the ingress data streams
- 2:1 selection of data streams at VC-3 granularity
- Loopback signals in sixteen TXI's from the transmitting side to the receiving side
- Pass-through K3e bytes with no processing or monitoring
- Frame synchronization to system clock on all 384 VC-3 signals
- Fanout/Duplicate 32 TXI output signals.

Functional block diagram

The following figure shows a functional block diagram of the PPROC/STS384 circuit pack switch function.

Figure 11-11 PPROC/STS384 circuit pack switch function



Control circuitry

The processor is the lowest level processor in the system control hierarchy. The processor controls and monitors the operation of the circuit pack. The processor also manages communication with other circuit packs via the operations network (ON) and control interface for devices (CTLI-D) interfaces. For more information about the operations network and CTLI-D, refer to Chapter 6, Control Architecture.

Memory circuitry

The memory circuitry is divided into

- Start-up memory
  The start-up memory consists of 1 megabyte of flash electrically-erasable programmable read-only memory (flash EEPROM). The start-up memory contains the program that allows the processor to load the executable code and data from the SYS50DM circuit pack into the operating memory. The program allows the processor to start up operation during a powerup, or a reset condition, or when initializing new software.
- Operating memory
  The operating memory consists of up to eight megabytes of dynamic random access memory (DRAM). The operating memory is used to store the operating executable code (program) and data (configuration information).
- Nonvolatile inventory memory
  The nonvolatile inventory memory consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the port unit history such as the ***CLEI*** code and type/version information.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal. If both 6.48-MHz timing reference signals are not available, a free-running 6.48-MHz oscillator provides a reference signal for the timing circuit.

Fault detection circuitry

The control circuit monitors all the activities on the circuit pack. The PPROC/STS384 circuit pack has an in-service and out-of-service built-in test capability. In-service testing is continuous. If an error occurs, the control circuit reports the error to the CTL/SYS50DM circuit pack using the operations network. An out-of-service test is performed during a powerup or a reset condition, or when initializing new software.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. A modular DC-to-DC converter produces +5 V and +3.3 V used on the circuit pack.

The PPROC/STS384 circuit pack monitors the two –48 V power sources. If the PPROC/STS384 circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The PPROC/STS384 circuit pack performs the following functions:

Switch functions

The PPROC/STS384 circuit pack performs the following switch functions:

- Receives 64 622.08 Mb/s TXI signals from the associated SWITCH/STS576 circuit packs on the Low Speed Shelves (= Extension Shelf and low-speed part of the Main Shelf) and selects 32 TXI signals
- Adjust the frame positions of the selected 32 TXI signals (static pointer offset)
- Sends the 32 TXI signals to the associated SWITCH/STS768 circuit pack on the High Speed Shelf.

Timing and control functions

The PPROC/STS384 circuit pack performs the following timing and control functions:

- Selects the working or standby timing reference signal from the shelf TMG/ STRAT3 circuit packs
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit pack using the operations network
- Stores inventory information (for example, the CLEI code and serial number)
- Controls the port unit faceplate FAULT and ACTIVE LEDs.

□

SWITCH/STS576 circuit pack (LEY4)

Overview

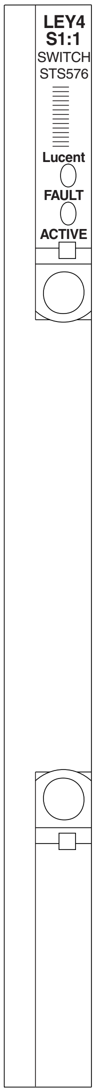
Purpose The SWITCH/STS576 circuit pack provides a 192x192 STM-1, single-stage, nonblocking switch. The switch allows VC-3 equivalent switching between port units on the shelf.

□

SWITCH/STS576 circuit pack faceplate

Faceplate diagram

The following diagram illustrates the SWITCH/STS576 circuit pack faceplate.



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Faceplate LEDs

The SWITCH/STS576 circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate. The red FAULT LED is controlled by the CTL/SYS50DM circuit packs.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected or the circuit pack loses one power feeder.

LED	Function
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.

☐

SWITCH/STS576 circuit pack functions

Overview

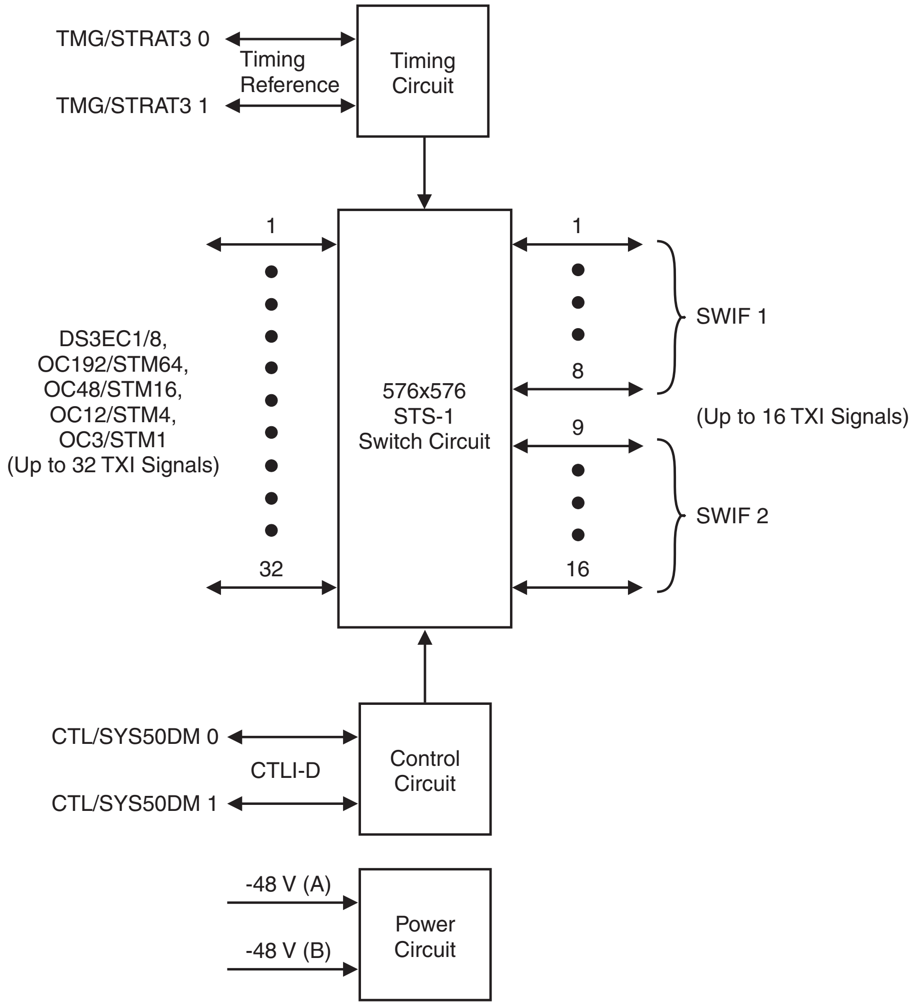
The SWITCH/STS576 circuit pack provides a 192x192 STM-1 single-stage, nonblocking switch. The switch has up to 48 transmission interface (TXI) signal inputs and up to 64 TXI signal outputs. Any input can be routed to any output. This allows the user-specified cross-connections between:

- Port units on the same shelf
- Port units on different shelves via the another SWITCH/STS576 and PPROC/STS192 circuit pack.

The SWITCH/STS576 circuit pack also supports OC-3/STM-1 1+1 MSP protection switching, OC-48/STM-16 1+1 MSP protection switching, and OC-48/STM-16 and OC-192/STM-64 2-fiber MS-SPRing.

Functional block diagram The following figure shows a functional block diagram of the SWITCH/STS576 circuit pack.

Figure 11-12 SWITCH/STS576 circuit pack functional block diagram



Control circuitry The SWITCH/STS576 circuit pack has no on-board processor. All control and switching information comes from the CTL/SYS50DM circuit packs via the control interface for devices (CTLI-D) interface. The SWITCH/STS576 circuit pack reports the status of the circuit pack and the incoming TXI signals, as well as the circuit pack inventory information (for example, the CLEI code and serial number). The CTL/SYS50DM circuit packs use the status information for fault detection and isolation.

Memory circuitry The memory circuitry consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the circuit pack history such as the CLEI code and type/version information.

Switch circuitry

The switch circuit provides transmission connection between the port units on the same shelf and between the port units and the main switch fabric. The SWITCH/STS576 circuit packs accept the following inputs:

- Up to 32 TXI signals from the STM1E/4, OC3/STM1, OC12/STM4, OC48/STM 16, and/or OC192/STM64 port units (service and protection)
- Up to 16 TXI signals from another SWITCH/STS576 circuit pack or from a PPROC/STS192 circuit pack.

The switch circuit forms a 192x192 STM-1 switch that completes VC-3 circuits for user-specified cross-connections and protection switching.

The SWITCH/STS576 circuit packs provide the following outputs:

- Up to 32 TXI signals to the OC3/STM1, OC12/STM4, OC48/STM16, and/or OC192/STM64 port units (service and protection)
- Up to 16 TXI signals to another SWITCH/STS576 circuit pack or to a PPROC/STS192 circuit pack.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal.

Protection circuitry

The protection circuitry consists of

- OC-3/STM-1 1+1 port protection
  The OC-3/STM-1 port protection is accomplished by the coordinated operation of the working and standby OC-3/STM-1 ports and the SWITCH/STS576 circuit pack. For example, the SWITCH/STS576 circuit pack selects the TXI signal from the standby OC-3/STM-1 port to substitute for the TXI signal from the failed working OC-3/STM1 port.The SWITCH/STS576 circuit pack also routes the TXI signal for the failed working OC-3/STM-1 port to the standby OC-3/STM-1port. OC-3/STM-1 port protection switching is performed in response to commands from the CTL/SYS50DM circuit packs via the CTLI-D interface.
- OC-12/STM-4 1+1 port protection
  The OC-12/STM-4 port protection is accomplished by the coordinated operation of the working and standby OC-12/STM-4 ports and the SWITCH/STS576 circuit pack. For example, the SWITCH/STS576 circuit pack selects the TXI signal from the standby OC-12/STM-4 port to substitute for the TXI signal from

the failed working OC-12/STM-4 port.
The SWITCH/STS576 circuit pack also routes the TXI signal for the failed working OC-12/STM-4 port to the standby OC-12/STM-4 port. OC-12/STM-4 port protection switching is performed in response to commands from the CTL/SYS50DM circuit packs via the CTLI-D interface.

- OC-192/STM-64 1+1 port protection
The OC-192/STM-64 port protection is accomplished by the coordinated operation of the working and standby OC-192/STM-64 ports and the SWITCH/STS576 circuit pack. For example, the SWITCH/STS576 circuit pack selects the TXI signal from the standby OC-192/STM-64 port to substitute for the TXI signal from the failed working OC-192/STM-64 port.The SWITCH/STS576 circuit pack also routes the TXI signal for the failed working OC-192/STM-64 port to the standby OC-192/STM-64 port. OC-192/STM-64 port protection switching is performed in response to commands from the CTL/SYS50DM circuit packs via the CTLI-D interface.
- OC-48/STM-16 2-fiber ring protection
The SWITCH/STS576 circuit pack provides all the OC-48/STM-16 2-fiber ring protection switching connections. All OC-48/STM-16 2-fiber ring protection switching occurs at the input and output stages of SWITCH/STS576 circuit packs. During the protection switch, the service traffic for the failed OC48/STM16 port unit is routed to the OC48/STM16 port unit in the opposite direction. For example, if the west OC48/STM16 port unit fails, the service traffic is routed to the east OC48/STM16 port unit.
- Timing reference signal protection
Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The SWITCH/STS576 circuit pack monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR’d, fused, and filtered. Modular DC-to-DC converters produce +3.3 V, +1.4 V, +1.2 V, and +1.0 V used on the circuit pack.

The circuit pack monitors the two –48 V power sources. If the circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The SWITCH/STS576 circuit pack performs the following functions:

Switch functions

The SWITCH/STS576 circuit pack performs the following switch functions:

- Receives up to 32 TXI signals from the STM1E/4, OC-3/STM-1, OC-12/STM-4, OC48/STM16, and/or OC192/STM64 port units (service and protection)
- Receives up to 16 TXI signals from other SWITCH/STS576 circuit pack or from PPROC/STS192 circuit pack
- Establishes VC-3 equivalent cross-connections through the VC-3 switch based on user-specified cross-connection commands
- Transmits up to 32 TXI signals to STM1E/4, OC-3/STM-1, OC-12/STM-4, OC48/STM16, and/or OC192/STM64 port units (service and protection)
- Transmits up to 16 TXI signals to other SWITCH/STS576 circuit pack or to PPROC/STS192 circuit pack.

Control functions

The SWITCH/STS576 circuit pack performs the following control functions:

- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the control interface for devices (CTLI-D) interface
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the circuit pack faceplate ACTIVE LED.

□

SWITCH/STS768 circuit pack (LEY73)

Overview

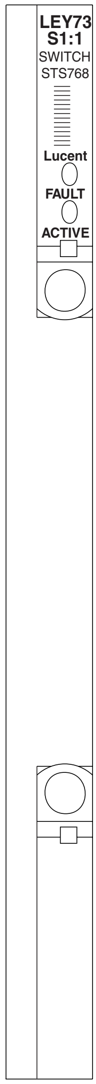
Purpose The SWITCH/STS768 circuit pack must always be used in combination with the PPROC/STS384 circuit pack. The switch capacity can be dublicated if both circuit packs are used. In that case all circuit packs (2x SWITCH/STS768 and 2x PPROC/STS384) have to be plugged in the high-speed part of the Main Shelf (cf. Chapter 4, "Main Shelf" (4-12)). The functions of the SWITCH/STS768 circuit packs in the High Speed Shelf are descibed in the following.

□

SWITCH/STS768 circuit pack faceplate

Faceplate diagram

The following diagram illustrates the SWITCH/STS768 circuit pack faceplate.



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Faceplate LEDs

The SWITCH/STS768 circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate. The red FAULT LED is controlled by the CTL/SYS50DM circuit packs.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected or the circuit pack loses one power feeder.

LED	Function
ACTIVE LED (green)	Lights when the circuit pack is active/in-service.

□

SWITCH/STS768 circuit pack functions

Overview

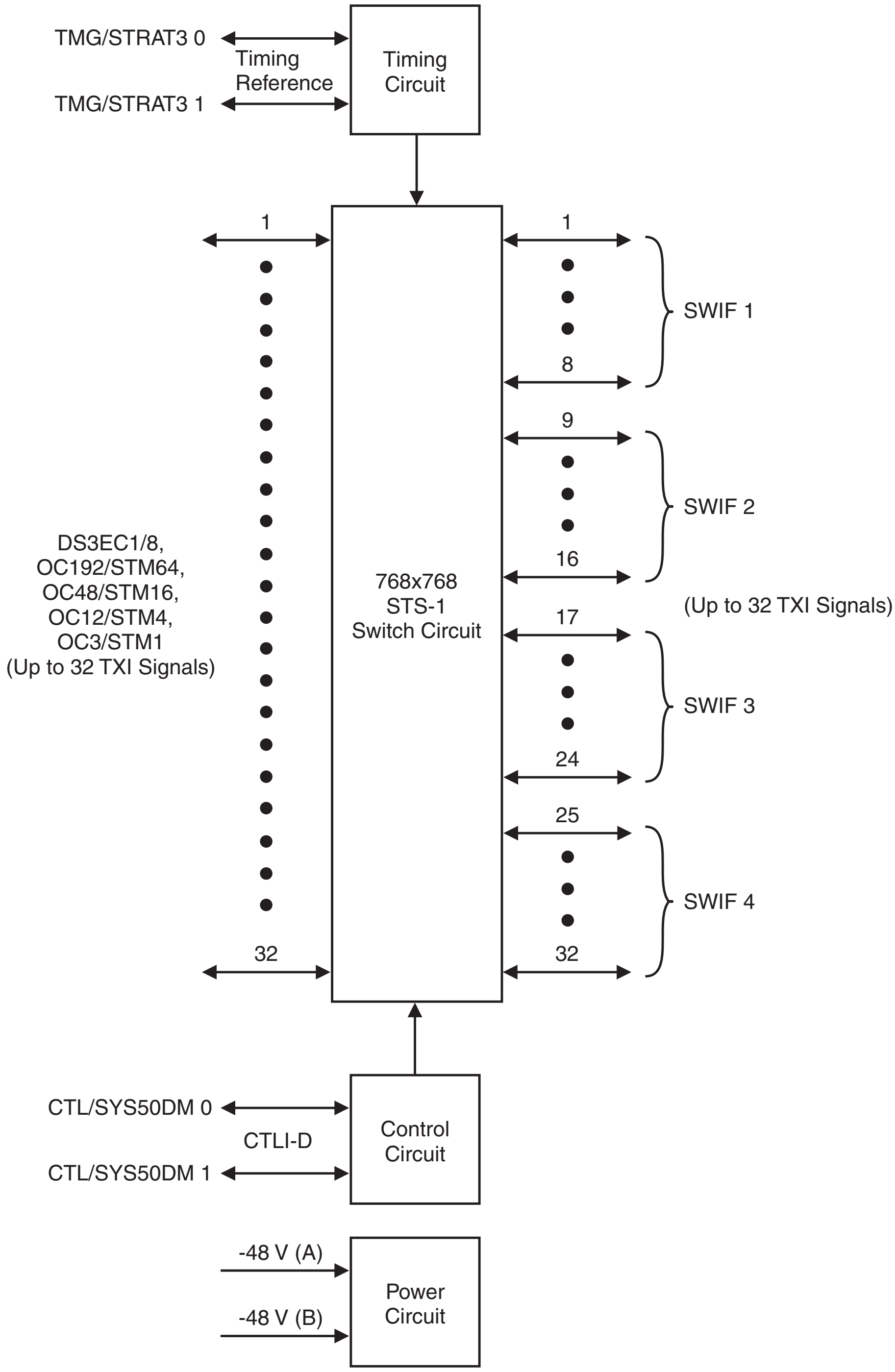
The SWITCH/STS768 circuit pack provides a 768x768 STS-1 / 256x256 STM-1 single-stage, nonblocking switch. The switch allows VC-3 equivalent switching between port units on the shelf and has up to 64 transmission interface (TXI) signal inputs and up to 96 TXI signal outputs. Any input can be routed to any output. This allows the user-specified cross-connections between port units on the Main Shelf and up to 3 different Extension Shelves via the SWITCH/STS576 circuit packs (located in the low speed part of the Main Shelf and in the Extension Shelves) and the PPROC/STS384 circuit packs (located in the high speed part of the Main Shelf).

The SWITCH/STS768 circuit pack also supports OC-3/STM-1 1+1 MSP protection switching, OC-48/STM-16 1+1 MSP protection switching, and OC-48/STM-16 and OC-192/STM-64 2-fiber MS-SPRing.

Functional block diagram

The following figure shows a functional block diagram of the SWITCH/STS768 circuit pack.

Figure 11-13 SWITCH/STS768 circuit pack functional block diagram



Control circuitry

The SWITCH/STS768 circuit pack has no on-board processor. All control and switching information comes from the CTL/SYS50DM circuit packs via the control interface for devices (CTLI-D) interface.

The SWITCH/STS768 circuit pack reports the status of the circuit pack and the incoming TXI signals, as well as the circuit pack inventory information (for example, the CLEI code and serial number). The CTL/SYS50DM circuit packs use the status information for fault detection and isolation.

Memory circuitry

The memory circuitry consists of 256 bytes of electrically-erasable programmable read-only memory (EEPROM). The nonvolatile memory is used to store information about the circuit pack history such as the CLEI code and type/version information.

Switch circuitry

The switch circuit provides transmission connection between the port units on the same shelf and between the port units on the low speed part of the Main Shelf and up to 3 different Extension Shelves. The SWITCH/STS768 circuit packs accept the following inputs:

- Up to 32 TXI signals from the STM1E/4, OC3/STM1, OC12/STM4, OC48/STM 16, and/or OC192/STM64 port units (service and protection)
- Up to 32 TXI signals from the SWITCH/STS576 circuit packs via the PPROC/STS384(DM0/DM1) circuit pack.

The switch circuit forms a 256x256 STM-1 switch that completes VC-3 circuits for user-specified cross-connections and protection switching.

The SWITCH/STS768 circuit packs provide the following outputs:

- Up to 32 TXI signals to the OC3/STM1, OC12/STM4, OC48/STM16, and/or OC192/STM64 port units (service and protection)
- Up to 32 TXI signals to the SWITCH/STS576 circuit packs.

Timing circuitry

The timing circuit receives two 6.48-MHz timing reference signals from the shelf TMG/STRAT3 circuit packs. The control circuit selects the timing reference signal that is used.The timing circuit multiplies the selected 6.48-MHz timing reference signal by 24 to generate an internal 155.52-MHz timing signal.

Protection circuitry

The protection circuitry consists of

- OC-3/STM-1 1+1 port protection
  The OC-3/STM-1 port protection is accomplished by the coordinated operation of the working and standby OC-3/STM-1 ports and the SWITCH/STS768 circuit pack. For example, the SWITCH/STS768 circuit pack selects the TXI signal from the standby OC-3/STM-1 port to substitute for the TXI signal from

the failed working OC-3/STM1 port. The SWITCH/STS768 circuit pack also routes the TXI signal for the failed working OC-3/STM-1 port to the standby OC-3/STM-1port. OC-3/STM-1 port protection switching is performed in response to commands from the CTL/SYS50DM circuit packs via the CTLI-D interface.

- OC-12/STM-4 1+1 port protection
  The OC-12/STM-4 port protection is accomplished by the coordinated operation of the working and standby OC-12/STM-4 ports and the SWITCH/STS768 circuit pack. For example, the SWITCH/STS768 circuit pack selects the TXI signal from the standby OC-12/STM-4 port to substitute for the TXI signal from the failed working OC-12/STM-4 port.
  The SWITCH/STS768 circuit pack also routes the TXI signal for the failed working OC-12/STM-4 port to the standby OC-12/STM-4 port. OC-12/STM-4 port protection switching is performed in response to commands from the CTL/SYS50DM circuit packs via the CTLI-D interface.
- OC-192/STM-64 1+1 port protection
  The OC-192/STM-64 port protection is accomplished by the coordinated operation of the working and standby OC-192/STM-64 ports and the SWITCH/STS768 circuit pack. For example, the SWITCH/STS768 circuit pack selects the TXI signal from the standby OC-192/STM-64 port to substitute for the TXI signal from the failed working OC-192/STM-64 port.
  The SWITCH/STS768 circuit pack also routes the TXI signal for the failed working OC-192/STM-64 port to the standby OC-192/STM-64 port. OC-192/STM-64 port protection switching is performed in response to commands from the CTL/SYS50DM circuit packs via the CTLI-D interface.
- OC-48/STM-16 2-fiber ring protection
  The SWITCH/STS768 circuit pack provides all the OC-48/STM-16 2-fiber ring protection switching connections. All OC-48/STM-16 2-fiber ring protection switching occurs at the input and output stages of SWITCH/STS768 circuit packs.

During the protection switch, the service traffic for the failed OC48/STM16 port unit is routed to the OC48/STM16 port unit in the opposite direction. For example, if the west OC48/STM16 port unit fails, the service traffic is routed to the east OC48/STM16 port unit.

- Timing reference signal protection
  Timing reference signal protection is performed by selecting the working or standby timing reference signal from the shelf TMG/STRAT3 circuit packs. The SWITCH/STS768 circuit pack monitors these timing reference signals and can select the working or standby timing reference signal until the protection algorithm of the CTL/SYS50DM circuit pack makes a selection.

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +3.3 V, +1.4 V, +1.2 V, and +1.0 V used on the circuit pack.

The circuit pack monitors the two –48 V power sources. If the circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The SWITCH/STS768 circuit pack performs the following functions:

Switch functions

The SWITCH/STS768 circuit pack performs the following switch functions:

- Receives up to 32 TXI signals from the STM1E/4, OC-3/STM-1, OC-12/STM-4, OC48/STM16, and/or OC192/STM64 port units (service and protection)
- Receives up to 32 TXI signals from the SWITCH/STS576 circuit packs via the PPROC/STS384(DM0/DM1) circuit pack
- Establishes VC-3 equivalent cross-connections through the VC-3 switch based on user-specified cross-connection commands
- Transmits up to 32 TXI signals to STM1E/4, OC-3/STM-1, OC-12/STM-4, OC48/STM16, and/or OC192/STM64 port units (service and protection)
- Transmits up to 32 TXI signals to the SWITCH/STS576 circuit packs.

Control functions

The SWITCH/STS768 circuit pack performs the following control functions:

- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the control interface for devices (CTLI-D) interface
- Stores inventory information (for example, the ***CLEI*** code and serial number)
- Controls the circuit pack faceplate ACTIVE LED.

□

TMG/STRAT3 circuit pack (LLY2)

Overview

Purpose

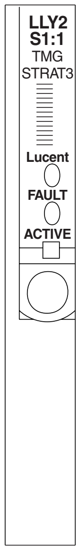
The Stratum 3 Timing (TMG/STRAT3) circuit packs distribute redundant timing signals to the circuit packs on the WaveStar® TDM 10G shelves.

□

TMG/STRAT3 circuit pack faceplate

Faceplate diagram

The following diagram illustrates the TMG/STRAT3 circuit pack faceplate.



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Faceplate LEDs

The TMG/STRAT3 circuit pack has a red FAULT LED and a green ACTIVE LED on its faceplate.

> **Important!** The red FAULT and green ACTIVE LEDs are controlled by the CTL/SYS50DM circuit pack.

The faceplate LEDs have the following functions.

LED	Function
FAULT LED (red)	Lights continuously when a circuit pack failure is detected or the circuit pack loses one power feeder.
ACTIVE LED (green)	Lights when a circuit pack failure is detected or the circuit pack loses one power feeder. The red FAULT LED flashes on and off when an incoming DS1 timing reference signal failure is detected.

□

TMG/STRAT3 circuit pack functions

Overview

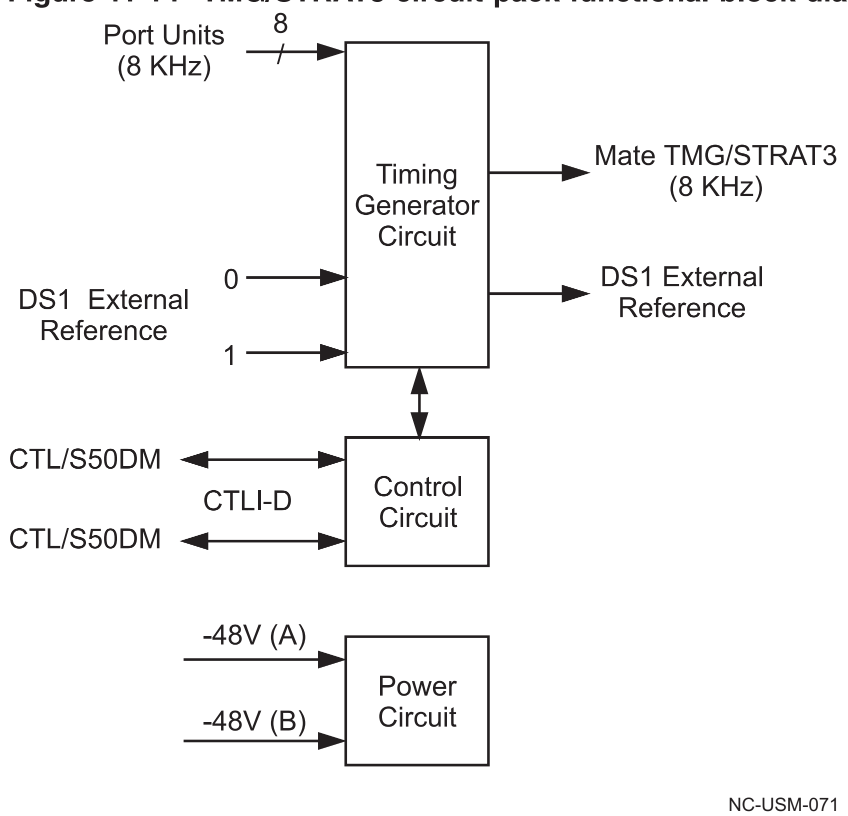
The TMG/STRAT3 circuit pack supports the following timing modes.

- Free-Running Mode: In the free-running mode, the TMG/STRAT3 circuit pack derives timing from a Stratum 3 oscillator.
- Locked Mode: In the locked mode, the TMG/STRAT3 circuit pack derives timing from a timing reference signal input.These references synchronize the local terminal, and any others that may reference it, with other network equipment operating under the same primary clock source.
- Holdover Mode: In the holdover mode, the timing generator circuit uses storage techniques to maintain the last known good frequency of the reference signal. The holdover mode is entered when the integrity of the reference signal is considered unacceptable or by manual command. In the holdover mode, the on-board oscillator frequency will not degrade below the stratum 3 level.

Functional block diagram

The following figure shows a functional block diagram of the TMG/STRAT3 circuit pack.

Figure 11-14 TMG/STRAT3 circuit pack functional block diagram



Control circuitry

The TMG/STRAT3 circuit pack has no on-board processor. All control information comes from the CTL/SYS50DM circuit pack via the control interface for devices (CTLI-D) interface. The TMG/STRAT3 circuit pack reports the status of the circuit pack and the incoming timing reference signals, as well as the circuit pack inventory information (for example, the ***CLEI*** code and serial number). The CTL/SYS50DM circuit pack uses the status information for fault detection and isolation.

Timing generator circuitry

The timing generator circuit can accept the following reference inputs and selects one of the inputs as the timing reference:

- Two external reference signals (2.048 MHz or 2.048 Mbit/s) from a stratum 3 or better source
- One line reference signal (8 kHz) from an OC192/STM64 port unit
- Two reference signals (8 KHz) from the master TMG/STRAT3 circuit packs
- Eight reference signals (8 KHz) from slave TMG/STRAT3 circuit packs

A digital phase-locked loop circuit generates the timing distribution signals.

The timing generator circuit distributes the following timing reference signals:

- 6.48 MHz to other circuit packs
- Four signals (8 MHz) to master TMG/STRAT3 circuit packs
- One signal (8 MHz) to the mate TMG/STRAT3 circuit pack
- Eight signals (8 MHz) to slave TM/STRAT3 circuit packs

Power circuitry

The power circuit accepts two –48 V power feeders from the backplane that are diode OR'd, fused, and filtered. Modular DC-to-DC converters produce +5 V and +3.3 V used on the circuit pack.

The TMG/STRAT3 circuit pack monitors the two –48 V power sources. If the circuit pack detects a failure of an on-board fuse or power converter, the red FAULT LED is lighted on the circuit pack faceplate.

Quick reference summary

The TMG/STRAT3 circuit pack performs the following timing and control functions:

- Accepts external timing reference signals, timing reference signals from the port units, and timing reference signals from other TMG/STRAT3 circuit packs
- Generates timing distribution signals
- Supports system timing in the free-running, locked, or holdover modes
- Performs internal fault detection and interfaces with the CTL/SYS50DM circuit packs using the CTLI-D interface
- Stores inventory information (for example, the ***CLEI*** code and serial number)

□

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Appendix A: An SDH Overview

Overview

Purpose

This chapter briefly describes the Synchronous Digital Hierarchy (SDH).

Synchronous Digital Hierarchy

In 1988, the ITU-T ***(formerly CCITT)*** came to an agreement on the Synchronous Digital Hierarchy (SDH). The corresponding ITU-T Recommendation forms the basis of a global, uniform optical transmission network. SDH can operate with plesiochronous networks and therefore allows the continuous evolution of existing digital transmission networks.

The major features and advantages of SDH are:

- Compatibility of transmission equipment and networks on a worldwide basis
- Uniform physical interfaces
- Easy cross connection of signals in the network nodes
- Possibility of transmitting PDH (Plesiochronous Digital Hierarchy) tributary signals at bit rates commonly used at present
- Simple adding and dropping of individual channels without special multiplexers (add/drop facility)
- Easy transition to higher transmission rates

- Due to the standardisation of the network element functions SDH supports a superordinate network management and new monitoring functions and provides transport capacity and protocols (Telecommunication Management Network, TMN) for this purpose in the overheads of the multiplex signals.
- High flexibility and user-friendly monitoring possibilities, e.g. end-to-end monitoring of the bit error ratio.

Purpose of SDH

The basic purpose of SDH is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in today's network, as well as those planned for the future.

SDH currently defines standard rates and formats and optical interfaces. Today, mid-span meet is possible at the optical transmission level. These and other related issues continue to evolve through the ITU-T committees.

ITU-T Addressed Issues

The set of ITU-T Recommendations defines

- Optical parameters
- Multiplexing schemes to map existing digital signals (PDH) into SDH payload signals
- Overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions
- Criteria for optical line Automatic Protection Switch (APS)

References

For more detailed information on SDH, refer to

- ITU-T Recommendation G.703, "Physical/electrical characteristics of hierarchical digital interfaces", October 1996
- ITU-T Recommendation G.780, "Vocabulary of terms for synchronous digital hierarchy (SDH) networks and equipment" , November 1993
- ITU-T Recommendation G.783, "Characteristics of Synchronous Digital Hierarchy (SDH) Multiplexing Equipment Functional Blocks ", April 1997
- ITU-T Recommendation G.784, "Synchronous Digital Hierarchy (SDH) Management ", January 1994
- ITU-T Recommendation G.785, "Characteristics of a flexible multiplexer in a synchronous digital hierarchy environment ", November 1996
- ITU-T Recommendation G.813, "Timing characteristics of SDH equipment slave clocks (SEC)", August 1996

- ITU-T Recommendation G.823, “The control of jitter and wander within digital networks which are based on the 2048-kbit/s hierarchy“, March 1993
- ITU-T Recommendation G.825, “The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)“, March 1993
- ITU-T Recommendation G.826, “ Error performance Parameters and Objectives for International, Constant Bit Rate Digital Paths at or Above the Primary Rate”, February 1999
- ITU-T Recommendation G.957, “Optical interfaces for equipments and systems relating to the synchronous digital hierarchy“, July 1995

Contents

SDH Signal Hierarchy

Overview

This section describes the basics of the SDH hierarchy.

STM-1 Frame

The SDH signal hierarchy is based on a basic “building block” frame called the Synchronous Transport Module 1 (STM-1), as shown in Figure A-1, “SDH STM-1 Frame Simplified Version” (A-5).

The STM-1 frame has a rate of 8000 frames per second and a duration of 125 microseconds

The STM-1 frame consists of 270 columns and 9 rows.

Each cell in the matrix represents an 8-bit byte.

Transmitting Signals

The STM-1 frame (STM = Synchronous Transport Module) is transmitted serially starting from the left with row 1 column 1 through column 270, then row 2 column 1 through 270, continuing on, row-by-row, until all 2430 bytes (9x270) of the STM-1 frame have been transmitted. Because each STM-1 frame consists of 2430 bytes and each byte has 8 bits, the frame contains 19440 bits a frame. There are 8000 STM-1 frames a second, at the STM-1 signal rate of 155.520.000 (19440 x 8000) kbit/s.

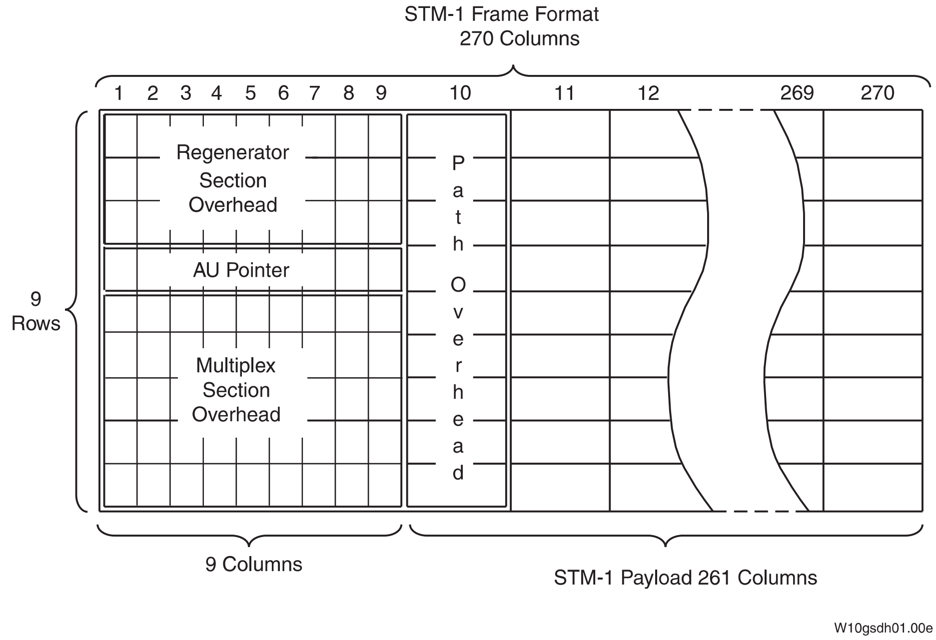
Three higher bit rates are also defined:

- 622.080 Mbit/s (STM-4)
- 2488.320 Mbit/s (STM-16)
- 9953.280 Mbit/s (STM-64)

The bit rates of the higher order hierarchy levels are integer multiples of the STM-1 transmission rate.

Figure The following figure illustrates the SDH STM-1 frame.

Figure A-1 SDH STM-1 Frame Simplified Version



Section Overhead (SOH) The first nine bytes of each row with exception of the fourth row are part of the SOH (Section OverHead). The first nine byte of the fourth row contain the AU pointer (AU = Administrative Unit).

STM-1 Payload Columns 10 through 270 (the remainder of the frame), are reserved for payload signals.

□

SDH Path and Line Sections

Overview

This section describes and illustrates the SDH path and line sections.

SDH Layers

SDH divides its processing functions into the following three path and line sections:

- Regenerator section
- Multiplex section
- Path

These three path and line sections are associated with

- Equipment that reflects the natural divisions in network spans
- Overhead bytes that carry information used by various network elements

Equipment Layers

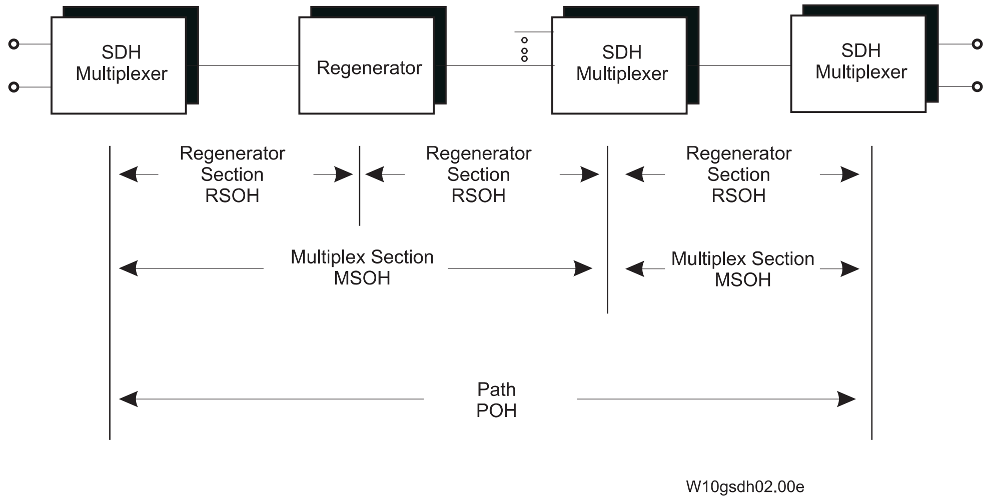
The following table lists and defines each SDH equipment path and line section.

Table A-1 SDH Equipment Sections

Path and Line Sections	Definition
Regenerator Section	A regenerator section describes the section between two network elements. The network elements, however, do not necessarily have to be regenerators.
Multiplex Section	A multiplex section is the section between two multiplexers. A multiplex section is defined as that part of a path where no multiplexing or demultiplexing of the STM-N frame takes place.
Path	A path is the logical signal connection between two termination points. A path can be composed of a number of multiplex sections which themselves can consist of several regenerator sections.

Figure The following figure illustrates the equipment path and line sections in a signal path.

Figure A-2 Section, Line, and Path Definitions



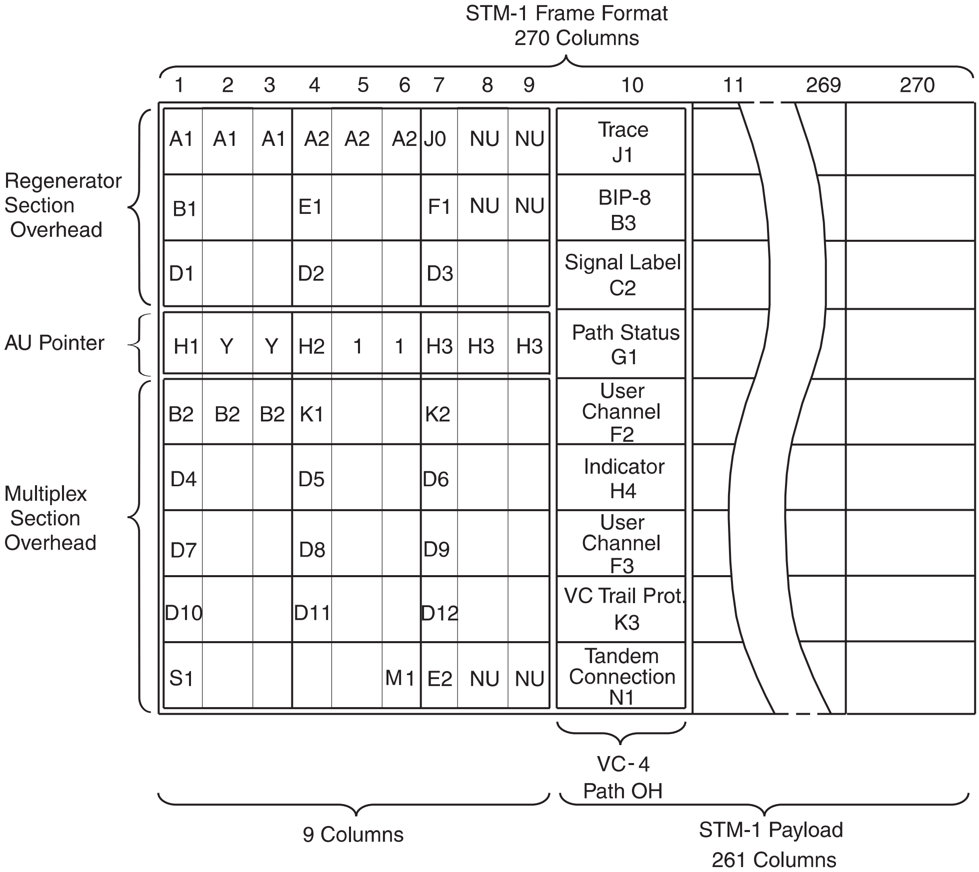
Overhead Bytes The following table lists and defines the overhead associated with each SDH path and line section.

Table A-2 Overhead Byte Sections

Overhead Byte Section	Definition
Regenerator Section	Contains information that is used by all SDH equipment including repeaters.
Multiplex Section	Used by all SDH equipment except repeaters.
Path	The POH contains all the additional signals of the respective hierarchy level so that a VC can be transmitted and switched through independently of its contents.

Figure The following figure illustrates each SDH frame section and its set of overhead bytes.

Figure A-3 SDH Frame Format



W10gsdh03.00e

□

SDH Frame Structure

Overview

This section provides detailed information on the locations and functions of various overhead bytes for each of the following SDH path and line sections:

- Regenerator Section
- Multiplex Section
- Path.

Section Overhead

The following table identifies the location and function of each regenerator section overhead byte.

Bytes	Function
A1, A2	Frame alignment A1 = 1111 0110 ; A2 = 0010 1000 ; These fixed-value bytes are used for synchronisation.
B1	BIP-8 parity test Regenerator section error monitoring; BIP-8 : Computed over all bits of the previous frame after scrambling; B1 is placed into the SOH before scrambling; BIP-X: (Bit Interleaved Parity X bits) Even parity, X-bit code; first bit of code = even parity over first bit of all X-bit sequences;
B2	Multiplex section error monitoring; BIP-24 : B2 is computed over all bits of the previous STM-1 frame except for row 1 to 3 of the SOH (RSOH); B2 is computed after and placed before scrambling;
Z0	Spare bytes
D1 - D3 (= DCC_R) D4 - D12 (= DCC_M)	Data Communication Channel (network management information exchange)
E1	Orderwire channel
E2	Orderwire channel
F1	User channel
K1, K2	Automatic protection switch
K2	MS-AIS/RDI indicator
S1	Synchronization Status Message

Bytes	Function
M1	REI (Remote Error Indication) byte
NU	National Usage

Path Overhead

The Path Overhead (POH) is generated for all plesiochronous tributary signals. The POH provides for integrity of communication between the point of assembly of a Virtual Container VC and its point of disassembly. The following table shows the POH bytes and their functions.

Byte	Location and Function
J1	Path Trace Identifier byte
B3	Path Bit Interleaved Parity (BIP-8) Provides each path performance monitoring. This byte is calculated over all bits of the previous payload before scrambling. As there is no path termination in the TDM 10G the B3 is only monitored. This is done on the port units for STM-N, N = 1 to 16 or on the PPROC for STM-64 respectively.
C2	Signal Label All ″0″ means unequipped; other and ″00000001″ means equipped
G1	Path Status Conveys the STM-1 path terminating status, performance, and remote defect indication (RDI) signal conditions back to an originating path terminating equipment.
F2, F3	User Data Channel Reserved for user communication.
H4	Multiframe Indicator Provides a general multiframe indicator for VC-structured payloads.
K3	VC Trail protection.
N1	Tandem connection OH

AU Pointer

The AU pointer together with the last 261 columns of the STM-1 frame forms an AUG (Administrative Unit Group). An AUG may contain one AU-4 or three byte-multiplexed AU-3s (an AU-3 is exactly one third of the size of an AU-4). AU-3s are also compatible with the SONET standard (Synchronous Optical NETwork) which is the predecessor of SDH (and still the prevailing technology within the USA). Three byte-multiplexed STS frames (SONET frame), each containing one AU-3 can be mapped into one STM-1.

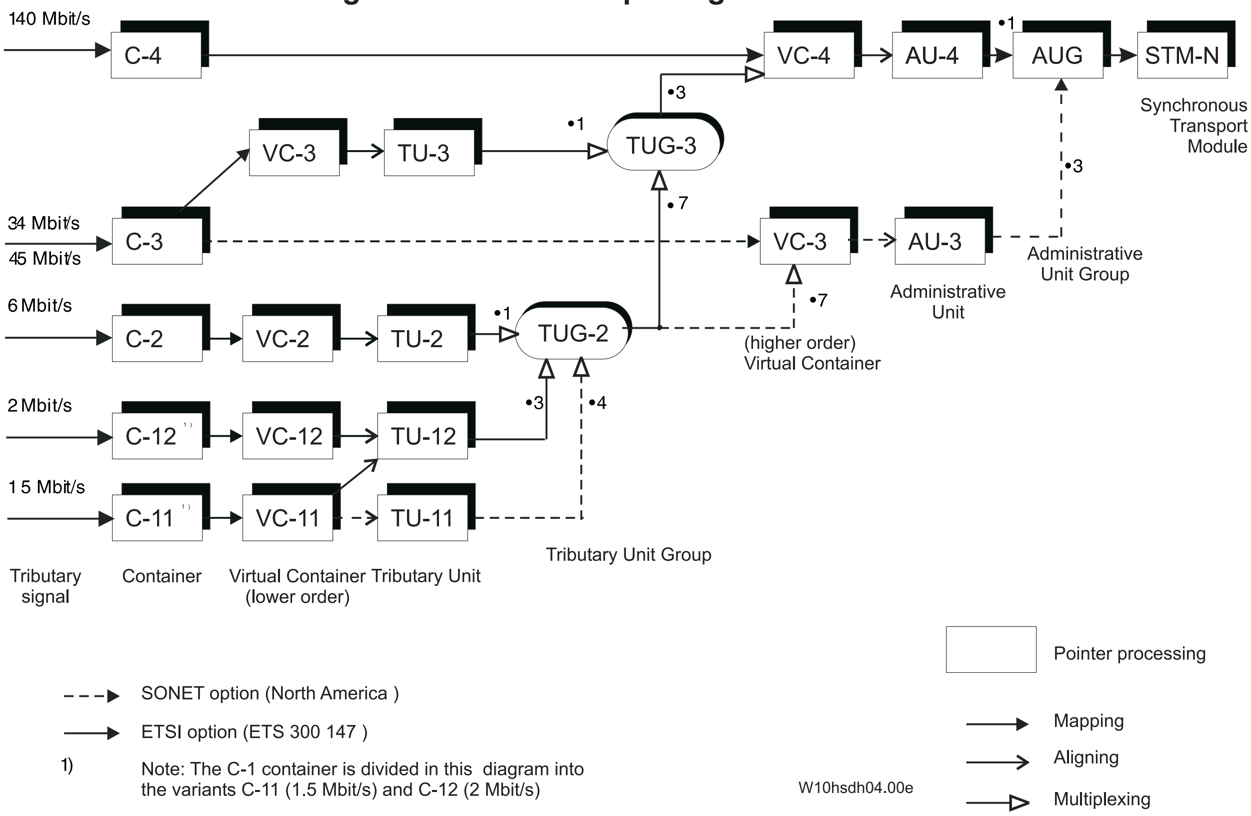
□

SDH Digital Multiplexing

Overview Digital multiplexing is SDH's method of byte mapping tributary signals to a higher signal rate, which permits economical extraction of a single tributary signal without the need to demultiplex the entire STM-1 payload. In addition, SDH provides overhead channels for use by OAM&P groups.

Figure The following figure illustrates the SDH technique of mapping tributary signals into an STM-1 frame.

Figure A-4 SDH Multiplexing Structure



Transporting SDH Payloads Tributary signals are mapped into a digital signal called a virtual container (VC). The VC is a structure designed for the transport and switching of sub-STM-1 payloads. There are five sizes of VCs: VC-11, VC-12, VC-2, VC-3, and VC-4.

Table The following table provides the digital signals that can be transported as SDH payloads.

Table A-3 SDH Payloads

Input tributary	Voice Channels	Rate	Mapped Into
1.5 Mbit/s	24	1.544 Mbit/s	VC-11
2 Mbit/s	32	2.048 Mbit/s	VC-12
6 Mbit/s	96	6.312 Mbit/s	VC-2
34 Mbit/s	672	34.368 Mbit/s	VC-3
45 Mbit/s	672	44.736 Mbit/s	VC-3
140 Mbit/s	2016	139.264 Mbit/s	VC-4

□

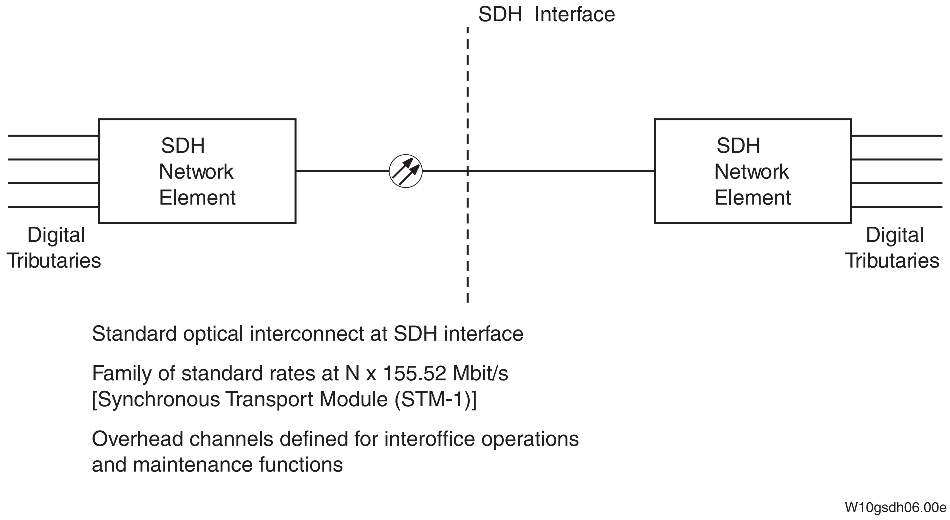
SDH Interface

Overview This section describes the SDH interface.

Description The SDH interface provides the optical mid-span meet between SDH network elements. An SDH network element is the hardware and software that affects the termination or repeating of an SDH standard signal.

Figure The following figure displays the SDH interface.

Figure A-5 SDH Interface



SDH Multiplexing Process

Overview SDH provides for multiplexing of 2-Mbit/s (C-12) and 34-Mbit/s (C-3) signals into an STM-1 frame.

Furthermore, multiplexing paths also exist for the SONET specific 1.5-Mbit/s, 6-Mbit/s and 45-Mbit/s signals.

Process The following describes the process for multiplexing a 2-Mbit/s signal. The Figure A-4, “SDH Multiplexing Structure” (A-12) illustrates the multiplexing process.

1 Input 2-Mbit/s tributary is mapped

- Each VC-12 carries a single 2-Mbit/s payload.
- The VC-12 is aligned into a Tributary Unit TU-2 using a TU pointer.
- Three TU-2 are then multiplexed into a Tributary Unit Group TUG-2.
- Seven TUG-2 are multiplexed into an TUG-3.
- Three TUG-3 are multiplexed into an VC-4.
- The VC-4 is aligned into an Administrative Unit AU-4 using a AU pointer.
- The AU-4 is mapped into an AUG which is then mapped into an STM-1 frame.

2 After VCs are multiplexed into the STM-1 payload, the section overhead is added.

3 Scrambled STM-1 signal is transported to the optical stage.

□

SDH Demultiplexing Process

Overview Demultiplexing is the inverse of multiplexing. This topic describes how to demultiplex a signal.

Process The following describes the process for demultiplexing an STM-1 signal to a 2 Mbit/s signal. The Figure A-4, "SDH Multiplexing Structure" (A-12) illustrates the demultiplexing process.

1 The unscrambled STM-1 signal from the optical conversion stages is processed to extract the path overhead and accurately locate the payload.

2 The STM-1 path overhead is processed to locate the VCs. The individual VCs are then processed to extract VC overhead and, via the VC pointer, accurately locate the 2-Mbit/s signal.

3 The 2-Mbit/s signal is desynchronized, providing a standard 2-Mbit/s signal to the asynchronous network.

Key Points SDH STM pointers are used to locate the payload relative to the transport overhead.

Remember the following key points about signal demultiplexing:

- The SDH frame is a fixed time (125 μs) and no bit-stuffing is used.
- The synchronous payload can float within the frame. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing).

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SDH Transport Rates

Overview

Higher rate STM-N frames are built through byte-multiplexing of N STM-1 signals.

Creating Higher Rate Signals

A STM-N signal can only be multiplexed out of N STM-1 frames with their first A1 byte at the same position (i.e. the first A1 byte arriving at the same time).

STM-N frames are built through byte-multiplexing of N STM-1 signals. Not all bytes of the multiplexed SOH (size = N x SOH of STM-1) are relevant in an STM-4/16.

For example there is only one B1 byte in an STM-4/16 frame which is computed the same way as for an STM-1. Generally the SOH of the first STM-1 inside the STM-N is used for SOH bytes that are needed only once.

SDH Transport Rates

The following table displays the SDH transport rates.

Table A-4 SDH Transport Rates

Designation	Line Rate (Mbit/s)	Capacity
STM-1	155.520	1 AU-4 or 3 AU-3
STM-4	622.080	4 AU-4 or 12 AU-3
STM-16	2488.320	16 AU-4 or 48 AU-3
STM-64	9953.280	64 AU-4 or 144 AU-3

Appendix B: Port Unit Data Sheets

Overview

Purpose

This chapter provides data sheets for the port units in WaveStar® TDM 10G (STM-64).

Usage of the data sheets

The data sheets provide technical specifications about each type of port unit used in WaveStar® TDM 10G (STM-64) in a singular location. Some information in the data sheets is included in other chapters in the APOG, but not necessarily in the same location for each product.

Using the data sheets

The different port units are arranged so that information about each type of port unit may be pulled out from Appendix B intact.

Port unit availability

The following table lists the availability of port units for WaveStar® TDM 10G (STM-64), Release 4. Please note that the functional qualifiers of the port units (e.g. SR1, IRS1, etc.) are not necessarily correlated to the optical range qualifiers specified in the Bellcore standards.

Table B-1 Availability of Port Units in WaveStar® TDM 10G (STM-64)

Port Unit	First released in
OC192/STM64/1.5IR1 (LEY69)	R2
OC192/STM64/1.5IRS1 (LEY97)	R2
LEY69 + Optical Booster Amplifier (SEN3)	R2
LEY97 + Optical Booster Amplifier (SEN3)	R4

Table B-1 Availability of Port Units in WaveStar® TDM 10G (STM-64) (continued)

Port Unit	First released in
LEY228 + Optical Booster and Pre-Amplifier (SEN4)	R3
OC192/STM64/WDM9580–WDM9190 (LEY201...240)	R2
OC192/STM64/POU01–16 (LEY284...299)	R3
OC48/STM16/1.3LR1 (LEY7)	R1
OC48/STM16/1.5LR1 (LEY8)	R1
OC48/STM16/1.3SR1 (LEY182)	R3
OC48/STM16/DWDM01-16 for OLS80G (LEY50...65)	R2
OC48/STM16/POU9590–POU9210 for OLS80G (LEY80...95)	R4.0.5
OC48/STM16/DWDM01-80 for OLS400G (LEY101...180)	R3
OC12/STM4/1.3LR2 (LEY13)	R2
OC12/STM4/1.3SR2 (LEY14)	R2
OC12/STM4/1.5LR2 (LEY190)	R2
OC3/STM1/1.3SR4 (LEY16)	R1
OC3/STM1/1.3SR8 (LEY23)	R3
OC3/STM1/1.3SR4 (LEY15)	R2
GE1/SX2 (LEY309)	R3
GE1/LX2 (LEY310)	R4
STM1E/4 (LEY44)	R2

Contents

OC192/STM64 Port Unit Data Sheets

Overview

Purpose

This section contains technical specifications for the OC192/STM64 port units that are used in WaveStar® TDM 10G (STM-64).

Contents

OC192/STM64/1.5SR1 (LEY67/LEY67AE) Data Sheet

Overview

This data sheet contains technical specifications for the OC192/STM64/1.5SR1 (short reach) port units that are used in WaveStar TDM 2.5G/10G (2-Fiber).

Capacity

Each OC192/STM64/1.5SR1 port unit supports one bidirectional (one receive and one transmit) OC-192 formatted optical signal. The capacity may be translated to 192 STS-1 equivalents or 129,024 two-way voice circuits per port unit.

STM-64 access

The table below describes STM-64 capabilities.

Table B-2 OC192/STM64/1.5IR1 /IRS1 Access

Specification	Description
Interface	Short-reach (40 km) interface [(a)]
Growth Increment	One OC-192/STM64 per port unit
Line Code	Scrambled NRZ

Note (a) This number is a typical value. 50 km can be achieved with forward error correction (FEC). The actual value must be calculated using measured data (see Figure B-1).

Protection switching

The table below describes protection switching information per high speed line.

Protection Switching for OC192/STM64/1.5SR1 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10 -3 to 10 -9 (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER =10 -3 line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/1.5SR1 port unit, is Class I in the FDA/CDRH Classification System.

Optical dispersion

The optical dispersion for the OC192/STM64/1.5SR1 port units is 800 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC192/STM64/1.5SR1 port units.

Table B-3 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The table below provides transmission specifications for the OC192/STM64/1.5SR1 port units.

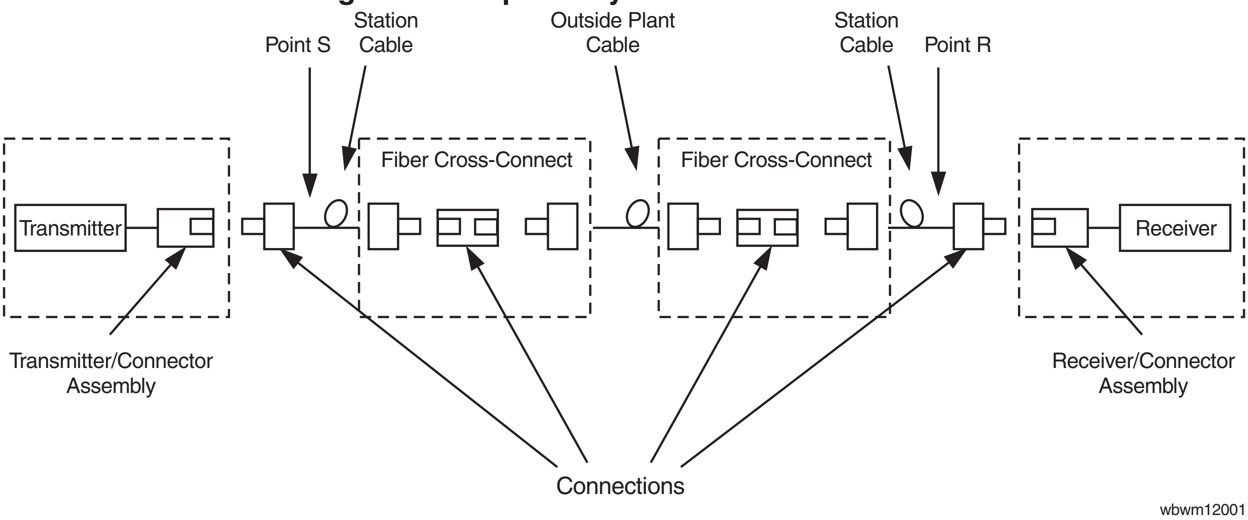
Table B-4 Transmission Specifications for OC192/STM64/1.5SR1 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 9.953 Gbit/s Output: 9.953 Gbit/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1565 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Electro-absorptive Modulated Laser (EML)

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-1 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC192/STM64/1.5SR1 port units.

Table B-5 Optical Loss Budgets for the OC192/STM64/1.5SR1 Port Units

Parameter	OC192/STM64/1.5SR1 Port Unit [(a)]
Maximum Transmitter Output Power (P_{Tmax})[(b)]	2.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[(c)]	-3.0 dBm
Maximum Received Power (P_{Rmax})[(d)]	-13.0 dBm
Receiver Sensitivity (P_{Rmin})[(c)(d)]	-21.0 dBm
Minimum System Gain (S-R)	17.0 dB
Optical Path Penalty (PO)	2.0 dB
Minimum Loss Budget[(e)]	10.0 dB
Maximum Loss Budget[(f)]	15.0 dB

Notes:

(a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar TDM 2.5G/10G (2-Fiber) complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-1.

(c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) These values are measured at a BER of 1x10-12.

(e) This value assumes that the maximum received power limitations are not exceeded.

(f) Dispersion is limited to 40 km for short-reach optics. (50 km can be achieved with FEC.)

□

OC192/STM64/1.5IR1 and OC192/STM64/1.5IRS1 Data Sheet

Overview

This data sheet contains technical specifications for the OC192/STM64/1.5IR1 (LEY69) and OC192/STM64/1.5IRS1 (LEY97) (intermediate reach) port units that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC192/STM64 port unit supports one bidirectional (one receive and one transmit) STM-64 formatted optical signal. The capacity may be translated to 64 STM-1 equivalents or 124,992 two-way voice circuits per fiber pair.

STM-64 access

The following table describes STM-64 capabilities.

Table B-6 OC192/STM64/1.5IR1 /IRS1 Access

Specification	Description
Interface	Intermediate-reach (40 km) interface (this is a typical value; the actual value must be calculated using measuring data, see Figure B-1, “Optical System Interfaces” (B-7))
Growth Increment	One STM-64 per port unit
Line Code	Scrambled NRZ

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/1.5IR1 /IRS1 port unit, is Level 1 in the IEC Classification System.

Optical dispersion

The max. allowed optical dispersion for the OC192/STM64/1.5IR1 port unit is 1200 ps/nm, the value for the OC192/STM64/IRS1 port unit is 800 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC192/STM64/1.5IR1 /IRS1 port units.

Table B-7 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC192/STM64/1.5IR1 /IRS1 port units.

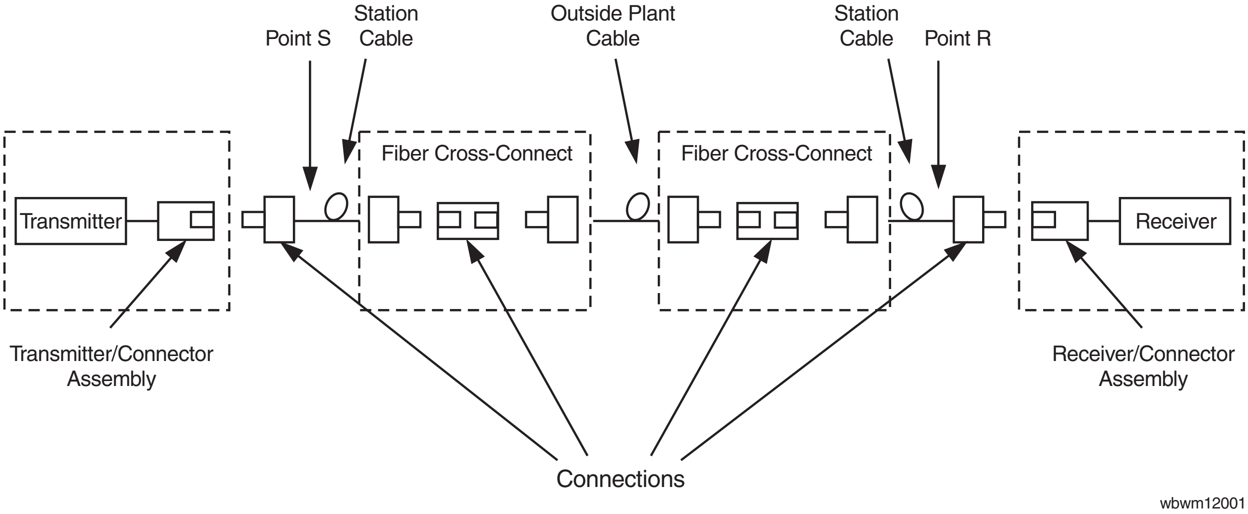
Table B-8 Transmission Specifications for OC192/STM64/1.5IR1 /IRS1 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 9.953 Gbit/s Output: 9.953 Gbit/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1565 nm
Min. side mode suppresion ratio	30 dB
Optical Source	MZ Laser (IR1), Electro-absorptive Modulated Laser (IRS1)

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-2 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC192/STM64/1.5IR1 /IRS1 port units.

Table B-9 Optical Loss Budgets for the OC192/STM64/1.5IR1 /IRS1 Port Units

Parameter	Values IR1[a]	Values IRS1[a]
Maximum Transmitter Output Power (P_{Tmax})[b]	2.0 dBm	2.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[c]	-1.0 dBm	-1.0 dBm
Maximum Received Power (P_{Rmax})[d]	-8.0 dBm	-3.0 dBm
Receiver Sensitivity (P_{Rmin})[c][d]	-21.0 dBm	-14.0 dBm
Minimum System Gain (S-R)	20.0 dB	13.0 dB
Optical Path Penalty (PO)	2.0 dB	2.0 dB
Minimum Loss Budget	10.0 dB	5.0 dB
Maximum Loss Budget[e]	18.0 dB	11.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-2.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded.

□

OC192/STM64/1.5IR1 (LEY69/LEY97) + Optical Booster Amplifier (SEN3) Data Sheet

Overview

This data sheet contains technical specifications for the OC192/STM64IR1 (LEY69) + Optical Booster Amplifier (SEN3) and OC192/STM64IRS1 (LEY97) + Optical Booster Amplifier (SEN3) which together form the OC192/STM64/1.5LR1 (long reach) interface that are used in WaveStar® TDM 10G (STM-64).

Additional information

Be aware of the following:

- The LEY97 paired with the SEN3 will not meet standards.
- Dispersion requirements for an OC192/STM64 long-reach interface are given in section “Parameters of STM-64 Interfaces: Summary” (B-32).

Capacity

Each OC192/STM64/1.5LR1 interface supports one bidirectional (one receive and one transmit) STM-64 formatted optical signal. The capacity may be translated to 64 STM-1 equivalents or 124,992 two-way voice circuits per fiber pair.

STM-64 access

The following table describes STM-64 capabilities.

Table B-10 OC192/STM64/1.5LR1 Access

Specification	Description
Interface	Long-reach (80 km) interface (this is a typical value; the actual value must be calculated using measuring data, see Figure B-3, “Optical System Interfaces” (B-14))
Growth Increment	One STM-64 per port unit
Line Code	Scrambled NRZ

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/1.5IR1 port unit, is Level 1 in the IEC Classification System (IEC825, EN60825). The optical booster amplifier is classified as Level 1 in normal operation and as Level 3A in case of failure. So ALS is not required by the standard, nevertheless it is supported.

Optical dispersion

The allowed optical dispersion for the OC192/STM64/1.5LR1 interface is 1600 ps/nm (if the LEY69 is paired with the SEN3).

Optical return loss

The following table provides the optical return loss for a system using OC192/STM64/1.5LR1 interfaces.

Table B-11 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC192/STM64/1.5LR1 interfaces.

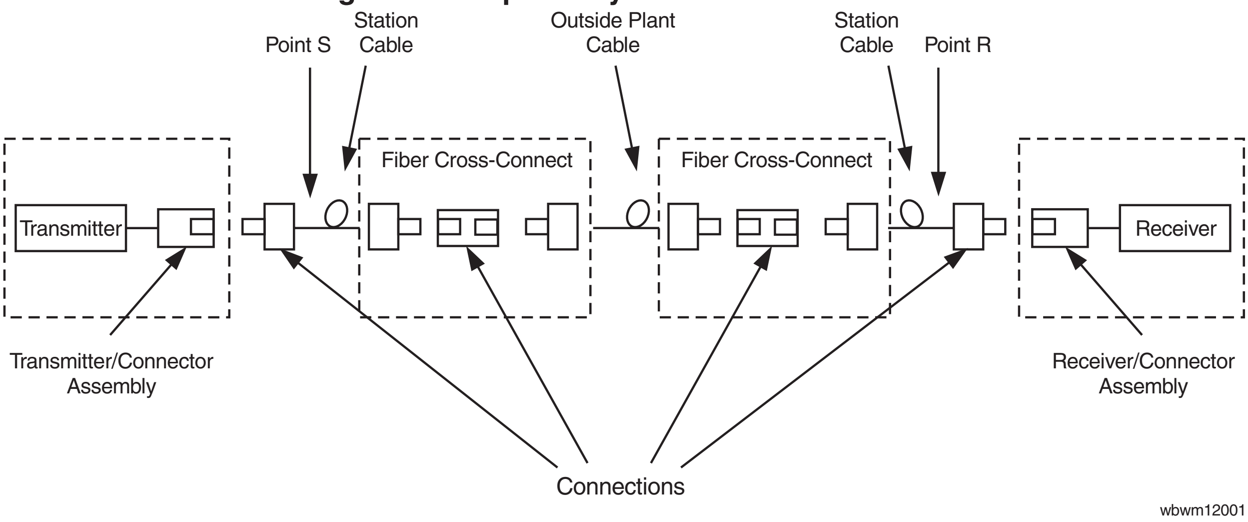
Table B-12 Transmission Specifications for OC192/STM64/1.5LR1 Interfaces

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 9.953 Gbit/s Output: 9.953 Gbit/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1565 nm
Min. side mode suppresion ratio	30 dB

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-3 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC192/STM64/1.5LR1 interfaces.

Table B-13 Optical Loss Budgets for the OC192/STM64/1.5LR1 Interfaces

Parameter	OC192/STM64/1.5LR1Port Units[(a)]	
	Using LEY69/SEN3	Using LEY97/SEN3
Maximum Transmitter Output Power (P_{Tmax})[(b)]	+13 dBm	+13 dBm
Minimum Transmitter Output Power (P_{Tmin})[(c)]	+10 dBm	+10 dBm
Maximum Received Power (P_{Rmax})[(d)]	-8 dBm	-3 dBm
Receiver Sensitivity (P_{Rmin})[(c)(d)]	-21 dBm	-14 dBm
Minimum System Gain (S-R)	18.0 dB	13.0 dB
Optical Path Penalty (PO)	2.0 dB	2.0 dB
Minimum Loss Budget	16.0 dB	11.0 dB
Maximum Loss Budget[(e)]	29.0 dB	22.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-3.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) For Single Mode Fibers (SMF), the dispersion is limited to 80 km.

□

OC192/STM64/DWDM28 (LEY228) + Optical Booster and Pre-Amplifier (SEN4) Data Sheet

Overview

This data sheet contains technical specifications for the OC192/STM64/DWDM28 (LEY228(AE)) + Optical Booster and Pre-Amplifier (SEN4(AE)) which together form the OC192/STM64/1.5VR1 (very long reach) interface V.64.2a/3 that is used in WaveStar® TDM 10G (STM-64). Additionally, two Dispersion Compensation Modules (DCM) are needed: DCM-40 and DCM-50. The numbers indicate the dispersion of Single Mode Fibers (in km) which is corrected by these DCM.

Capacity

Each OC192/STM64/DWDM28 interface supports one bidirectional (one receive and one transmit) STM-64 formatted optical signal. The capacity may be translated to 64 STM-1 equivalents or 124,992 two-way voice circuits per fiber pair.

STM-64 access

The following table describes STM-64 capabilities.

Table B-14 OC192/STM64/1.5LR1 Access

Specification	Description
Interface	Very long-reach (120 km) interface (this is a typical value; the actual value must be calculated using measuring data, see Figure B-4, “Optical System Interfaces” (B-18))
Growth Increment	One STM-64 per port unit
Line Code	Scrambled NRZ

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/DWDM28 port unit, is Level 1 in the IEC Classification System (IEC825, EN60825). The optical booster amplifier is classified as Level 1 in normal operation and as Level 3A in case of failure. So ALS is not required by the standard, nevertheless it is supported.

Optical dispersion

The allowed optical dispersion for the OC192/STM64/DWDM28 interface is 2400 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC192/STM64/DWDM28 interfaces.

Table B-15 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC192/STM64/DWDM28 interfaces.

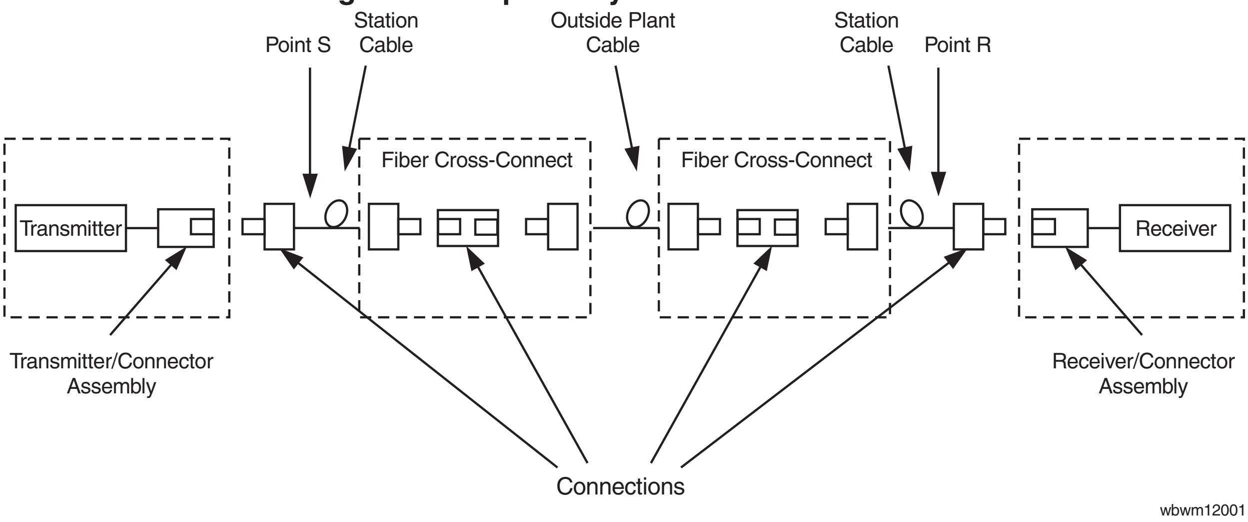
Table B-16 Transmission Specifications for OC192/STM64/DWDM Interfaces

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 9.953 Gbit/s Output: 9.953 Gbit/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1565 nm
Min. side mode suppresion ratio	30 dB

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-4 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC192/STM64/DWDM28 interfaces including OBPA.

Table B-17 Optical Loss Budgets for the OC192/STM64/DWDM28 Interfaces (incl. OBPA)

Parameter	Values(a)
Maximum Transmitter Output Power (P_{Tmax})(b)	+13 dBm
Minimum Transmitter Output Power (P_{Tmin})(c)	+10 dBm
Maximum Received Power (P_{Rmax})(d)	-9 dBm
Receiver Sensitivity (P_{Rmin})(c)(d)	-25 dBm
Minimum System Gain (S-R)	35.0 dB
Optical Path Penalty (PO)	2.0 dB
Minimum Loss Budget	22.0 dB
Maximum Loss Budget(e)	33.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-4.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The VLR interface is specified to 120 km for SMF acc. to ITU-T Rec. G.691. Tests have shown that, depending on the fiber properties, also more distance is possible. For more details please contact your account responsible.

□

OC192/STM64 Interface with External Optical Amplifiers

Overview

This data sheet contains technical specifications for an OC192/STM64 interface with attached external optical amplifiers manufactured by Ditech Communications Corporation. By using a booster amplifier and a pre-amplifier, single span lengths of up to 150 km can be achieved. It is also possible to additionally use optical inline amplifiers for multiple span applications (for distances beyond 150 km between two WaveStar® TDM 10G (STM-64) multiplexers).

Capacity

The external optical amplifiers are used in conjunction with OC192/STM64 port units from the DWDM compatible versions, the OC192/STM64/DWDM port units (LEY228), transmitting at a wavelength of 1549.32 nm (cf. "OC192/STM64/DWDM01-40 Data Sheet" (B-24)). The OC192/STM64/DWDM port unit supports one bidirectional (one receive and one transmit) STM-64 formatted, ITU-compatible optical signal. The capacity may be translated to 64 STM-1 equivalents or 124,992 two-way voice circuits per fiber pair.

Optical Safety

Optical safety data on laser-containing port units, such as the OC192/STM64/DWDM port unit, is Level 1 in the IEC Classification System (IEC825, EN60825). The Ditech external amplifiers are classified as either Level 1 or Level 3A depending on the types. When a loss of the optical input signal is detected, there is an automatic shutdown of the output signal of the amplifiers.

Amplifier Types

The following table gives an overview of the available amplifier types, i.e. booster, inline and pre-amplifiers. To serve application specific needs, several booster amplifiers with different gain are offered. In the next sections, detailed optical parameters of the amplifiers are shown.

Ditech Designation	Type
STAR T10	Booster Amplifier, output power over input power range ≤ 10 dBm
STAR T13	Booster Amplifier, output power over input power range ≤ 13 dBm
STAR T16	Booster Amplifier, output power over input power range ≤ 16 dBm
STAR LMA19	Inline Amplifier, gain over input range ≤ 33 dB
STAR PFG	Pre-Amplifier, gain over input range ≤ 28 dB

STAR T10: Optical Parameters

Parameter	Unit	Min	Typ	Max	Condition
Input Power	dBm	– 1.5		+ 2.5	
Output Power	dBm	9.5	10	11	0 dBm input
Operating Wavelength	nm	1535		1560	
Output Variation over Wavelength / Polarization	dB			1.0	– 3 dBm input
Output Stability	dB			0.5	Over temperature range
Noise Figure	dB	4.5	5	5.5	OSNR method, 0 dBm input
Optical Feedback	dB			– 40	From input & output ports
Residual Pump Power	dBm			– 30	Output port

STAR T13: Optical Parameters

Parameter	Unit	Min	Typ	Max	Condition
Input Power	dBm	– 1.5		+ 2.5	
Output Power	dBm	12.5	13	14	0 dBm input
Operating Wavelength	nm	1535		1560	
Output Variation over Wavelength / Polarization	dB			1.0	– 3 dBm input
Output Stability	dB			0.5	Over temperature range
Noise Figure	dB	4.5	5	5.5	OSNR method, 0 dBm input
Optical Feedback	dB			– 40	From input & output ports
Residual Pump Power	dBm			– 30	Output port

STAR T16: Optical Parameters

Parameter	Unit	Min	Typ	Max	Condition
Input Power	dBm	– 1.5		+ 2.5	
Output Power	dBm	15.5	16	16.5	0 dBm input
Operating Wavelength	nm	1535		1560	
Output Variation over Wavelength / Polarization	dB			0.8	– 3 dBm input
Output Stability	dB			0.5	Over temperature range
Noise Figure	dB	4.5	5	5.5	OSNR method, 0 dBm input
Optical Feedback	dB			– 40	From input & output ports
Residual Pump Power	dBm			– 30	Output port

STAR LMA19: Optical Parameters

Parameter	Unit	Min	Typ	Max	Condition
Input Power	dBm	– 31	– 20	– 10	
Gain	dBm	23	28	30	Over the input range
Operating Wavelength	nm	1548		1560	
Output Variation over Wavelength / Polarization	dB			1.0	– 15 dBm input
Output Stability	dB			0.5	Over temperature range
Noise Figure	dB	5.0	5.5	6.0	OSNR method, –20 dBm input first stage and –20 dBm input second stage
Optical Feedback	dB			– 40	From input & output ports

Parameter	Unit	Min	Typ	Max	Condition
Residual Pump Power	dBm			– 30	Output port

STAR PFG: Optical Parameters

Parameter	Unit	Min	Typ	Max	Condition
Input Power	dBm	– 20	– 15	– 10	
Gain	dBm	23	25	28	Over the input range EOL
Output Power	dBm	3		13	With Filter
Operating Wavelength	nm	1530		1560	0.5 nm filter per ITU Rec. G.692
Filter Drift	nm/°C			0.003	
Polarization Mode Dispersion	ps		0.2		
Output Stability	dB			0.5	–20 dBm input
Noise Figure	dB	4.0	4.5	5.0	OSNR method, – 15 dBm input
Optical Feedback	dB			– 40	From input & output ports
Residual Pump Power	dBm			– 40	Output port

□

OC192/STM64/DWDM01-40 Data Sheet

Overview

This data sheet contains technical specifications for the OC192/STM64/WDM9580–WDM9190 port units (LEY201...LEY240). These circuit packs are suitable for direct interworking with OLS400G, i.e., no Optical Translator Unit (OTU) is needed.

Capacity

Each OC192/STM64/DWDM01-40 port unit supports one bidirectional (one receive and one transmit) STM-64 formatted, ITU-compatible optical signal. The capacity may be translated to 64 STM-1 equivalents or 124,992 two-way voice circuits per fiber pair.

STM-64 access

The following table describes STM-64 capabilities.

Table B-18 OC192/STM64/DWDM01-40 Access

Specification	Description
Interface	Intermediate-reach (40 km) interface (this is a typical value)
Growth Increment	One STM-64 per port unit
Line Code	Scrambled NRZ

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/DWDM01-40 port units, is Level 1 in the IEC Classification System.

Optical dispersion

The optical dispersion for the OC192/STM64/DWDM01-40 port units is dependant on the infrastructure used. On the OLS side, dispersion compensation fibers can be used.

Optical return loss

The following table provides the optical return loss for a system using OC192/STM64/DWDM01-40 port units.

Table B-19 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC192/STM64/DWDM01-40 port units.

Table B-20 Transmission Specifications for OC192/STM64/DWDM01-40

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	LC-type connectors, for the attenuators please consult the OLS 400G APG
Optical Line Rate	Input: 2.488 Gbit/s Output: 2.488 Gbit/s
Transmitter Wavelengths (refer to Table B-21, "OC192/STM64/ DWDM01-40 Port Unit Operating Wavelengths" (B-25) for a complete list of the operating wavelengths)	Minimum: 1531 nm Maximum: 1563 nm
Minimum SMSR	35 dB

Operating wavelengths

The following table lists the operating wavelengths for the OC192/STM64/DWDM01-40 port units.

Table B-21 OC192/STM64/DWDM01-40 Port Unit Operating Wavelengths

Item Code	Port Unit	f (THz)	Wavelength (nm)
LEY201	OC192/STM64/DWDM01	195.8	1531.116
LEY202	OC192/STM64/DWDM02	195.7	1531.898
LEY203	OC192/STM64/DWDM03	195.6	1532.681
LEY204	OC192/STM64/DWDM04	195.5	1533.465
LEY205	OC192/STM64/DWDM05	195.4	1534.250
LEY206	OC192/STM64/DWDM06	195.3	1535.035

Table B-21 OC192/STM64/DWDM01-40 Port Unit Operating Wavelengths (continued)

Item Code	Port Unit	f (THz)	Wavelength (nm)
LEY207	OC192/STM64/DWDM07	195.2	1535.822
LEY208	OC192/STM64/DWDM08	195.1	1536.609
LEY209	OC192/STM64/DWDM09	195.0	1537.397
LEY210	OC192/STM64/DWDM10	194.9	1538.186
LEY211	OC192/STM64/DWDM11	194.8	1538.975
LEY212	OC192/STM64/DWDM12	194.7	1539.766
LEY213	OC192/STM64/DWDM13	194.6	1540.557
LEY214	OC192/STM64/DWDM14	194.5	1541.349
LEY215	OC192/STM64/DWDM15	194.4	1542.142
LEY216	OC192/STM64/DWDM16	194.3	1542.936
LEY217	OC192/STM64/DWDM17	194.2	1543.730
LEY218	OC192/STM64/DWDM18	194.1	1544.526
LEY219	OC192/STM64/DWDM19	194.0	1545.322
LEY220	OC192/STM64/DWDM20	193.9	1546.119
LEY221	OC192/STM64/DWDM21	193.8	1546.917
LEY222	OC192/STM64/DWDM22	193.7	1547.715
LEY223	OC192/STM64/DWDM23	193.6	1548.515
LEY224	OC192/STM64/DWDM24	193.5	1549.315
LEY225	OC192/STM64/DWDM25	193.4	1550.116
LEY226	OC192/STM64/DWDM26	193.3	1550.918
LEY227	OC192/STM64/DWDM27	193.2	1551.721
LEY228	OC192/STM64/DWDM28	193.1	1552.524
LEY229	OC192/STM64/DWDM29	193.0	1553.329
LEY230	OC192/STM64/DWDM30	192.9	1554.134
LEY231	OC192/STM64/DWDM31	192.8	1554.940
LEY232	OC192/STM64/DWDM32	192.7	1555.747
LEY233	OC192/STM64/DWDM33	192.6	1556.555
LEY234	OC192/STM64/DWDM34	192.5	1557.363
LEY235	OC192/STM64/DWDM35	192.4	1558.173
LEY236	OC192/STM64/DWDM36	192.3	1558.983
LEY237	OC192/STM64/DWDM37	192.2	1559.794

Table B-21 OC192/STM64/DWDM01-40 Port Unit Operating Wavelengths (continued)

Item Code	Port Unit	f (THz)	Wavelength (nm)
LEY238	OC192/STM64/DWDM38	192.1	1560.606
LEY239	OC192/STM64/DWDM39	192.0	1561.419
LEY240	OC192/STM64/DWDM40	191.9	1562.233

Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC192/STM64/DWDM01-40 port units.

Table B-22 Optical Loss Budgets for the OC192/STM64/DWDM01-40 port units

Parameter	Values
Maximum Transmitter Output Power (P_{Tmax})	-4.6 dBm
Minimum Transmitter Output Power (P_{Tmin})	-5.7 dBm
Maximum Received Power (P_{Rmax})	-13 dBm
Receiver Sensitivity (P_{Rmin})	-20 dBm
Optical Path Penalty (PO)	2.0 dB
Minimum Loss Budget	7.7 dB
Maximum Loss Budget	11.8 dB

OC192/STM64/POU Data Sheet

Overview

This data sheet contains technical specifications for the OC192/STM64/POU passive port units (LEY284...LEY299) that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC192/STM64/POU port unit supports one bidirectional (one receive and one transmit) STM-64 formatted optical signal. The capacity may be translated to 64 STM-1 equivalents or 124,992 two-way voice circuits per fiber pair.

STM-64 access

The table below describes STM-64 capabilities.

Table B-23 OC192/STM64/POU Access

Specification	Description
Interface	Short-reach (40 km) interface(a)
Growth Increment	One STM-64 per port unit
Line Code	Scrambled NRZ

Notes:

1. (a) The 40 km assumes that you are using 16mux+16mux passive optics box with FEC enabled.

Protection switching

The table below describes protection switching information per high speed line.

Table B-24 Protection Switching for OC192/STM64/POU Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-3} to 10^{-9} (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER $^{3}10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC192/STM64/POU port unit, is Class 1 in the IEC Classification System.

Optical dispersion

The optical dispersion for the OC192/STM64/POU port units is 1200 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC192/STM64/POU port units.

Table B-25 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The table below provides transmission specifications for the OC192/STM64/POU port units.

Table B-26 Transmission Specifications for OC192/STM64/POU Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 9.953 Gb/s Output: 9.953 Gb/s
Transmitter Wavelengths	Minimum: 1530 nm Maximum: 1565 nm
Spectral Width	0.07 nm (RMS)
Optical Source	CW[(a)] Laser with a Mach-Zender Modulator

Notes:

1. (a) Continuous Wave

Operating wavelengths

The table below lists the operating wavelengths for the OC192/STM64/POU port units.

Table B-27 OC192/STM64/POU Port Unit Operating Wavelengths

Item Code	Port Unit	f (THz)	Wavelength (nm)
LEY284AE	OC192/STM64/POU9590	195.90	1530.334
LEY285AE	OC192/STM64/POU9570	195.70	1531.898
LEY286AE	OC192/STM64/POU9550	195.50	1533.465
LEY287AE	OC192/STM64/POU9530	195.30	1535.036
LEY288AE	OC192/STM64/POU9490	194.90	1538.186
LEY289AE	OC192/STM64/POU9470	194.70	1539.766
LEY290AE	OC192/STM64/POU9450	194.50	1541.349
LEY291AE	OC192/STM64/POU9430	194.30	1542.936
LEY292AE	OC192/STM64/POU9370	193.70	1547.715
LEY293AE	OC192/STM64/POU9350	193.50	1549.315
LEY294AE	OC192/STM64/POU9330	193.30	1550.918
LEY295AE	OC192/STM64/POU9310	193.10	1552.524
LEY296AE	OC192/STM64/POU9270	192.70	1555.747
LEY297AE	OC192/STM64/POU9250	192.50	1557.363
LEY298AE	OC192/STM64/POU9230	192.30	1558.983
LEY299AE	OC192/STM64/POU9210	192.10	1560.606

Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the OC192/STM64/POU port units.

Table B-28 Optical Loss Budgets for the OC192/STM64/POU Port Units

Parameter	OC192/STM64/POU Port Unit[a]	
	16mux/demux box	32mux/demux box (consists of 16mux/demux + 16muxint/demuxint)
Max. Transmitter Output Power (P_{Tmax})[b]	2.0 dBm	2.0 dBm
Min. Transmitter Output Power (P_{Tmin})[c]	0.0 dBm	0.0 dBm

Table B-28 Optical Loss Budgets for the OC192/STM64/POU Port Units (continued)

Parameter	**OC192/STM64/POU Port Unit[a]**	
	16mux/demux box	**32mux/demux box (consists of 16mux/demux + 16muxint/demuxint)**
Maximum Received Power (P_{Rmax})[d]	-8.0 dBm	-8.0 dBm
Receiver Sensitivity (P_{Rmin})[c][d]	-21.0 dBm	-21.0 dBm
Minimum System Gain (S-R)	20.0 dB	20.0 dB
Optical Path Penalty (PO)	2.0 dB	2.0 dB
Minimum Loss Budget	10.0 dB	10.0 dB
Max. mux/demux insertion loss	6.4 dB	10.2 dB
Maximum Loss Budget	11.6 dB	7.8 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber.
2. (b) Transmit and receive points are referenced as points S and R in Figure B-3.
3. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.
4. (d) These values are measured at a BER of 1x10E-12.

□

Parameters of STM-64 Interfaces: Summary

Summary

The following table lists the optical parameters of all STM-64 interface units.

		Reference Interface G.691 S-64.2b	LEY67 (DA'ed)	LEY69	LEY97	LEY201-LEY240	LEY284-LEY299	Reference Interface G.691 L-64.2b	LEY97 +SEN3	LEY69 +SEN3	Reference Interface G.691 V-64.2a	LEY228 +SEN4
Typical Distance	km	40	40	60	40	40	40	80	80 (SSM)	90 (SSM)	120	120
Transmitter Reference Point MPI-S												
Type of Laser Diode	-	-	EML	MZ	EML	MZ	MZ	EML/MZM+ booster	EML + booster	MZ + booster	-	MZ + booster
Operating Wavelength	nm	1530-1565	1530-1565	1530-1565	1530-1565	1531-1563	1530-1565	1530-1565	1530-1565	1530-1565	1530-1565	1552.52
Mean Launched power min...max	dBm	-1...+2	-4...+2	-1...+2	-1...+2	-6.2...-4.8	-1...+1	+10...+13	+10...+13	+10...+13	+10...+13	+10...+13
Source Chirp	-	ffs	-1...+0.1	-1...+0.2	-1...+0.1	-1...+0.1	-1...+0.2	ffs	-1...+0.1	-1...+0.1	ffs	-1...+0.1
Side Mode Suppression Ratio min	dB	30	30	30	30	35	30	ffs	30	30	ffs	30
Extinction Ratio min	dB	8.2	10	10	10	12	10	8.2	8.2	8.2	10	N/A
Receiver Reference Point MPI-R												
Receiver Sensitivity min	dBm	-18	-18.5	-21	-14	-20	-21	-14	-14	-21	-25	-25
Receiver Overload min	dBm	-8	-13	-8	-3	-12.5	-8	-3	-3	-8	-9	-9
Path Penalty max	dB	2	2	2	2	2	2	2	2	2	2	2
Receiver Reflectance max	dB	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27

		Reference Interface G.691 S-64.2b	**LEY67 (DA'ed)**	**LEY69**	**LEY97**	**LEY201-LEY240**	**LEY284-LEY299**	**Reference Interface G.691 L-64.2b**	**LEY97 +SEN3**	**LEY69 +SEN3**	**Reference Interface G.691 V-64.2a**	**LEY228 +SEN4**
OSNR min	dB	-	24	24	24	18.5	24	-	24	24	-	28 (inband FEC: 25dB, outband FEC: 22dB)
Main Optical Path MPI-S to MPI-R												
Attenuation Range min...max	dB	7...11	12.5	10...18	5...11	7.7...11.8	9...18	1622	16...22	21...29	22...33	22...33 (42) (depends on DCM usage)
Chromatic Dispersion max	ps/nm	800	800	1200	800	1000	1200	1600	1500	1600	2400	2400

□

OC48/STM16 Port Unit Data Sheets

Overview

Purpose This section contains technical specifications for the OC48/STM16 port units that are used in WaveStar® TDM 10G (STM-64).

Contents

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OC48/STM16/1.3VSR1 Data Sheet

Overview

This data sheet contains technical specifications for the OC48/STM16/1.3VSR1 (very short-reach) port units (LEY182) that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC48/STM16/1.3VSR1 port unit supports one bidirectional (one receive and one transmit) STM-16 formatted optical signal. The capacity may be translated to 48 STS-1 equivalents or 32,256 two-way voice circuits per port unit.

STM-16 access

The table below describes STM-16 capabilities.

Table B-29 OC48/STM16/1.3VSR1 Access

Specification	Description
Interface	very short-reach (1-2 km) interface
Growth Increment	One STM-16 per port unit
Line Code	Scrambled NRZ

Protection switching

The table below describes protection switching information per high speed line.

Table B-30 Protection Switching for OC48/STM16/1.3VSR1 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-3} to 10^{-9} (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER $^{3}10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/1.3VSR1 port unit, is Class 1 in the IEC Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/1.3VSR1 port units is 12 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC48/STM16/1.3VSR1 port units.

Table B-31 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–14.0 dB
Maximum discrete reflectance	–14.0 dB

Transmission specifications

The table below provides transmission specifications for the OC48/STM16/1.3VSR1 port units.

Table B-32 Transmission Specifications for OC48/STM16/1.3VSR1 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gb/s Output: 2.488 Gb/s
Transmitter Wavelengths	Minimum: 1280 nm Maximum: 1335 nm
Spectral Width	3.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser

Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the OC48/STM16/1.3VSR1 port units.

Table B-33 Optical Loss Budgets for the OC48/STM16/1.3VSR1 Port Units

Parameter	OC48/STM16/1.3VSR1 Port Unit [(a)]
Maximum Transmitter Output Power (P_{Tmax})[(b)]	-1.0 dBm

Table B-33 Optical Loss Budgets for the OC48/STM16/1.3VSR1 Port Units (continued)

Parameter	**OC48/STM16/1.3VSR1 Port Unit** [(a)]
Minimum Transmitter Output Power (P_{Tmin})[(c)]	-6.0 dBm
Maximum Received Power (P_{Rmax})[(d)]	-1.0 dBm
Receiver Sensitivity (P_{Rmin})[(c)(d)]	-14.0 dBm
Minimum System Gain (S-R)	5.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget[(e)]	0.0 dB
Maximum Loss Budget[(f)]	4.0 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber.
2. (b) Transmit and receive points are referenced as points S and R in Figure B-6.
3. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.
4. (d) These values are measured at a BER of 1x10E-12.
5. (e) This value assumes that the maximum received power limitations are not exceeded.
6. (f) Loss is dispersion limited and not power limited.

□

OC48/STM16/1.3LR1 Data Sheet

Overview

This data sheet contains technical specifications for the OC48/STM16/1.3LR1 (long reach, LEY7) port units that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC48/STM16/1.3LR1 port unit supports one bidirectional (one receive and one transmit) STM-16 formatted optical signal.

STM-16 access

The following table describes STM-16 capabilities.

Table B-34 OC48/STM16/1.3LR1 Access

Specification	Description
Interface	Long-reach (51 km) interface (this is a typical value; the actual value must be calculated using measuring data, see theFigure B-5, “Optical System Interfaces” (B-42))
Growth Increment	One STM-16 per port unit
Line Code	Scrambled NRZ

Protection switching

The following table describes protection switching information per high speed line.

Table B-35 Protection Switching for OC48/STM16/1.3LR1 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/1.3LR1 port unit, is Level 1 in the IEC Classification System.

Optical dispersion

The max. allowed optical dispersion for the OC48/STM16/1.3LR1 port unit is 300 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC48/STM16/1.3LR1 port units.

Table B-36 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC48/STM16/1.3LR1 port units.

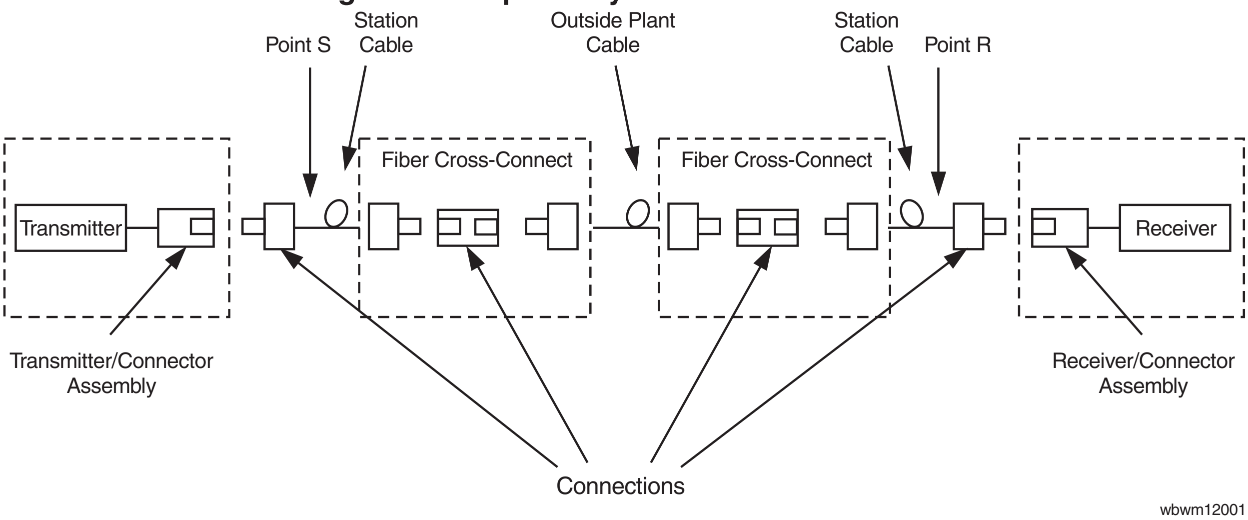
Table B-37 Transmission Specifications for OC48/STM16/1.3LR1 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gbit/s Output: 2.488 Gbit/s
Transmitter Wavelengths	Minimum: 1280 nm Maximum: 1335 nm
Spectral Width	less than 1.0 nm
Minimum Side Mode Suppression Ratio (SMSR)	30 dB
Optical Source	Distributed Feedback (DFB) laser

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-5 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC48/STM16/1.3LR1 port units.

Table B-38 Optical Loss Budgets for the OC48/STM16/1.3LR1 Port Units

Parameter	**Values**[(a)]
Maximum Transmitter Output Power (P_{Tmax})[(b)]	3.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[(c)]	-2.0 dBm
Maximum Received Power (P_{Rmax})[(d)]	-9.0 dBm
Receiver Sensitivity (P_{Rmin})[(c)(d)]	-27.0 dBm
Minimum System Gain (S-R)	25.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget	10.0 dB
Maximum Loss Budget[(e)]	24.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-5.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded. Dispersion is limited to 92 km for long reach optics.

□

OC48/STM16/1.5LR1 Data Sheet

Overview

This data sheet contains technical specifications for the OC48/STM16/1.5LR1 (long reach, LEY8) port units that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC48/STM16/1.5LR1 port unit supports one bidirectional (one receive and one transmit) STM-16 formatted optical signal.

STM-16 access

The following table describes STM-16 capabilities.

Table B-39 OC48/STM16/1.5LR1 Access

Specification	Description
Interface	Long-reach (80 km) interface (this is a typical value; the actual value must be calculated using measuring data, see theFigure B-6, "Optical System Interfaces" (B-46))
Growth Increment	One STM-16 per port unit
Line Code	Scrambled NRZ

Protection switching

The following table describes protection switching information per high speed line.

Table B-40 Protection Switching for OC48/STM16/1.5LR1 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/1.5LR1 port unit, is Level 1 in the IEC Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/1.5LR1 port units is 1800 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC48/STM16/1.5LR1 port units.

Table B-41 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC48/STM16/1.5LR1 port units.

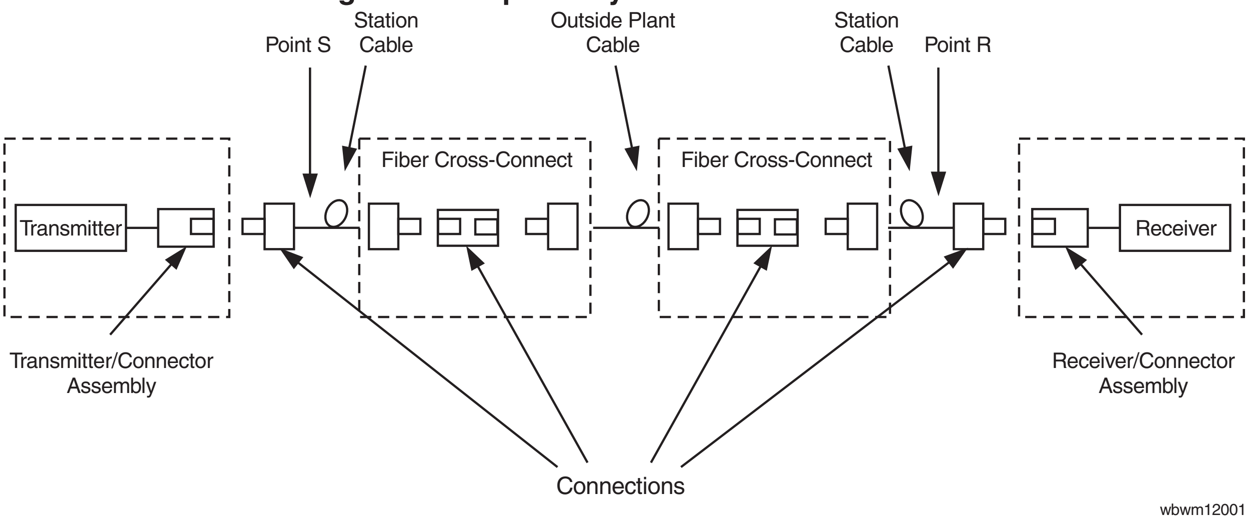
Table B-42 Transmission Specifications for OC48/STM16/1.5LR1 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gbit/s Output: 2.488 Gbit/s
Transmitter Wavelengths	Minimum: 1550 nm Maximum: 1580 nm
Spectral Width	less than 1.0 nm
Minimum Side Mode Suppression Ratio (SMSR)	30 dB
Optical Source	Distributed Feedback (DFB) laser

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-6 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC48/STM16/1.5LR1 port units.

Table B-43 Optical Loss Budgets for the OC48/STM16/1.5LR1 Port Units

Parameter	Values[a]
Maximum Transmitter Output Power (P_{Tmax})[b]	3.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[c]	-2.0 dBm
Maximum Received Power (P_{Rmax})[d]	-9.0 dBm
Receiver Sensitivity (P_{Rmin})[c][d]	-28.0 dBm
Minimum System Gain (S-R)	26.0 dB
Optical Path Penalty (PO)	2.0 dB
Minimum Loss Budget	10.0 dB
Maximum Loss Budget[e]	24.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-6

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded. Dispersion is limited to 92 km for long reach optics.

□

OC48/STM16/WDM (LEY101–LEY180 for OLS400G) Data Sheet

Overview

This data sheet contains technical specifications for the OC48/STM16/WDM port units that are used in WaveStar® TDM 10G.

Capacity

This data sheet contains technical specifications for the OC48/STM16/WDM port units that are used in WaveStar® TDM 10G (STM-64). These circuit packs are suitable for direct interworking with OLS 400G, i.e., no Optical Translator Unit (OTU) is needed.

STM-16 access

The following table describes STM-16 capabilities.

Table B-44 OC48/STM16/WDM Access

Specification	Description
Interface	Long-reach (80 km) interface (this is a typical value)
Growth Increment	One STM-16 per port unit
Line Code	Scrambled NRZ

Protection switching

The table below describes protection switching information per high speed line.

Table B-45 Protection Switching for OC48/STM16/WDM Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-3} to 10^{-9} (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER ^{3}10-3 line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/WDM port units, is Class I in the FDA/CDRH Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/WDM port units is 1800 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC48/STM16/WDM port units.

Table B-46 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The table below provides transmission specifications for the OC48/STM16/WDM port units.

Table B-47 Transmission Specifications for OC48/STM16/WDM

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gb/s Output: 2.488 Gb/s
Transmitter Wavelengths	Minimum: 1549 nm Maximum: 1560 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser

Operating wavelengths

The table below lists the operating wavelengths for the OC48/STM16/WDM port units.

Table B-48 OC48/STM16/WDM Port Unit Operating Wavelengths

Item Code	Port Unit	Wavelength (nm)
LEY101	OC48/STM16/WDM9585	1530.72
LEY102	OC48/STM16/WDM9580	1531.11

Table B-48 OC48/STM16/WDM Port Unit Operating Wavelengths (continued)

LEY103	OC48/STM16/WDM9575	1531.50
LEY104	OC48/STM16/WDM9570	1531.89
LEY105	OC48/STM16/WDM9565	1532.28
LEY106	OC48/STM16/WDM9560	1532.68
LEY107	OC48/STM16/WDM9555	1533.07
LEY108	OC48/STM16/WDM9550	1533.46
LEY109	OC48/STM16/WDM9545	1533.85
LEY110	OC48/STM16/WDM9540	1534.25
LEY111	OC48/STM16/WDM9535	1534.64
LEY112	OC48/STM16/WDM9530	1535.03
LEY113	OC48/STM16/WDM9525	1535.42
LEY114	OC48/STM16/WDM9520	1535.82
LEY115	OC48/STM16/WDM9515	1536.21
LEY116	OC48/STM16/WDM9510	1536.60
LEY117	OC48/STM16/WDM9505	1537.00
LEY118	OC48/STM16/WDM9500	1537.39
LEY119	OC48/STM16/WDM9495	1537.79
LEY120	OC48/STM16/WDM9490	1538.18
LEY121	OC48/STM16/WDM9485	1538.58
LEY122	OC48/STM16/WDM9480	1538.97
LEY123	OC48/STM16/WDM9475	1539.37
LEY124	OC48/STM16/WDM9470	1539.76
LEY125	OC48/STM16/WDM9465	1540.16
LEY126	OC48/STM16/WDM9460	1540.55
LEY127	OC48/STM16/WDM9455	1540.95
LEY128	OC48/STM16/WDM9450	1541.34
LEY129	OC48/STM16/WDM9445	1541.74
LEY130	OC48/STM16/WDM9440	1542.14
LEY131	OC48/STM16/WDM9435	1542.53
LEY132	OC48/STM16/WDM9430	1542.93
LEY133	OC48/STM16/WDM9425	1543.33
LEY134	OC48/STM16/WDM9420	1543.73
LEY135	OC48/STM16/WDM9415	1544.12

Table B-48 OC48/STM16/WDM Port Unit Operating Wavelengths (continued)

LEY136	OC48/STM16/WDM9410	1544.52
LEY137	OC48/STM16/WDM9405	1544.92
LEY138	OC48/STM16/WDM9400	1545.32
LEY139	OC48/STM16/WDM9395	1545.72
LEY140	OC48/STM16/WDM9390	1546.11
LEY141	OC48/STM16/WDM9385	1546.51
LEY142	OC48/STM16/WDM9380	1546.91
LEY143	OC48/STM16/WDM9375	1547.31
LEY144	OC48/STM16/WDM9370	1547.71
LEY145	OC48/STM16/WDM9365	1548.11
LEY146	OC48/STM16/WDM9360	1548.51
LEY147	OC48/STM16/WDM9355	1548.91
LEY148	OC48/STM16/WDM9350	1549.31
LEY149	OC48/STM16/WDM9345	1549.71
LEY150	OC48/STM16/WDM9340	1550.11
LEY151	OC48/STM16/WDM9335	1550.11
LEY152	OC48/STM16/WDM9330	1550.91
LEY153	OC48/STM16/WDM9325	1551.31
LEY154	OC48/STM16/WDM9320	1551.72
LEY155	OC48/STM16/WDM9315	1552.12
LEY156	OC48/STM16/WDM9310	1552.52
LEY157	OC48/STM16/WDM9305	1552.92
LEY158	OC48/STM16/WDM9300	1553.32
LEY159	OC48/STM16/WDM9295	1553.73
LEY160	OC48/STM16/WDM9290	1554.13
LEY161	OC48/STM16/WDM9285	1554.53
LEY162	OC48/STM16/WDM9280	1554.94
LEY163	OC48/STM16/WDM9275	1555.34
LEY164	OC48/STM16/WDM9270	1555.74
LEY165	OC48/STM16/WDM9265	1556.15
LEY166	OC48/STM16/WDM9260	1556.55
LEY167	OC48/STM16/WDM9255	1556.95
LEY168	OC48/STM16/WDM9250	1557.36

Table B-48 OC48/STM16/WDM Port Unit Operating Wavelengths (continued)

LEY169	OC48/STM16/WDM9245	1557.76
LEY170	OC48/STM16/WDM9240	1558.17
LEY171	OC48/STM16/WDM9235	1558.57
LEY172	OC48/STM16/WDM9230	1558.98
LEY173	OC48/STM16/WDM9225	1559.38
LEY174	OC48/STM16/WDM9220	1559.79
LEY175	OC48/STM16/WDM9215	1560.20
LEY176	OC48/STM16/WDM9210	1560.60
LEY177	OC48/STM16/WDM9205	1561.01
LEY178	OC48/STM16/WDM9200	1561.41
LEY179	OC48/STM16/WDM9195	1561.82
LEY180	OC48/STM16/WDM9190	1562.23

Optical power values

The following table lists the optical power values for the OC48/STM16/WDM port units. For calculating the loss budgets, refer to the “WaveStar® OLS 400G Applications, Planning, and Ordering Guide”.

Table B-49 Optical power values for the OC48/STM16/WDM port units

Parameter	Values
Maximum Transmitter Output Power (P_{Tmax})	2.0 dBm
Minimum Transmitter Output Power (P_{Tmin})	0.0 dBm
Maximum Received Power (P_{Rmax})	-8.0 dBm
Receiver Sensitivity (P_{Rmin})	-21.0 dBm

□

OC48/STM16/DWDM01-16 (for OLS80G) Data Sheet

Overview

This data sheet contains technical specifications for the OC48/STM16/DWDM01-16 port units (LEY50...LEY65) that are used in WaveStar® TDM 10G (STM-64). These circuit packs are suitable for direct interworking with OLS 80G, i.e., no Optical Translator Unit (OTU) is needed.

Capacity

Each OC48/STM16/DWDM01-16 port unit supports one bidirectional (one receive and one transmit) STM-16 formatted, ITU-compatible optical signal. The capacity may be translated to16 STM-1 equivalents or 32,256 two-way voice circuits per fiber pair.

STM-16 access

The following table describes STM-16 capabilities.

Table B-50 OC48/STM16/DWDM01-16 Access

Specification	Description
Interface	Long-reach (80 km) interface (this is a typical value)
Growth Increment	One STM-16 per port unit
Line Code	Scrambled NRZ

Protection switching

The following table describes protection switching information per high speed line.

Table B-51 Protection Switching for OC48/STM16/DWDM01-16 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/DWDM01-16 port units, is Level 1 in the IEC Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/DWDM01-16 port units is 1800 ps/nm.

Optical return loss The following table provides the optical return loss for a system using OC48/STM16/DWDM01-16 port units.

Table B-52 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications The following table provides transmission specifications for the OC48/STM16/DWDM01-16 port units.

Table B-53 Transmission Specifications for OC48/STM16/DWDM01-16

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gbit/s Output: 2.488 Gbit/s
Transmitter Wavelengths	Minimum: 1549 nm Maximum: 1560 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser

Operating wavelengths The following table lists the operating wavelengths for the OC48/STM16/DWDM01-16 port units.

Table B-54 OC48/STM16/DWDM01-16 Port Unit Operating Wavelengths

Item Code	Port Unit	Channel	Wavelength (nm)
LEY50	OC48/STM16/DWDM01	1	1549.32

Table B-54 OC48/STM16/DWDM01-16 Port Unit Operating Wavelengths (continued)

Item Code	Port Unit	Channel	Wavelength (nm)
LEY51	OC48/STM16/DWDM02	2	1550.92
LEY52	OC48/STM16/DWDM03	3	1552.52
LEY53	OC48/STM16/DWDM04	4	1554.13
LEY54	OC48/STM16/DWDM05	5	1555.75
LEY55	OC48/STM16/DWDM06	6	1557.36
LEY56	OC48/STM16/DWDM07	7	1558.98
LEY57	OC48/STM16/DWDM08	8	1560.61
LEY58	OC48/STM16/DWDM09	9	1548.52
LEY59	OC48/STM16/DWDM10	10	1550.12
LEY60	OC48/STM16/DWDM11	11	1551.72
LEY61	OC48/STM16/DWDM12	12	1553.33
LEY62	OC48/STM16/DWDM13	13	1554.94
LEY63	OC48/STM16/DWDM14	14	1556.56
LEY64	OC48/STM16/DWDM15	15	1558.17
LEY65	OC48/STM16/DWDM16	16	1559.79

Optical power values

The following table lists the optical power values for the OC48/STM16/DWDM01-16 port units. For calculating the loss budgets, refer to the “WaveStar® OLS 80G Applications, Planning, and Ordering Guide”.

Table B-55 Optical power values for the OC48/STM16/DWDM01-16 port units

Parameter	Values
Maximum Transmitter Output Power (P_{Tmax})	-2.0 dBm
Minimum Transmitter Output Power (P_{Tmin})	-8.2 dBm
Maximum Received Power (P_{Rmax})	-12.0 dBm
Receiver Sensitivity (P_{Rmin})	-27.0 dBm

□

OC48/STM16/POU (LEY80AE-LEY95AE) Data Sheet

Overview

This data sheet contains technical specifications for the OC48/STM16/POU port units (LEY80AE...LEY95AE) that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC48/STM16/POU port unit supports one bidirectional (one receive and one transmit) OC-48 formatted, ITU-compatible optical signal. The capacity may be translated to 48 STS-1 equivalents or 32,256 two-way voice circuits per port unit.

OC—48 access

The following table describes OC-48 capabilities.

Table B-56 OC48/STM16/POU Access

Specification	Description
Interface	Long-reach (80 km) interface. This number is a typical value
Growth Increment	One OC-48 per port unit
Line Code	Scrambled NRZ

Protection switching

The following table describes protection switching information per high speed line.

Table B-57 Protection Switching for OC48/STM16/POU Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-3} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC48/STM16/POU port units, is Class1 in the FDA/CDRH Classification System.

Optical dispersion

The optical dispersion for the OC48/STM16/POU port units is 1800 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC48/STM16/POU port units.

Table B-58 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	–27.0 dB
Maximum discrete reflectance	–27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC48/STM16/POU port units.

Table B-59 Transmission Specifications for OC48/STM16/POU

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or FC-type or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 2.488 Gbit/s Output: 2.488 Gbit/s
Transmitter Wavelengths (Refer to Table B-40 for a complete list of the operating wavelengths)	Minimum: 1549 nm Maximum: 1560 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Electro—absorptive Modulated Laser (EML)

Operating wavelengths

The table below lists the operating wavelengths for the OC48/STM16/POU port units.

Table B-60 OC48/STM16/POU Port Unit Operating Wavelengths

Item Code	Port Unit	Channel	Wavelength (nm)
LEY80	OC48/STM16/POU9590	1	1530.33
LEY81	OC48/STM16/POU9570	2	1531.90
LEY82	OC48/STM16/POU9550	3	1533.47
LEY83	OC48/STM16/POU9530	4	1535.04
LEY84	OC48/STM16/POU9490	5	1538.19
LEY85	OC48/STM16/POU9470	6	1539.77
LEY86	OC48/STM16/POU9450	7	1541.35
LEY87	OC48/STM16/POU9430	8	1542.94
LEY88	OC48/STM16/POU9370	9	1547.72
LEY89	OC48/STM16/POU9350	10	1549.32
LEY90	OC48/STM16/POU9330	11	1550.92
LEY91	OC48/STM16/POU9310	12	1552.52
LEY92	OC48/STM16/POU9270	13	1555.75
LEY93	OC48/STM16/POU9250	14	1557.36
LEY94	OC48/STM16/POU9230	15	1558.98
LEY95	OC48/STM16/POU9210	16	1560.61

Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC48/STM16/POU port units.

Table B-61 Optical Loss Budgets for the OC48/STM16/POU Port Units

Parameter	**OC48/STM16/POU[a] with 16CH-MUX and DEMUX**	**OC48/STM16/POU[a] with 16CH-MUXINT and DEMUXINT**
Maximum Transmitter Output Power (P_{Tmax}) [b]	1.0 dBm	1.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[c]	-2.8 dBm	-2.8 dBm
Maximum Received Power (P_{Rmax})[d]	-9.0 dBm	-9.0 dBm

Table B-61 Optical Loss Budgets for the OC48/STM16/POU Port Units (continued)

Parameter	**OC48/STM16/POU[a] with 16CH-MUX and DEMUX**	**OC48/STM16/POU[a] with 16CH-MUXINT and DEMUXINT**
Receiver Sensitivity (P_{Rmin})[c][d]	-28.0 dBm	-28.0 dBm
Optical Path Penalty (PO)	2.0 dB	2.0 dBM
Minimum Loss Budget	6.4 dBm	10.2 dBm
Maximum Loss Budget	24.0 dB[e]16.8 dB	23.2 dB[f] 13.0 dB

(a) All values assume that standard single-mode non dispersion shifted fiber is used Dispersion shifted fiber may be used. WaveStar TDM 2.5G/10G (2 fiber) complies with Telcordia Technologied and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in next figure.

(c) These values include transmitter/receiver connectors at 0.7 dB each (worse case) and the system margins.

(d) These values are measured at a BER of $1x10^{-12}$

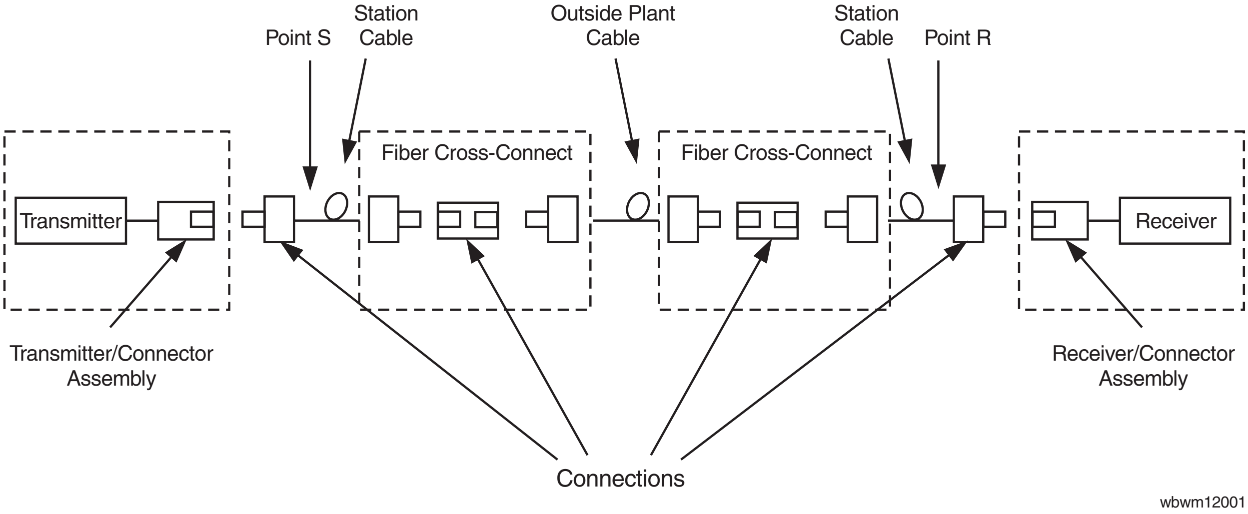
(e) When using the 16CH-MUX and 16CH-DMUX with the OC48/STM16/POU port units, you must subtract 6.4 dB from the maximum loss budget to compensate for the mux/demux functions.

(f) When using the 16CH-MUXINT and 16CH-DMUXINT with the OC48/STM16/POU port units, you must subtract 10.2 dB from the maximum loss budget to compensate for the mux/demux functions. This is valid for all applications, whether or not the wavelengths are interleaved with those from the 16CH-MUX and 16CH-DMUX.

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-7 Optical System Interfaces



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OC12/STM4 Port Unit Data Sheets

Overview

Purpose

This section contains technical specifications for the OC12/STM4 port units that are used in WaveStar® TDM 10G (STM-64).

Contents

OC12/STM4/1.3LR2 Data Sheet

Overview This data sheet contains technical specifications for the OC12/STM4/1.3LR2 (long reach) port units (LEY13) that are used in WaveStar® TDM 10G (STM-64).

Capacity Each OC12/STM4/1.3LR2 port unit supports two bidirectional (one receive and one transmit) STM-4 formatted optical signals.

STM-4 access The following table describes STM-4 access capabilities.

Table B-62 OC12/STM4/1.5LR2 Access

Specification	Description
Interface	Long-reach (80 km) interface (this is a typical value; the actual value must be calculated using measured data, see Figure B-8, “Optical System Interfaces” (B-64)).
Growth Increment	Two STM-4s per port unit
Line Code	Scrambled NRZ

Protection switching The following table describes protection switching information per high speed line.

Table B-63 Protection Switching for OC12/STM4/1.3LR2 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety Optical safety data on laser-containing port units, such as the OC12/STM4/1.3LR2 port unit, is Class 1 in the IEC Classification System and Class I in the FDA/CDRH Classification System.

Optical dispersion The optical dispersion for the OC12/STM4/1.3LR2 port units is 300 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC12/STM4/1.3LR2 port units.

Table B-64 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB
Maximum discrete reflectance	-27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC12/STM4/1.3LR2 port units.

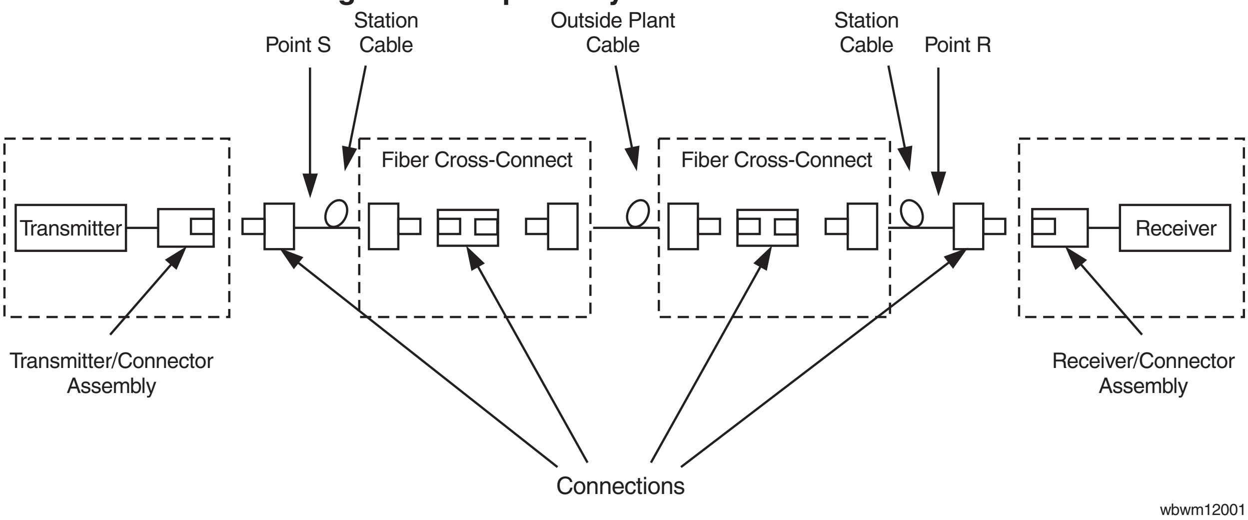
Table B-65 Transmission Specifications for OC12/STM4/1.3LR2 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 622.08 Mbit/s Output: 622.08 Mbit/s
Transmitter Wavelengths	Minimum: 1298 nm Maximum: 1325 nm
Minimum Side Mode Suppression Ratio (SMSR)	30 dB
Optical Source	MLM Laser

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-8 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC12/STM4/1.3LR2 port units.

Table B-66 Optical Loss Budgets for the OC12/STM4/1.3LR2 Port Units

Parameter	OC12/STM4/1.3LR2 Port Unit[a]
Maximum Transmitter Output Power (P_{Tmax})[b]	+2.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[c]	-3.0 dBm
Maximum Received Power (P_{Rmax})[d]	-8.0 dBm
Receiver Sensitivity (P_{Rmin})[c][d]	-28.0 dBm
Minimum System Gain (S-R)	25.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget	10.0 dB
Maximum Loss Budget[e]	24.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-8.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded.

□

OC12/STM4/1.3SR2 Data Sheet

Overview This data sheet contains technical specifications for the OC12/STM4/1.3SR2 (short reach) port units (LEY14) that are used in WaveStar® TDM 10G (STM-64).

Capacity Each OC12/STM4/1.3SR2 port unit supports two bidirectional (one receive and one transmit) STM-4 formatted optical signals.

STM-4 access The following table describes STM-4 access capabilities.

Table B-67 OC12/STM4/1.3SR2 Access

Specification	Description
Interface	Short-reach (15 km) interface (this is a typical value; the actual value must be calculated using measured data, see Figure B-9, "Optical System Interfaces" (B-68)).
Growth Increment	Two STM-4s per port unit
Line Code	Scrambled NRZ

Protection switching The following table describes protection switching information per high speed line.

Table B-68 Protection Switching for OC12/STM4/1.3SR2 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety Optical safety data on laser-containing port units, such as the OC12/STM4/1.3SR2 port unit, is Class 1 in the IEC Classification System and Class I in the FDA/CDRH Classification System.

Optical dispersion The max. allowed optical dispersion for the OC12/STM4/1.3SR2 port units is 300 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC12/STM4/1.3SR2 port units.

Table B-69 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB
Maximum discrete reflectance	-27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC12/STM4/1.3SR2 port units.

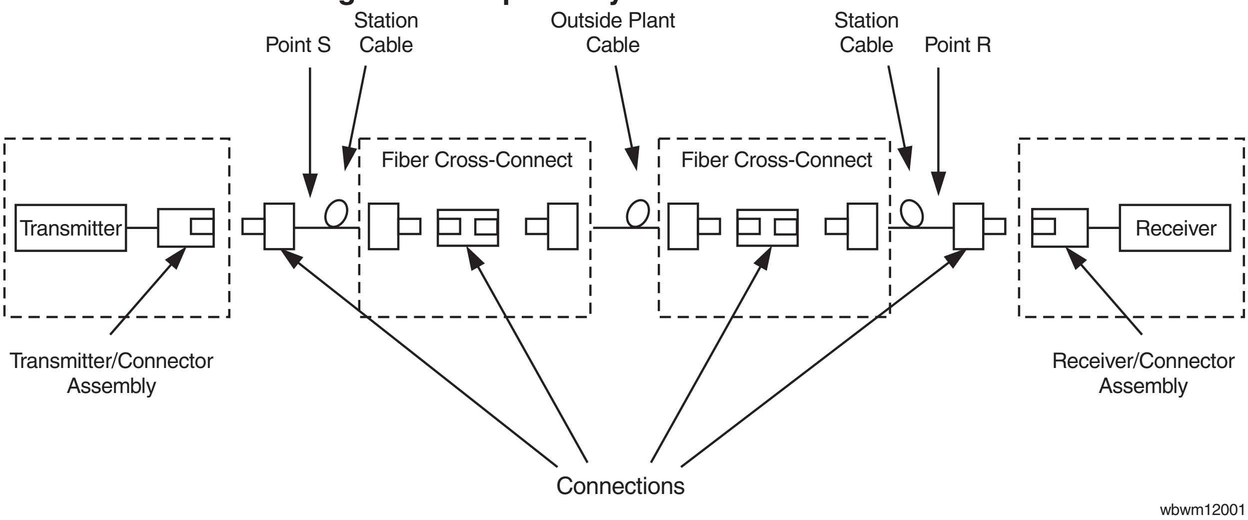
Table B-70 Transmission Specifications for OC12/STM4/1.3SR2 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 622.08 Mbit/s Output: 622.08 Mbit/s
Transmitter Wavelengths	Minimum: 1298 nm Maximum: 1325 nm
Spectral Width	less than 4.0 nm (RMS)
Minimum Side Mode Suppression Ratio (SMSR)	30 dB
Optical Source	MLM Laser

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-9 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC12/STM4/1.3SR2 port units.

Table B-71 Optical Loss Budgets for the OC12/STM4/1.3SR2 Port Units

Parameter	OC12/STM4/1.3SR2 Port Unit(a)
Maximum Transmitter Output Power (P_{Tmax})(b)	-8.0 dBm
Minimum Transmitter Output Power (P_{Tmin})(c)	-15.0 dBm
Maximum Received Power (P_{Rmax})(d)	-8.0 dBm
Receiver Sensitivity (P_{Rmin})(c)(d)	-28.0 dBm
Minimum System Gain (S-R)	13.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget	0.0 dB
Maximum Loss Budget(e)	12.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-9.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded.

□

OC12/STM4/1.5LR2 Data Sheet

Overview

This data sheet contains technical specifications for the OC12/STM4/1.5LR2 (long reach) port units (LEY190) that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC12/STM4/1.5LR2 port unit supports two bidirectional (one receive and one transmit) STM-4 formatted optical signals.

STM-4 access

The following table describes STM-4 access capabilities.

Table B-72 OC12/STM4/1.5LR2 Access

Specification	Description
Interface	Long-reach (80 km) interface (this is a typical value; the actual value must be calculated using measured data, see Figure B-10, "Optical System Interfaces" (B-72)).
Growth Increment	Two STM-4s per port unit
Line Code	Scrambled NRZ

Protection switching

The following table describes protection switching information per high speed line.

Table B-73 Protection Switching for OC12/STM4/1.5LR2 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC12/STM4/1.5LR2 port unit, is Class 1 in the IEC Classification System and Class I in the FDA/CDRH Classification System.

Optical dispersion

The optical dispersion for the OC12/STM4/1.5LR2 port units is 300 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC12/STM4/1.5LR2 port units.

Table B-74 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB
Maximum discrete reflectance	-27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC12/STM4/1.5LR2 port units.

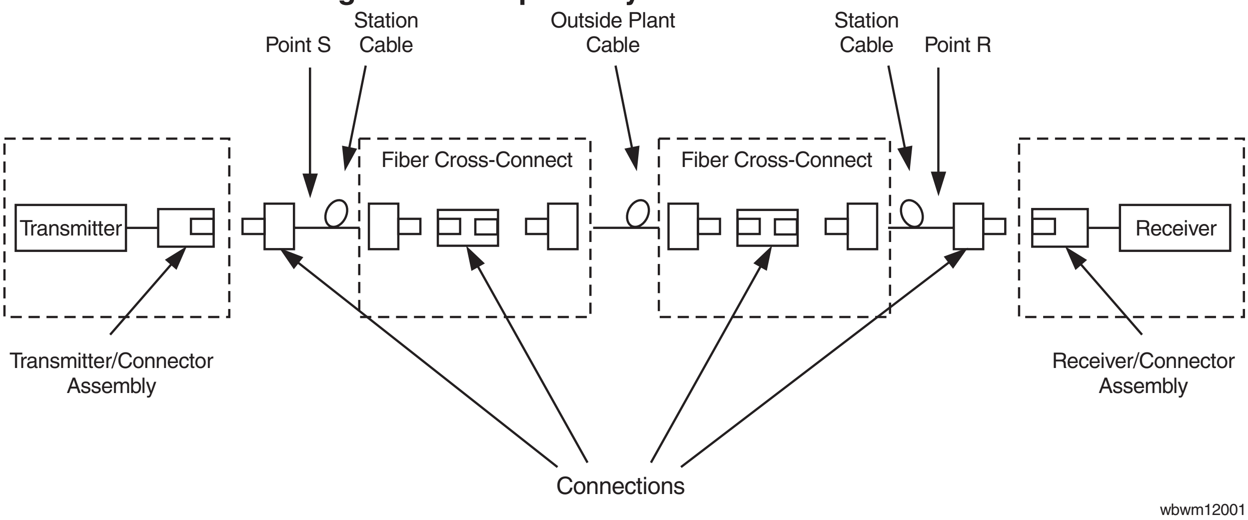
Table B-75 Transmission Specifications for OC12/STM4/1.5LR2 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 622.08 Mbit/s Output: 622.08 Mbit/s
Transmitter Wavelengths	Minimum: 1480 nm Maximum: 1580 nm
Minimum Side Mode Suppression Ratio (SMSR)	30 dB
Spectral Width	less than 1.0 nm

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-10 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC12/STM4/1.5LR2 port units.

Table B-76 Optical Loss Budgets for the OC12/STM4/1.5LR2 Port Units

Parameter	OC12/STM4/1.5LR2 Port Unit[a]
Maximum Transmitter Output Power (P_{Tmax})[b]	+2.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[c]	-3.0 dBm
Maximum Received Power (P_{Rmax})[d]	-8.0 dBm
Receiver Sensitivity (P_{Rmin})[c][d]	-28.0 dBm
Minimum System Gain (S-R)	25.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget	10.0 dB
Maximum Loss Budget[e]	24.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-10.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded.

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OC3/STM1 Port Unit Data Sheets

Overview

Purpose This section contains technical specifications for the OC3/STM1 port units that are used in WaveStar® TDM 10G (STM-64).

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OC3/STM1/1.3IR-SR8 Data Sheet

Overview

This data sheet contains technical specifications for the OC3/STM1/1.3IR-SR8 (intermediate-short reach) port units (LEY23) that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC3/STM1/1.3IR-SR8 port unit supports eight bidirectional (one receive and one transmit) STM-1 formatted optical signals.

STM-1 access

The table below describes STM-1 access capabilities.

Table B-77 OC3/STM1/1.3IR-SR8 Access

Specification	Description
Interface	Intermediate-short reach (15-25 km) interface
Growth Increment	Eight STM-1s per port unit
Line Code	Scrambled NRZ

Protection switching

The table below describes protection switching information per high speed line.

Table B-78 Protection Switching for OC3/STM1/1.3IR-SR8 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-3} to 10^{-9} (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER $^{3}10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC3/STM1/1.3IR-SR8 port unit, is Class 1 in the IEC Classification System.

Optical return loss

The table below provides the optical return loss for a system using OC3/STM1/1.3IR-SR8 port units.

Table B-79 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB

Table B-79 Optical Return Loss (continued)

Specification	Amount
Maximum discrete reflectance	-27.0 dB

Transmission specifications

The table below provides transmission specifications for the OC3/STM1/1.3IR-SR8 port units.

Table B-80 Transmission Specifications for OC3/STM1/1.3IR-SR8 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	LC connector types. Special patch cords have to be used to connect this pack
Optical Line Rate	Input: 155.52 Mb/s Output: 155.52 Mb/s
Transmitter Wavelengths	Minimum: 1298 nm Maximum: 1325 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser or Fabry-Perot laser

Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the OC3/STM1/1.3IR-SR8 port units.

Table B-81 Optical Loss Budgets for the OC3/STM1/1.3IR-SR8 Port Units

Parameter	OC3/STM1/1.3IR-SR8 Port Unit[a]
Maximum Transmitter Output Power (P_{Tmax})[b]	-8.0 dBm
Minimum Transmitter Output Power (P_{Tmin})[c]	-15.0 dBm
Maximum Received Power (P_{Rmax})[d]	-8.0 dBm
Receiver Sensitivity (P_{Rmin})[c][d]	-28.0 dBm
Minimum System Gain (S-R)	13.0 dB

Table B-81 Optical Loss Budgets for the OC3/STM1/1.3IR-SR8 Port Units (continued)

Parameter	**OC3/STM1/1.3IR-SR8 Port Unit[(a)]**
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget[(e)]	0.0 dB
Maximum Loss Budget	12.0 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G (STM-64) complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber.
2. (b) Transmit and receive points are referenced as points S and R.
3. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.
4. (d) These values are measured at a BER of 1x10E-12.
5. (e) This value assumes that the maximum received power limitations are not exceeded.

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OC3/STM1/1.3LR4 Data Sheet

Overview

This data sheet contains technical specifications for the OC3/STM1/1.3LR4 (long reach) port units (LEY15) that are used in WaveStar® TDM 10G (STM-64).

Capacity

Each OC3/STM1/1.3LR4 port unit supports four bidirectional (one receive and one transmit) STM-1 formatted optical signals.

STM-1 access

The table below describes STM-1 access capabilities.

Table B-82 OC3/STM1/1.3LR4 Access

Specification	Description
Interface	Long-reach (51 km) interface (typical value)
Growth Increment	Four STM-1s per port unit
Line Code	Scrambled NRZ

Protection switching

The table below describes protection switching information per high speed line.

Table B-83 Protection Switching for OC3/STM1/1.3LR4 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-3} to 10^{-9} (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER $^{3}10^{-3}$ line signal failure)

Optical safety

Optical safety data on laser-containing port units, such as the OC3/STM1/1.3LR4 port unit, is Class 1 in the IEC Classification System.

Optical dispersion

The optical dispersion for the OC3/STM1/1.3LR4 port units is 300 ps/nm.

Optical return loss

The table below provides the optical return loss for a system using OC3/STM1/1.3LR4 port units.

Table B-84 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB
Maximum discrete reflectance	-27.0 dB

Transmission specifications

The table below provides transmission specifications for the OC3/STM1/1.3LR4 port units.

Table B-85 Transmission Specifications for OC3/STM1/1.3LR4 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 155.52 Mb/s Output: 155.52 Mb/s
Transmitter Wavelengths	Minimum: 1298 nm Maximum: 1325 nm
Spectral Width	2.0 nm (RMS)
Optical Source	Distributed Feedback (DFB) laser

Optical requirements and loss budgets

The table below lists the optical requirements and loss budgets for the OC3/STM1/1.3LR4 port units.

Table B-86 Optical Loss Budgets for the OC3/STM1/1.3LR4 Port Units

Parameter	OC3/STM1/1.3LR4 Port Unit[(a)]
Maximum Transmitter Output Power (P_{Tmax})[(b)]	0.0 dBm

Table B-86 Optical Loss Budgets for the OC3/STM1/1.3LR4 Port Units (continued)

Parameter	OC3/STM1/1.3LR4 Port Unit[(a)]
Minimum Transmitter Output Power (P_{Tmin})[(c)]	-5.0 dBm
Maximum Received Power (P_{Rmax})[(d)]	-10.0 dBm
Receiver Sensitivity (P_{Rmin})[(c)(d)]	-34.0 dBm
Minimum System Gain (S-R)	29.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget[(e)]	10.0 dB
Maximum Loss Budget	28.0 dB

Notes:

1. (a) All values assume that standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G (STM-64) complies with Telcordia Technologies and ITU requirements for dispersion shifted fiber.
2. (b) Transmit and receive points are referenced as points S and R.
3. (c) These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.
4. (d) These values are measured at a BER of 1x10E-12).
5. (e) This value assumes that the maximum received power limitations are not exceeded.

□

OC3/STM1/1.3SR4 Data Sheet

Overview This data sheet contains technical specifications for the OC3/STM1/1.3SR4 (short reach) port units (LEY16) that are used in WaveStar® TDM 10G (STM-64).

Capacity Each OC3/STM1/1.3SR4 port unit supports four bidirectional (one receive and one transmit) STM-1 formatted optical signals.

STM-1 access The following table describes STM-1 access capabilities.

Table B-87 OC3/STM1/1.3SR4 Access

Specification	Description
Interface	Short-reach (15 km) interface (this is a typical value; the actual value must be calculated using measured data, see Figure B-11, "Optical System Interfaces" (B-83)).
Growth Increment	Four STM-1s per port unit
Line Code	Scrambled NRZ

Protection switching The following table describes protection switching information per high speed line.

Table B-88 Protection Switching for OC3/STM1/1.3SR4 Port Units

Specification	Length of Time
Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Optical safety Optical safety data on laser-containing port units, such as the OC3/STM1/1.3SR4 port unit, is Level 1 in the IEC Classification System.

Optical dispersion The optical dispersion for the OC3/STM1/1.3SR4 port units is 300 ps/nm.

Optical return loss

The following table provides the optical return loss for a system using OC3/STM1/1.3SR4 port units.

Table B-89 Optical Return Loss

Specification	Amount
Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB
Maximum discrete reflectance	-27.0 dB

Transmission specifications

The following table provides transmission specifications for the OC3/STM1/1.3SR4 port units.

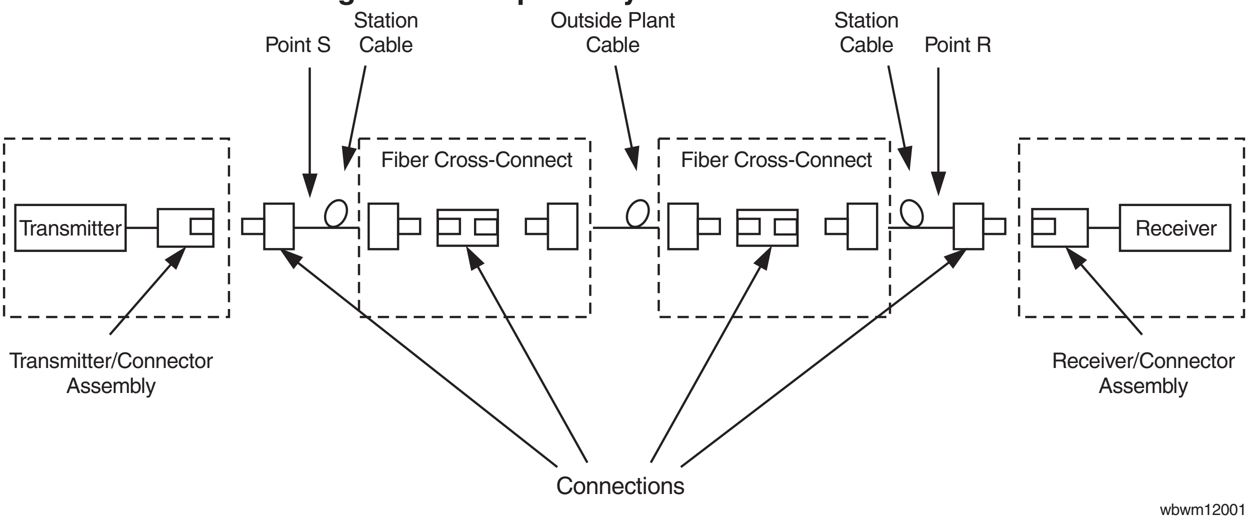
Table B-90 Transmission Specifications for OC3/STM1/1.3SR4 Port Units

Specification	Description
Transmission Medium	Input Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber Output Fiber: Standard Single-Mode Non-Dispersion Shifted Fiber
Operating Connector Interfaces	Universal build-out block and optional ST-type, FC-type, or SC-type lightguide build-out (LBO) connectors for optical attenuation
Optical Line Rate	Input: 155.52 Mbit/s Output: 155.52 Mbit/s
Transmitter Wavelengths	Minimum: 1298 nm Maximum: 1325 nm
Spectral Width	2.0 nm (RMS)
Optical Source	INGaAsP Laser, MLM Structure

Optical system interfaces

The following figure illustrates the optical path between the transmitter and the receiver.

Figure B-11 Optical System Interfaces



Optical requirements and loss budgets

The following table lists the optical requirements and loss budgets for the OC3/STM1/1.3SR4 port units.

Table B-91 Optical Loss Budgets for the OC3/STM1/1.3SR4 Port Units

Parameter	OC3/STM1/1.3SR4 Port Unit(a)
Maximum Transmitter Output Power (P_{Tmax})(b)	-8.0 dBm
Minimum Transmitter Output Power (P_{Tmin})(c)	-15.0 dBm
Maximum Received Power (P_{Rmax})(d)	-8.0 dBm
Receiver Sensitivity (P_{Rmin})(c)(d)	-28.0 dBm
Minimum System Gain (S-R)	13.0 dB
Optical Path Penalty (PO)	1.0 dB
Minimum Loss Budget	0.0 dB
Maximum Loss Budget(e)	12.0 dB

(a) All values assume that a standard single-mode non-dispersion shifted fiber is used. Dispersion shifted fiber may be used. WaveStar® TDM 10G complies with Telecordia and ITU requirements for dispersion shifted fiber.

(b) Transmit and receive points are referenced as points S and R in Figure B-11.

(c) The values for the Minimum Transmitter Output Power and the Receiver Sensivity include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

(d) The values for the Maximum Received Power and the Receiver Sensivity are measured at a BER of $1x10^{-12}$.

(e) The value for the Maximum Loss Budget assumes that the maximum received power limitations are not exceeded.

□

STM1(e) Port Unit Data Sheets

Overview

Purpose This section contains technical specifications for the STM1E/4 port units that are used in WaveStar® TDM 10G (STM-64).

☐

STM1E/4 Data Sheet

Overview This data sheet contains technical specifications for the STM1E/4 port units that are used in WaveStar® TDM 10G (STM-64).

Capacity Each STM1(e) port unit supports four bidirectional STM-1 lines (four receive and four transmit).

Transmission medium One unbalanced coaxial line is used for each direction of transmission. Therefore, two coaxial lines are used for each of the four bidirectional ports on a STM1(e) port unit.

Line rate Each bidirectional port on the STM1(e) port unit transmits and receives one STM-1 signal with a nominal rate of 155.520 Mbit/s (± 20 ppm).

Line code The line code for the STM1(e) port units is bipolar with Coded Mark Inversion (CMI). The pulse frame is a nominal square wave. The pulse mask complies to ITU-T recommendation G.703.

DIN connectors The physical interface for each port, both the transmit and receive directions, of the STM1(e) port unit is a 1.6/5.6 coax DIN connector. The DIN connectors are located on the STM1(e) I/O Panels.

□

Gigabit Ethernet Port Unit Data Sheets

Overview

Purpose

This section provides detailed information concerning Gigabit Ethernet (GE1/SX2 and GE1/LX2) port units available for use with the WaveStar® TDM 10G (STM-64).

☐

GE1/SX2 Data Sheet

Capacity

The GE1/SX2 port unit supports 2 fully independent bidirectional ports. Ethernet frames received from a GE1/SX2 port are mapped into VC-4s using virtual concatenation. The number of VC-4s per virtual concatenated path can be user provisioned as up to 7 VC-4s at single VC-4 intervals. This offers an effective capacity over a network of 150 to 1050 Mbit/s in steps of 150 Mbit/s.

Protection Switching

The GE1/SX2 port unit supports standard MS-SPRing and SNCP protection schemes on the individual VC-4s that are part of the virtually concatenated path.

Optical Safety

The GE1/SX2 port unit uses a Low Power Laser.

Ethernet Standards Compliance

The GE1/SX2 interface port unit complies to the standards listed in the tables below.

GE1/SX2 Operating range

The table below describes the various operating ranges for the GE1/SX2 port unit over each optical fiber type.

Table B-92 GE1/SX2 Operating ranges

Fiber Type	Modal Bandwidth @ 850nm (min. overfilled launch) (MHz - km)	Minimum range (meters)
62.5 µm MMF	160	2 to 220
62.5 µm MMF	200	2 to 275
50 µm MMF	400	2 to 500
50 µm MMF	500	2 to 550
10 µm SMF	N/A	Not supported

GE1/SX2 Transmission Characteristics

The table below provides the specific transmission characteristics for the GE1/SX2 port unit.

Table B-93 GE1/SX2 Transmission

Description	62.5 µm MMF	50 µm MMF	10 µm SMF	Unit
Transmitter type	Shortwave Laser			
Signaling speed (range)	1.25 +/– 100ppm			GBd
Wavelength (range)	770 to 860			nm

Table B-93 GE1/SX2 Transmission (continued)

Description	62.5 µm MMF	50 µm MMF	10 µm SMF	Unit
Trise/Tfall (max, 20-80%; l > 830 nm)	0.26			ns
Trise/Tfall (max, 20-80%; l <830 nm)	0.21			ns
RMS spectral width (max)	0.85			nm
Average launch power (max)	See footnote [a]			dBm
Average launch power (min)	-9.5			dBm
Average launch power of OFF transmitter (max)[b]	N/A			dBm
Extinction ratio (min)	9			dB
RIN (max)	-117			dB/Hz
Coupled Power Ratio (CPR)[c]	9 < CPR			dB

Notes:

1. a)The GE1/SX2 launch power shall be the lesser of the class 1 safety limit as defined by 38.7.2 or the average receive power (max) defined by the following table.
2. b)During all conditions when the PMA is powered, the ac signal (data) into the transmitt port will be valid encoded 8B/10B patterns (this is a requirement of the PCS layers) except for short durations during system power-on-reset or diagnostics when the PMA is placed in a loopback mode.
3. c)Radial overfilled launches, while they meet CPR ranges, should be avoided.

GE1/SX2 Receive characteristics

The table below provides the specific receive characteristics for the GE1/SX2 port unit.

Table B-94 GE1/SX2 Receive

Description	62.5 µm MMF	50 µm MMF	Unit
Signaling speed (range)	1.25 +/– 100 ppm		GBd
Wavelength (range)	770 to 860		nm

Table B-94 GE1/SX2 Receive (continued)

Description	62.5 µm MMF	50 µm MMF	Unit
Average receive power (max)	0		dBm
Receive sensitivity	-17		dBm
Return loss (min)	12		dB
Stressed receive sensitivity[a,b]	12.5	13.5	dBm
Vertical eye-closure penalty[c]	2.60	2.20	dB
Receive electrical 3 dB upper cutoff frequency (max)	1500		MHz

Notes:

1. a)Measured with conformance test signal at TP3 for BER= 10 E-12 at the eye center.
2. b)Measured with a transmit signal having a 9 dB extinction ratio. If another extinction ratio is used, the stressed recieved sensitivity should be corrected for the extinction ratio penalty.
3. c)Vertical eye-closure penalty is a test condition for measuring stressed recieve sensitivity. It is not a required characteristic of the reciever.

GE1/SX2 Power budget and loss penalties

The table below provides the worst-case power budget and link penalties for a GE1/SX2 port unit.

Table B-95 Worst-case GE1/SX2 Power Budget and Penaltiesa

Parameter	62.5 µm MMF		50 µm MMF		Unit
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	160	200	400	500	MHz - km
Link power budget	7.5	7.5	7.5	7.5	dB
Operating distance	220	275	500	550	m
Channel insertion loss[b,c]	2.38	2.60	3.37	3.56	dB
Link power penalties[c]	4.27	4.29	4.07	3.57	dB
Unallocated margin in link power budget[c]	0.84	0.60	0.05	0.37	dB

Notes:

1. a) Link penalties are used for link budget calculations. They are requirements and are not meant to be tested.
2. b) Operating distances used to calculate the channel insertion loss are the maximum values
3. c) A wavelength of 830 nm is used to calculate channel insertion loss, link power penalties, and unallocated margin.

□

GE1/LX2 Data Sheet

Capacity

The GE1/LX2 port unit supports 2 fully independent bidirectional ports. Ethernet frames received from a GE1/LX2 port are mapped into VC-4s using virtual concatenation. The number of VC-4s per virtual concatenated path can be user provisioned as up to 7 VC-4s at single VC-4 intervals. This offers an effective capacity over a network of 150 to 1050 Mbit/s in steps of 150 Mbit/s.

Protection Switching

The GE1/LX2 port unit supports standard MS-SPRing and SNCP protection schemes on the individual VC-4s that are part of the virtually concatenated path.

Optical Safety

The GE1/LX2 port unit uses a Low Power Laser.

Ethernet Standards Compliance

The GE1/LX2 interface port unit complies to the standards listed in the tables below.

GE1/LX2 Operating range

The table below describes the various operating ranges for the GE1/LX2 port unit over each optical fiber type.

Table B-96 GE1/LX2 Operating ranges

Fiber Type	Modal Bandwidth @ 1300 nm (min. overfilled launch) (MHz - km)	Minimum range (meters)
62.5 µm MMF	500	2 to 550
50 µm MMF	400	2 to 550
50 µm MMF	500	2 to 550
10 µm SMF	N/A	2 to 5000

GE1/LX2 Transmission Characteristics

The table below provides the specific transmission characteristics for the GE1/LX2 port unit.

Table B-97 GE1/LX2 Transmission

Description	62.5 µm MMF	50 µm MMF	10 µm SMF	Unit
Transmitter type	Longwave Laser			
Signaling speed (range)	1.25 +/– 100ppm			GBd
Wavelength (range)	1270 to 1335			nm

Table B-97 GE1/LX2 Transmission (continued)

Description	62.5 μm MMF	50 μm MMF	10 μm SMF	Unit
Trise/Tfall (max, 20-80%; response time	0.26			ns
RMS spectral width (max)	4			nm
Average launch power (max)	-3			dBm
Average launch power (min)	-11.5	-11.5	-11.0	dBm
Average launch power of OFF transmitter (max)	N/A			dBm
Extinction ratio (min)	9			dB
RIN (max)	-120			dB/Hz
Coupled Power Ratio (CPR)[a]	28 < CPR < 40	12 > CPR < 20	N/A	dB

Notes:

1. a)Due to dual media (single-mode and multimode) support of the GE1/LX2 transmitter, fulfillment of this specification requires a single-mode fiber offset-launch mode-conditioning patch cord (as described in IEEE 802.3, Section 38.11.4) for MMF and SMF operation. This patch cord is not used for single-mode operation.

GE1/LX2 Receive characteristics

The table below provides the specific receive characteristics for the GE1/LX2 port unit.

Table B-98 GE1/LX2 Receive

Description	Value	Unit
Signaling speed (range)	1.25 +/– 100 ppm	GBd
Wavelength (range)	1270 to 1335	nm
Average receive power (max)	-3	dBm
Receive sensitivity	-19	dBm
Return loss (min)	12	dB
Stressed receive sensitivity[a,b]	-14.4	dBm
Vertical eye-closure penalty[c]	2.60	dB

Table B-98 GE1/LX2 Receive (continued)

Description	Value	Unit
Receive electrical 3 dB upper cutoff frequency (max)	1500	MHz

Notes:

1. a)Measured with conformance test signal at TP3 for BER= 10 E-12 at the eye center.
2. b)Measured with a transmit signal having a 9 dB extinction ratio. If another extinction ratio is used, the stressed recieved sensitivity should be corrected for the extinction ratio penalty.
3. c)Vertical eye-closure penalty is a test condition for measuring stressed recieve sensitivity. It is not a required characteristic of the reciever.

GE1/LX2 Power budget and loss penalties

The table below provides the worst-case power budget and link penalties for a GE1/LX2 port unit.

Table B-99 Worst-case GE1/SX2 Power Budget and Penalties

Parameter	62.5 µm MMF	50 µm MMF		10 µm SMF	Unit
Modal bandwidth as measured at 850 nm (minimum, overfilled launch)	500	400	500	N/A	MHz - km
Link power budget	8.5	8.5	8.5	9.0	dB
Operating distance	550	550	550	5000	m
Channel insertion loss[a,b]	2.35	2.35	2.35	4.57	dB
Link power penalties[b]	3.48	5.08	3.96	3.27	dB
Unallocated margin in link power budget[b]	2.67	1.07	2.19	1.16	dB

Notes:

1. a)Operating distances used to calculate the channel insertion loss are the maximum values
2. b)A wavelength of 1270 nm is used to calculate channel insertion loss, link power penalties, and unallocated margin.

□

Lucent Technologies
Bell Labs Innovations

Glossary

μ
Microns

NUMERICS

0x1 Line Operation
0x1 means unprotected operation. The connection between network elements has one bidirectional line (no protection line).

1+1 Line Protection
A protection architecture in which the transmitting equipment transmits a valid signal on both the working and protection lines. The receiving equipment monitors both lines. Based on performance criteria and OS control, the receiving equipment chooses one line as the active line and designates the other as the standby line.

1xN Equipment Protection
1xN protection pertains to N number of circuit pack/port units protected by one circuit pack or port unit. When a protection switch occurs, the working signals are routed from the failed pack to the protection pack. When the fault clears, the signals revert to the working port unit.

12NC (12-digit Numerical Code)
Used to uniquely identify an item or product. The first ten digits uniquely identify an item. The eleventh digit is used to specify the particular variant of an item. The twelfth digit is used for the revision issue. Items with the first eleven digits the same, are functionally equal and may be exchanged.

A

ABN
Abnormal (condition)

ABS (Absent)
Used to indicate that a given circuit pack is not installed.

AC
Alternating Current

ACO (Alarm Cut-Off)

A button on the user panel used to silence audible alarms.

ACT (Active)
Used to indicate that a circuit pack or module is in-service and currently providing service functions.

ADM (Add/Drop Multiplexer)
The term for a synchronous network element capable of combining signals of different rates and having those signals added to or dropped from the stream.

AEL
Accessible Emission Limits

Agent
Performs operations on managed objects and issues events on behalf of these managed objects. All SDH managed objects will support at least an agent. Control of distant agents is possible via local “Managers”.

AGNE
Alarm Gateway Network Element

AID (Access Identifier)
A technical specification for explicitly naming entities (both physical and logical) of an NE using a grammar comprised of ASCII text, keywords, and grammar rules.

AIS (Alarm Indication Signal)
A code transmitted downstream in a digital network that indicates that an upstream failure has been detected and alarmed if the upstream alarm has not been suppressed.

AITS
Acknowledged Information Transfer Service: Confirmed mode of operation of the LAPD protocol.

Alarm
Visible or audible signal indicating that an equipment failure or significant event/condition has occurred.

Alarm Correlation
The search for a directly-reported alarm that can account for a given symptomatic condition.

Alarm Severity
An attribute defining the priority of the alarm message. The way alarms are processed depends on the severity.

Alarm Suppression
Selective removal of alarm messages from being forwarded to the GUI or to network management layer OSs.

Alarm Throttling
A feature that automatically or manually suppresses autonomous messages that are not priority alarms.

Aligning
Indicating the head of a virtual container by means of a pointer, for example, creating an Administrative Unit (AU) or a Tributary Unit (TU).

AMI (Alternate Mark Inversion)
A line code that employs a ternary signal to convert binary digits, in which successive binary ones are represented by signal elements that are normally of alternative positive and negative polarity but equal in amplitude and in which binary zeros are represented by signal elements that have zero amplitude.

Anomaly
A difference between the actual and desired operation of a function.

ANSI
American National Standards Institute

APD
Avalanche Photo Diode

APS (Automatic Protection Switch)
A protection switch that occurs automatically in response to an automatically detected fault condition.

ASCII (American Standard Code for Information Interchange)
A standard 7-bit code that represents letters, numbers, punctuation marks, and special characters in the interchange of data among computing and communications equipment.

ASN.1
Abstract Syntax Notation 1

Assembly
Gathering together of payload data with overhead and pointer information (an indication of the direction of the signal).

Association
A logical connection between manager and agent through which management information can be exchanged.

Asynchronous
The essential characteristic of time-scales or signals such that their corresponding significant instants do not necessarily occur at the same average rate.

ATM (Asynchronous Transfer Mode)
A high-speed transmission technology characterized by high bandwidth and low delay. It utilizes a packet switching and multiplexing technique which allocates bandwidth on demand.

Attribute
Alarm indication level: critical, major, minor, or no alarm.

AU (Administrative Unit)
Carrier for TUs.

AU PTR (Administrative Unit Pointer)
Indicates the phase alignment of the VC-N with respect to the STM-N frame. The pointer position is fixed with respect to the STM-N frame.

AUG
Administrative Unit Group

AUTO (Automatic)
One possible state of a port or slot. When a port is in the AUTO state and a good signal is detected, the port automatically enters the IS (in-service) state. When a slot is in the AUTO state and a circuit pack is detected, the slot automatically enters the EQ (equipped) state.

Autolock
Action taken by the system in the event of circuit pack failure/trouble. System switches to protection and prevents a return to the working circuit pack even if the trouble clears. Multiple protection switches on a circuit pack during a short period of time cause the system to autolock the pack.

Autonomous Message
A message transmitted from the controlled Network Element to the SNMS which was not a response to an SNMS originated command.

AVAIL
Available

B

Bandwidth
The difference in Hz between the highest and lowest frequencies in a transmission channel. The data rate that can be carried by a given communications circuit.

Baud Rate
Transmission rate of data (bits per second) on a network link.

BER (Bit Error Rate)
The ratio of error bits received to the total number of bits transmitted.

Bidirectional Line
A transmission path consisting of two fibers that handle traffic in both the transmit and receive directions.

Bidirectional Ring
A ring in which both directions of traffic between any two nodes travel through the same network elements (although in opposite directions).

Bidirectional Switch
Protection switching performed in both the transmit and receive directions.

BIP-N (Bit Interleaved Parity-N)
A method of error monitoring over a specified number of bits (BIP-3 or BIP-8).

Bit
The smallest unit of information in a computer, with a value of either 0 or 1.

Bit Error Rate Threshold
The point at which an alarm is issued for bit errors.

BLD OUT LG
Build-Out Lightguide

Bridge Cross-Connection
The setting up of a cross-connection leg with the same input tributary as that of an existing cross-connection leg. Thus, forming a 1:2 bridge from an input tributary to two output tributaries.

Broadband Communications
Voice, data, and/or video communications at greater than 2 Mb/s rates.

Broadband Service Transport
STM-1 concatenation transport over the WaveStar® TDM 10G (STM-64) for ATM applications.

Byte
Refers to a group of eight consecutive binary digits.

C

C
Container

CC (Clear Channel)
A digital circuit where no framing or control bits are required, thus making the full bandwidth available for communications.

CC (Cross-Connection)
Path-level connections between input and output tributaries or specific ports within a single NE. Cross-connections are made in a consistent way even though there are various types of ports and various types of port protection. Cross-Connections are reconfigurable interconnections between tributaries of transmission interfaces.

Cell Relay
Fixed-length cells. For example, ATM with 53 octets.

CEPT
Conférence Européenne des Administrations des Postes et des Télécommunications

Channel
A sub-unit of transmission capacity within a defined higher level of transmission capacity.

Circuit
A set of transmission channels through one or more network elements that provides transmission of signals between two points, to support a single communications path.

CIT or *WaveStar*™ CIT (Customer Interface Terminal)
The user interface terminal used by craft personnel to communicate with a network element.

CL
Clear

CLEI
Common Language Equipment Identifier

Client
Computer in a computer network that generally offers a user interface to a server.

CLLI
Common Language Location Identifier

Closed Ring Network
A network formed of a ring-shaped configuration of network elements. Each network element connects to two others, one on each side.

CM (Configuration Management)
Subsystem that configures the network and processes messages from the network.

CMI
Coded Mark Inversion

CMIP
Common Management Information Protocol. OSI standard protocol for OAM&P information exchange.

CMISE
Common Management Information Service Element

CO (Central Office)
A building where common carriers terminate customer circuits.

Co-Resident
A hardware configuration where two applications can be active at the same time independently on the same hardware and software platform without interfering with each others functioning.

Collocated
System elements that are located in the same location.

Command Group
An administrator-defined group that defines commands to which a user has access.

Concatenation
A procedure whereby multiple virtual containers are associated one with each other resulting in a combined capacity that can be used as a single container across which bit sequence integrity is maintained.

Correlation
A process where related hard failure alarms are identified.

CP
Circuit Pack

CPE
Customer Premises Equipment

CPU
Central Processing Unit

CR (Critical (alarm))
Alarm that indicates a severe, service-affecting condition.

CRC
Cyclical Redundancy Check

Cross-Connect Map
Connection map for an SDH Network Element; contains information about how signals are connected between high speed time slots and low speed tributaries.

Crosstalk
An unwanted signal introduced into one transmission line from another.

CSMA/CD
Carrier Sense Multiple Access with Collision Detection

ctp PM
Intermediate Performance Monitoring

CTS
Customer Technical Support within Lucent Technologies

Current Value
The value currently assigned to a provisionable parameter.

D

DACS/DCS
Digital Access Cross-Connect System

Data
A collection of system parameters and their associated values.

Database Administrator
A user who administers the database of the application.

dB
Decibels

DC
Direct Current

DCC (Data Communications Channel)
The embedded overhead communications channel in the synchronous line, used for end-to-end communications and maintenance. The DCC carries alarm, control, and status information between network elements in a synchronous network.

DCE (Data Communications Equipment)
The equipment that provides signal conversion and coding between the data terminating equipment (DTE) and the line. The DCE may be separate equipment or an integral part of the DTE or of intermediate equipment. A DCE may perform other functions usually performed at the network end of the line.

DCF
Data Communications Function

DCN
Data Communications Network

Default
An operation or value that the system or application assumes, unless a user makes an explicit choice.

Default Provisioning
The parameter values that are preprogrammed as shipped from the factory.

Defect
A limited interruption of the ability of an item to perform a required function. It may or may not lead to maintenance action depending on the results of additional analysis.

Demultiplexing
A process applied to a multiplexed signal for recovering signals combined within it and for restoring the distinct individual channels of these signals.

DEMUX (Demultiplexer)
A device that splits a combined signal into individual signals at the receiver end of transmission.

Deprovisioning
The inverse order of provisioning. To manually remove/delete a parameter that has (or parameters that have) previously been provisioned.

Digital Link
A transmission span such as a point-to-point 2 Mb/s, 34 Mb/s, 140 Mb/s, VC12, VC3 or VC4 link between controlled network elements.

Digital Multiplexer
Equipment that combines by time-division multiplexing several digital signals into a single composite digital signal.

Digital Section
A transmission span such as an STM-N signal. A digital section may contain multiple digital channels.

Disassembly
Splitting up a signal into its constituents as payload data and overhead (an indication of the direction of a signal).

Dispersion
Time-broadening of a transmitted light pulse.

Dispersion Shifted Optical Fiber
1330/1550 nm minimum dispersion wavelength.

Divergence
When there is unequal amplification of incoming wavelengths, the result is a power divergence between wavelengths.

DNI (Dual Node Ring Interworking)
A topology in which two rings are interconnected at two nodes on each ring and operate so that inter-ring traffic is not lost in the event of a node or link failure at an interconnecting point.

Doping
The addition of impurities to a substance in order to attain desired properties.

Downstream
At or towards the destination of the considered transmission stream, for example, looking in the same direction of transmission.

DPLL
Digital Phase Locked Loop

DRAM
Dynamic Random Access Memory

Drop and Continue
A circuit configuration that provides redundant signal appearances at the outputs of two network elements in a ring. Can be used for Dual Node Ring Interworking (DNI) and for video distribution applications.

Drop-Down Menu
A menu that is displayed from a menu bar.

DSNE (Directory Service Network Element)
A designated Network Element that is responsible for administering a database that maps Network Elements names (node names) to addresses (node Id). There can be one DSNE per (sub)network.

DTE (Data Terminating Equipment)
The equipment that originates data for transmission and accepts transmitted data.

DTMF
Dual Tone Multifrequency

DUS
Do not Use for Synchronization

DWDM (Dense Wavelength Division Multiplexing)
Transmitting two or more signals of different wavelengths simultaneously over a single fiber.

E

EBER (Excessive Bit Error Rate)
The calculated average bit error rate over a data stream.

ECC
Embedded Control Channel

EEPROM
Electrically Erasable Programmable Read-Only Memory

EIA (Electronic Industries Association)
A trade association of the electronic industry that establishes electrical and functional standards.

EM (Event Management)
Subsystem of *WaveStar*™ SNMS that processes and logs event reports of the network.

EMC (Electromagnetic Compatibility)
A measure of equipment tolerance to external electromagnetic fields.

EMI (Electromagnetic Interference)
High-energy, electrically induced magnetic fields that cause data corruption in cables passing through the fields.

EMS
Element Management System

Entity
A specific piece of hardware (usually a circuit pack, slot, or module) that has been assigned a name recognized by the system.

Entity Identifier
The name used by the system to refer to a circuit pack, memory device, or communications link.

EPROM
Erasable Programmable Read-Only Memory

EQ (Equipped)
Status of a circuit pack or interface module that is in the system database and physically in the frame, but not yet provisioned.

ES (Errored Seconds)
A performance monitoring parameter. ES “type A” is a second with exactly one error; ES “type B” is a second with more than one and less than the number of errors in a severely errored second for the given signal. ES by itself means the sum of the type A and type B ESs.

ESD
Electrostatic Discharge

ESP
Electrostatic Protection

Establish
A user initiated command, at the *WaveStar*™ CIT, to create an entity and its associated attributes in the absence of certain hardware.

ETSI
European Telecommunications Standards Institute

Event
A significant change. Events in controlled Network Elements include signal failures, equipment failures, signals exceeding thresholds, and protection switch activity. When an event occurs in a controlled Network Element, the controlled Network Element will generate an alarm or status message and send it to the management system.

Event Driven
A required characteristic of network element software system: NEs are reactive systems, primarily viewed as systems that wait for and then handle events. Events are provided by the external interface packages, the hardware resource packages, and also by the software itself.

Externally Timed
An operating condition of a clock in which it is locked to an external reference and is using time constants that are altered to quickly bring the local oscillator’s frequency into approximate agreement with the synchronization reference frequency.

Extra traffic
Unprotected traffic that is carried over protection channels when their capacity is not used for the protection of working traffic.

F

Fault
Term used when a circuit pack has a hard (not temporary) fault and cannot perform its normal function.

Fault Management
Collecting, processing, and forwarding of autonomous messages from network elements.

FCC
Federal Communications Commission

FDA/CDRH
The Food and Drug Administration′s Center for Devices and Radiological Health.

FDDI (Fiber Distributed Data Interface)
Fiber interface that connects computers and distributes data among them.

FE (Far End)
Any other network element in a maintenance subnetwork other than the one the user is at or working on. Also called remote.

FEBE (Far-End Block Error)
An indication returned to the transmitting node that an errored block has been detected at the receiving node. A block is a specified grouping of bits.

FEPROM (Flash EPROM)
A technology that combines the nonvolatility of EPROM with the in-circuit reprogrammability of EEPROM (electrically-erasable PROM).

FERF (Far-End Receive Failure)
An indication returned to a transmitting Network Element that the receiving Network Element has detected an incoming section failure. Also known as RDI.

FIT (Failures in Time)
Circuit pack failure rates per 10^9 hours as calculated using the method described in Reliability Prediction Procedure for Electronic Equipment, BellCore Method I, Issue 6, December 1997.

Folded Rings
Folded (collapsed) rings are rings without fiber diversity. The terminology derives from the image of folding a ring into a linear segment.

Forced
Term used when a circuit pack (either working or protection) has been locked into a service-providing state by user command.

FR (Frame Relay)

A form of packet switching that relies on high-quality phone lines to minimize errors. It is very good at handling high-speed, bursty data over wide area networks. The frames are variable lengths and error checking is done at the end points.

Frame
The smallest block of digital data being transmitted.

Framework
An assembly of equipment units capable of housing shelves, such as a bay framework.

Free Running
An operating condition of a clock in which its local oscillator is not locked to an internal synchronization reference and is using no storage techniques to sustain its accuracy.

G

GB
Gigabytes

Gbit/s
Gigabits per second

GHz
Gigahertz

Global Wait to Restore Time
Corresponds to the time to wait before switching back to the timing reference. It occurs after a timing link failure has cleared. This time applies for all timing sources in a system hence the name global. This can be between 0 and 60 minutes, in increments of one minute.

GNE (Gateway Network Element)
A network element that passes information between other network elements and management systems through a data communication network.

H

Hard Failure
An unrecoverable nonsymptomatic (primary) failure that causes signal impairment or interferes with critical network functions, such as DCC operation.

HDB3 (High Density Bipolar 3 Code)
Line code for 2 Mb/s transmission systems.

HDLC (High Level Data Link Control)
OSI reference model datalink layer protocol.

HMI
Human Machine Interface

HML (Human Machine Language)
A standard language developed by the ITU for describing the interaction between humans and

dumb terminals.

HO
High Order

Holdover
An operating condition of a clock in which its local oscillator is not locked to an external reference but is using storage techniques to maintain its accuracy with respect to the last known frequency comparison with a synchronization reference.

Hot Standby
A circuit pack ready for fast, automatic placement into operation to replace an active circuit pack. It has the same signal as the service going through it, so that choice is all that is required.

HPA (Higher Order Path Adaptation)
Function that adapts a lower order Virtual Container to a higher order Virtual Container by processing the Tributary Unit pointer which indicates the phase of the lower order Virtual Container Path Overhead relative to the higher order Virtual Container Path Overhead and assembling/disassembling the complete higher order Virtual Container.

HPC (Higher Order Path Connection)
Function that provides for flexible assignment of higher order Virtual Containers within an STM-N signal.

HPT (Higher Order Path Termination)
Function that terminates a higher order path by generating and adding the appropriate Virtual Container Path Overhead to the relevant container at the path source and removing the Virtual Container Path Overhead and reading it at the path sink.

HS
High Speed

HW
Hardware

Hz
Hertz

I

I/O
Input/Output

IAO LAN
Intraoffice Local Area Network

ID
Identifier

IEC
International Electro-Technical Commission

IEEE
Institute of Electrical and Electronics Engineers

IMF
Infant Mortality Factor

Insert
To physically insert a circuit pack into a slot, thus causing a system initiated restoral of an entity into service and/or creation of an entity and associated attributes.

Interface Capacity
The total number of STM-1 equivalents (bidirectional) tributaries in all transmission interfaces with which a given transmission interface shelf can be equipped at one time. The interface capacity varies with equipage.

Intermediate System (IS)
A system which routes/relays management information. An SDH Network Element may be a combined intermediate and end system.

IS (In-Service)
A memory administrative state for ports. IS refers to a port that is fully monitored and alarmed.

IS-IS Routing
The Network Elements in a management network, route packets (data) between each other using an IS-IS level protocol. The size of a network running IS-IS Level 1 is limited, and therefore certain mechanisms are employed to facilitate the management of larger networks.
For STATIC ROUTING, the capability exists for disabling the protocol over the LAN connections, effectively causing the management network to be partitioned into separate IS-IS Level 1 areas. In order for the network management system to communicate with a specific Network Element in one of these areas, the network management system must identify through which so-called Gateway Network Element this specific Network Element is connected to the LAN. All packets to this specific Network Element are routed directly to the Gateway Network Element by the network management system, before being re-routed (if necessary) within the Level 1 area.
For DYNAMIC ROUTING an IS-IS Level 2 routing protocol is used allowing a number of Level 1 areas to interwork. The Network Elements which connect an IS-IS area to another area are set to run the IS-IS Level 2 protocol within the Network Element and on the connection between other Network Elements. Packets can now be routed between IS-IS areas and the network management system does not have to identify the Gateway Network Elements.

ISDN
Integrated Services Digital Network

ITM
Integrated Transport Management

ITM-NM
Integrated Transport Management Network Module

ITU
International Telecommunications Union

ITU-T
International Telecommunications Union — Telecommunication standardization sector. Formerly known as CCITT: Comité Consultatif International Télégraphique & Téléphonique; International Telegraph and Telephone Consultative Committee.

J

Jitter
Short term variations of amplitude and frequency components of a digital signal from their ideal position in time.

K

kbit/s
Kilobits per second

L

LAN (Local Area Network)
A communications network that covers a limited geographic area, is privately owned and user administered, is mostly used for internal transfer of information within a business, is normally contained within a single building or adjacent group of buildings, and transmits data at a very rapid speed.

LBC
Laser Bias Current

LBFC
Laser Backface Currents

LBO (Lightguide Build-Out)
An attenuating (signal-reducing) element used to keep an optical output signal strength within desired limits.

LCAS
Link Capacity Adjustment Scheme

LCN
Local Communications Network

LED
Light-Emitting Diode

LH
Long Haul

Line
A transmission medium, together with the associated equipment, required to provide the means of transporting information between two consecutive network elements. One network element originates the line signal; the other terminates it.

Line Protection
The optical interfaces can be protected by line protection. Line protection switching protects against failures of line facilities, including the interfaces at both ends of a line, the optical fibers, and any equipment between the two ends. Line protection includes protection of equipment failures.

Line Timing
Refers to a network element that derives its timing from an incoming STM-N signal.

Link
The mapping between in-ports and out-ports. It specifies how components are connected to one another.

Link Pass Trough
If an Ethernet port is in link pass trough mode, its GbE transmitter is disabled in case of failures in the upstream network.

LL
Lucent Learning

LO
Low Order

Location
An identifier for a specific circuit pack, interface module, interface port, or communications link.

Lockout of Protection
The *WaveStar*™ CIT command that prevents the system from switching traffic to the protection line from a working line. If the protection line is active when a "Lockout of Protection" is entered – this command causes the working line to be selected. The protection line is then locked from any Automatic, Manual, or Forced protection switches.

Lockout State
The Lockout State shall be defined for each working or protection circuit pack. The two permitted states are: None – meaning no lockout is set for the circuit pack, set meaning the circuit pack has been locked out. The values (None & Set) shall be taken independently for each working or protection circuit pack.

LOF (Loss of Frame)
A failure to synchronize an incoming signal.

LOM
Loss Of Multiframe

Loop Timing
A special case of line timing. It applies to network elements that have only one OC-N/STM-N interface. For example, terminating nodes in a linear network are loop timed.

Loopback
Type of diagnostic test used to compare an original transmitted signal with the resulting received signal. A loopback is established when the received optical or electrical external transmission signal is sent from a port or tributary input directly back toward the output.

LOP (Loss of Pointer)
A failure to extract good data from a signal payload.

LOS (Loss of Signal)
The complete absence of an incoming signal.

Loss Budget
Loss (in dB) of optical power due to the span transmission medium (includes fiber loss and splice losses).

LPA (Lower order Path Adaptation)
Function that adapts a PDH signal to a synchronous network by mapping the signal into or de-mapping the signal out of a synchronous container.

LPC (Lower Order Path Connection)
Function that provides for flexible assignment of lower order VCs in a higher order VC.

LPT (Link Pass Through)
A GbE failure or an associated SDH path failure is forwarded by shutting off the GbE optical output. This makes the SDH network look like 'dark fiber'.

LS
Low Speed

LTE
Line Terminating Equipment

M

μm
Micrometer

MAF
Management Application Function

Maintenance Condition
An equipment state in which some normal service functions are suspended, either because of a problem or to perform special functions (copy memory) that can not be performed while normal service is being provided.

Management Connection
Identifies the type of routing used (STATIC or DYNAMIC), and if STATIC is selected allows the gateway network element to be identified.

Manager
Capable of issuing network management operations and receiving events. The manager communicates with the agent in the controlled network element.

Manual Switch State
A protection group shall enter the Manual Switch State upon the initiation and successful completion of the Manual Switch command. The protection group leaves the Manual Switch state by means of the Clear or Forced Switch commands. While in the Manual Switch state the system may switch the active unit automatically if required for protection switching.

Mapping
The logical association of one set of values, such as addresses on one network, with quantities or values of another set, such as devices or addresses on another network.

MB
Megabytes

Mbit/s
Megabits per second

MCF (Message Communications Function)
Function that provides facilities for the transport and routing of Telecommunications Management Network messages to and from the Network Manager.

MD (Mediation Device)
Allows for exchange of management information between Operations System and Network Elements.

MDI
Miscellaneous Discrete Input

MDO
Miscellaneous Discrete Output

MEC (Manufacturer Executable Code)
Network Element system software in binary format that after being downloaded to one of the stores can be executed by the system controller of the network element.

MEM
Memory

Mid-Span Meet
The capability to interface between two lightwave network elements of different vendors. This applies to high-speed optical interfaces.

MIPS
Millions of Instructions Per Second

Miscellaneous Discrete Interface
Allows an operations system to control and monitor equipment collocated within a set of input and output contact closures.

MJ (Major (alarm))
Indicates a service-affecting failure, main or unit controller failure, or power supply failure.

MMI
Man-Machine Interface

MML
Human-Machine Language

MN (Minor (alarm))
Indicates a non-service-affecting failure of equipment or facility.

MO
Managed Object

MS
Multiplexer Section

ms
Millisecond

MS-SPRING (Multiplexer Section Shared Protection Ring)
A protection method used in Add-Drop Multiplexer Network Elements.

MSOH (Multiplexer Section OverHead)
Part of the Section Overhead. Is accessible only at line terminals and multiplexers.

MSP (Multiplexer Section Protection)
Provides capability for switching a signal from a working to a protection section.

MST (Multiplexer Section Termination)
Function that generates the Multiplexer Section OverHead in the transmit direction and terminates the part of the Multiplexer Section overhead that is acceptable in the receive direction.

MTBF
Mean Time Between Failures

MTBMA
Mean Time Between Maintenance Activities

MTIE
Maximum Time Interval Error

MTPI
Multiplexer Timing Physical Interface

MTS (Multiplexer Timing Source)
Function that provides timing reference to the relevant component parts of the multiplex equipment and represents the SDH Network Element clock.

MTTR
Mean Time To Repair

Multiplexer
A device (circuit pack) that combines two or more transmission signals into a combined signal on a shared medium.

Multiplexing
A procedure by which multiple lower order path layer signals are adapted into a higher order path, or the multiple higher order path layer signals are adapted into a multiplex section.

N

NA
Not Applicable

NCC
Network Communication Control

NE (Network Element)
A node in a telecommunication network that supports network transport services and is directly manageable by a management system.

NEBS
Network Equipment-Building System

nm
Nanometer (10^{-9} meters)

NMON (Not Monitored)
A provisioning state for equipment that is not monitored or alarmed.

NMS
Network Management System

No Request State
This is the routine-operation quiet state in which no external command activities are occurring.

Node
A network element in a ring or, more generally, in any type of network. In a network element supporting interfaces to more than one ring, node refers to an interface that is in a particular ring. Node is also defined as all equipment that is controlled by one system controller. A node is not always directly manageable by a management system.

Non-Revertive Switching
In non-revertive switching, an active and stand-by line exist on the network. When a protection switch occurs, the standby line is selected to support traffic, thereby becoming the active line. The original active line then becomes the stand-by line. This status remains in effect even when the fault clears. That is, there is no automatic switch back to the original status.

Non-Synchronous
The essential characteristic of time-scales or signals such that their corresponding significant instants do not necessarily occur at the same average rate.

NORM
Normal

NPI
Null Pointer Indication

NPPA (Non-Preemptible Protection Access)
Non-preemptible protection access increases the available span capacity for traffic which does not require protection by a ring, but which cannot be preempted.

NRZ
Nonreturn to Zero

NSA
Non-Service Affecting

NSAP Address (Network Service Access Point Address)
Network Service Access Point Address (used in the OSI network layer 3). An automatically assigned number that uniquely identifies a Network Element for the purposes of routing DCC messages.

NUT
Non-preemtible Unprotected Traffic (NUT) offers the user the possibility to exclude timeslots from the MS-SPRING protection.

NVM (Non-Volatile Memory)
Memory that retains its stored data after power has been removed. An example of NVM would be a hard disk.

O

O&M
Operation and Maintenance

OA
Optical Amplifier

OAM&P
Operations, Administration, Maintenance, and Provisioning

OC, OC-n
Optical Carrier

OC-12
Optical Carrier, Level 12 Signal (622.08 Mbit/s)

OC-192
Optical Carrier, Level 192 (9953.28 Mb/s) (10 Gbit/s)

OC-3
Optical Carrier, Level 3 Signal (155 Mbit/s)

OC-48
Optical Carrier, Level 48 (2488.32 Mb/s) (2.5 Gbit/s)

OI (Operations Interworking)
The capability to access, operate, provision, and administer remote systems through craft interface access from any site in an SDH network or from a centralized operations system.

OLS
Optical Line System

OOF
Out-of-Frame

OOS (Out-of-Service)
The circuit pack is not providing its normal service function (removed from either the working or protection state) either because of a system problem or because the pack has been removed from service.

Open Ring Network
A network formed of a linear chain-shaped configuration of network elements. Each network element connects to two others, one on each side, except for two network elements at the ends which are connected on only one side. A closed ring can be formed by adding a connection between the two end nodes.

Operations Interface
Any interface providing you with information on the system behavior or control. These include the equipment LEDs, user panel, *WaveStar*™ CIT, office alarms, and all telemetry interfaces.

Operator
A user of the system with operator-level user privileges.

Optical Channel
A STM-N wavelength within an optical line signal. Multiple channels, differing by 1.5 µm in wavelength, are multiplexed into one signal.

Optical Line Signal
A multiplexed optical signal containing multiple wavelengths or channels.

Original Value Provisioning
Preprogramming of a system's original values at the factory. These values can be overridden using local or remote provisioning.

OS (Operations System)
A central computer-based system used to provide operations, administration, and maintenance functions.

OSF
Open Software Foundation Operations System Function

OSI (Open Systems Interconnection)
Referring to the OSI reference model, a logical structure for network operations standardized by the International Standards Organization (ISO).

Outage
A disruption of service that lasts for more than 1 second.

OW (Orderwire)
A dedicated voice-grade line for communications between maintenance and repair personnel.

P

Parameter
A variable that is given a value for a specified application. A constant, variable, or expression that is used to pass values between components.

Parity Check
Tests whether the number of ones (or zeros) in an array of binary bits is odd or even; used to determine that the received signal is the same as the transmitted signal.

Pass-Through
Paths that are cross-connected directly across an intermediate node in a network.

Path
A logical connection between the point at which a standard frame format for the signal at the given rate is assembled, and the point at which the standard frame format for the signal is disassembled.

Path Terminating Equipment
Network elements in which the path overhead is terminated.

PCB
Printed Circuit Board

PCM
Pulse Code Modulation

PDH
Plesiochronous Digital Hierarchy

PI
Physical Interface

Platform
A family of equipment and software configurations designed to support a particular application.

Plesiochronous Network
A network that contains multiple subnetworks, each internally synchronous and all operating at the same nominal frequency, but whose timing may be slightly different at any particular instant.

PM (Performance Monitoring)
Measures the quality of service and identifies degrading or marginally operating systems (before an alarm would be generated).

PMD (Polarization Mode Dispersion)
Output pulse broadening due to random coupling of the two polarization modes in an optical fiber.

POH (Path Overhead)
Informational bytes assigned to, and transported with the payload until the payload is demultiplexed. It provides for integrity of communication between the point of assembly of a virtual container and its point of disassembly.

Pointer
An indicator whose value defines the frame offset of a virtual container with respect to the frame reference of the transport entity on which it is supported.

POP
Point of Presence

Port (also called Line)
The physical interface, consisting of both an input and output, where an electrical or optical transmission interface is connected to the system and may be used to carry traffic between network elements. The words “port” and “line” may often be used synonymously. “Port” emphasizes the physical interface, and “line” emphasizes the interconnection. Either may be used to identify the signal being carried.

Port State Provisioning
A feature that allows a user to suppress alarm reporting and performance monitoring during provisioning by supporting multiple states (automatic, in-service, and not monitored) for low-speed ports.

POTS
Plain Old Telephone Service

PP
Pointer Processing

PPA
Preemptible Protection Access

PRC (Primary Reference Clock)
The main timing clock reference in SDH equipment.

Preprovisioning
The process by which the user specifies parameter values for an entity in advance of some of the equipment being present. These parameters are maintained only in NVM. These modifications are initiated locally or remotely by either a CIT or an OS. Preprovisioning provides for the decoupling of manual intervention tasks (for example, install circuit packs) from those tasks associated with configuring the node to provide services (for example, specifying the entities to be cross-connected).

PRI
Primary

Proactive Maintenance
Refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming, but indicative of an impending signal fail or signal degrade defect.

Protection Access
To provision traffic to be carried by protection tributaries when the port tributaries are not being used to carry the protected working traffic.

Protection Group Configuration
The members of a group and their roles, for example, working protection, line number, etc.

Protection Path
One of two signals entering a path selector used for path protection switching or dual ring interworking. The other is the working path. The designations working and protection are provisioned by the user, whereas the terms active path and standby path indicate the current protection state.

Protection State
When the working unit is currently considered active by the system and that it is carrying traffic. The “active unit state” specifically refers to the receive direction of operation — since protection switching is unidirectional.

PROTN (Protection)
Extra capacity (channels, circuit packs) in transmission equipment that is not intended to be used for service, but rather to serve as backup against equipment failures.

PROV (Provisioned)
Indicating that a circuit pack is ready to perform its intended function. A provisioned circuit pack can be active (ACT), in-service (IS), standby (STBY), provisioned out-of-service (POS), or out-of-service (OOS).

PSDN
Public Switched Data Network

PSTN
Public Switched Telephone Network

PTE
Path Terminating Equipment

PWR
Power

PWR ON
Power On

Q

Q-LAN
Thin Ethernet LAN which connects the manager to Gateway Network Elements so that management information between Network Elements and management systems can be exchanged.

QL (Quality Level)
The quality of the timing signal(s) provided to clock a Network Element. The level is provided by the Synchronization Status Marker which can accompany the timing signal. If the System and Output Timing Quality Level mode is “Enabled”, and if the signal selected for the Station Clock Output has a quality level below the Acceptance Quality Level, the Network Element “squelches” the Station Clock Output Signal, which means that no signal is forwarded at all.

Possible levels are:

- PRC (Primary Reference Clock)
- SSU_T (Synchronization Supply Unit - Transit)
- SSU_L (Synchronization Supply Unit - Local)
- SEC (SDH Equipment Clock)
- DUS (Do not Use for Synchronization)

QOS
Quality of Service

R

RAM
Random Access Memory

RDI (Remote Defect Indication)
An indication returned to a transmitting terminal that the receiving terminal has detected an incoming section failure. [Previously called far-end-receive failure (FERF).]

Reactive Maintenance
Refers to detecting defects/failures and clearing them.

Receive-Direction
The direction towards the Network Element.

Regeneration

The process of reconstructing a digital signal to eliminate the effects of noise and distortion.

Regenerator Loop

Loop in a Network Element between the Station Clock Output(s) and one or both Station Clock Inputs, which can be used to dejitterize the selected timing reference in network applications.

Regenerator Section Termination (RST)

Function that generates the Regenerator Section Overhead (RSOH) in the transmit direction and terminates the RSOH in the receive direction.

Reliability

The ability of a software system performing its required functions under stated conditions for a stated period of time. The probability for an equipment to fulfill its function. Some of the ways in which reliability is measured are: MTBF (Mean Time Between Failures) expressed in hours; Availability = (MTBF)/(MTBF+MTTR)(%) [where MTTR = mean time to restore]; outage in minutes per year; failures per hour; percentage of failures per 1,000 hours.

Remote Network Element

Any Network Element that is connected to the referenced Network Element through either an electrical or optical link. It may be the adjacent node on a ring, or N nodes away from the reference. It also may be at the same physical location but is usually at another (remote) site.

Restore Timer

Counts down the time (in minutes) during which the switch waits to let the worker line recover before switching back to it. This option can be set to prevent the protection switch continually switching if a line has a continual transient fault.

Revertive

A protection switching mode in which, after a protection switch occurs, the equipment returns to the nominal configuration (that is, the working equipment is active, and the protection equipment is standby) after any failure conditions that caused a protection switch to occur, clear, or after any external switch commands are reset. (See “Non-Revertive”.)

Revertive Switching

In revertive switching, there is a working and protection high-speed line, circuit pack, etc. When a protection switch occurs, the protection line, circuit pack, etc. is selected. When the fault clears, service “reverts” to the working line.

Ring

A configuration of nodes comprised of network elements connected in a circular fashion. Under normal conditions, each node is interconnected with its neighbor and includes capacity for transmission in either direction between adjacent nodes. Path switched rings use a head-end bridge and tail-end switch. Line switched rings actively reroute traffic over the protection capacity.

Route

A series of contiguous digital sections.

Router
An interface between two networks. While routers are like bridges, they work differently. Routers provide more functionality than bridges. For example, they can find the best route between any two networks, even if there are several different networks in between. Routers also provide network management capabilities such as load balancing, partitioning of the network, and trouble-shooting.

RSOH
Regenerator Section OverHead; part of SOH

RST
Regenerator Section Termination

RT
Remote Terminal

RTRV
Retrieve

RZ (Return to Zero)
A code form having two information states (termed zero and one) and having a third state or an at-rest condition to which the signal returns during each period.

S

SA
Service Affecting

SA
Section Adaptation

SD
Signal Degrade

SDH (Synchronous Digital Hierarchy)
A hierarchical set of digital transport structures, standardized for the transport of suitable adapted payloads over transmission networks.

SDS
Standard Directory Service based on ANSI recommendation T1.245

SEC
Secondary

SEC
SDH Equipment Clock

Section
The portion of a transmission facility, including terminating points, between a terminal network element and a line-terminating network element, or two line-terminating network elements.

Section Adaptation
Function that processes the AU-pointer to indicate the phase of the VC-3/4 POH relative to the STM-N SOH and assembles/disassembles the complete STM-N frame.

Self-Healing
A network's ability to automatically recover from the failure of one or more of its components.

SEMF (Synchronous Equipment Management Function)
Function that converts performance data and implementation specific hardware alarms into object-oriented messages for transmission over the DCC and/or Q-interface. It also converts object-oriented messages related to other management functions for passing across the S reference points.

Server
Computer in a computer network that performs dedicated main tasks which generally require sufficient performance.

Service
The operational mode of a physical entity that indicates that the entity is providing service. This designation will change with each switch action.

SES (Severely Errored Seconds)
This performance monitoring parameter is a second in which a signal failure occurs, or more than a preset amount of coding violations (dependent on the type of signal) occurs.

SH
Short Haul

Single-Ended Operations
Provides operations support from a single location to remote Network Elements in the same SDH subnetwork. With this capability you can perform operations, administration, maintenance, and provisioning on a centralized basis. The remote Network Elements can be those that are specified for the current release.

Site Address
The unique address for a Network Element.

Slot
A physical position in a shelf designed for holding a circuit pack and connecting it to the backplane. This term is also used loosely to refer to the collection of ports or tributaries connected to a physical circuit pack placed in a slot.

SM (Single-Mode Fiber)
A low-loss, long-span optical fiber typically operating at either 1310 nm, 1550 nm, or both.

SMN
SDH Management Network

SNC/I
SubNetwork Connection (protection) / Inherent monitoring

SNC/N
SubNetwork Connection (protection) / Non-Intrusive Monitoring

SNR (Signal-to-Noise Ratio)
The relative strength of signal compared to noise.

Software Backup
The process of saving an image of the current network element's databases, which are contained in its NVM, to a remote location. The remote location could be the *WaveStar*™ CIT or an OS.

Software Download
The process of transferring a generic (full or partial) or provisioned database from a remote entity to the target network element's memory. The remote entity may be the *WaveStar*™ CIT or an OS. The download procedure uses bulk transfer to move an uninterpreted binary file into the network element.

Software ID
Number that provides the software version information for the system.

SOH (Section Overhead)
Capacity added to either an AU-4 or assembly of AU-3s to create an STM-1. Contains always STM-1 framing and optionally maintenance and operational functions. SOH can be subdivided in MSOH (multiplex section overhead) and RSOH (regenerator section overhead).

SONET (Synchronous Optical Network)
The North American standard for the rates and formats that defines optical signals and their constituents.

Span
An uninterrupted bidirectional fiber section between two network elements.

Span Growth
A type of growth in which one wavelength is added to all lines before the next wavelength is added.

SPE
Synchronous Payload Envelope

SPI
SDH Physical Interface

Squelch Map
This map contains information for each cross-connection in a ring and indicates the source and destination nodes for the low-speed circuit that is part of the cross-connection. This information is used to prevent traffic misconnection in rings with isolated nodes or segments.

SSM
Synchronization Status Marker

SSU_L
Synchronization Supply Unit — Local

SSU_T
Synchronization Supply Unit — Transit

Standby Path
One of two signals entering a constituent path selector, the standby path is the path not currently being selected.

State
The state of a circuit pack indicates whether it is defective or normal (ready for normal use).

Station Clock Input
An external clock may be connected to a Station Clock Input.

Status
The indication of a short-term change in the system.

STBY (Standby)
The circuit pack is in service but is not providing service functions. It is ready to be used to replace a similar circuit pack either by protection or by duplex switching.

STM
Synchronous Transport Module (SDH)

STM-N (Synchronous Transport Module, Level N)
A building block information structure that supports SDH section layer connections, where N represents a multiple of 155.52 Mbit/s. Normally N=1, 4, 16, or 64.

STS
Synchronous Transport Signal (SONET)

Subnetwork
A group of interconnected/interrelated Network Elements. The most common connotation is a synchronous network in which the Network Elements have data communications channel (DCC) connectivity.

Supervisor
A user of the application with supervisor user privileges.

Suppression
A process where service-affecting alarms that have been identified as an “effect” are not displayed to a user.

SYNC
Synchronizer

Synchronization Messaging
Synchronization messaging is used to communicate the quality of network timing, internal timing status, and timing states throughout a subnetwork.

Synchronous
The essential characteristic of time scales or signals such that their corresponding significant instances occur at precisely the same average rate, generally traceable to a single Stratum-1 source.

Synchronous Network
The synchronization of transmission systems with synchronous payloads to a master (network) clock that can be traced to a reference clock.

Synchronous Payload
Payloads that can be derived from a network transmission signal by removing integral numbers of bits from every frame. Therefore, no variable bit-stuffing rate adjustments are required to fit the payload in the transmission signal.

SYSCTL
System Controller circuit pack

System Administrator
A user of the computer system on which the system's OS software application can be installed.

T

TARP
Target Identifiers Address Resolution Protocol

TBD
To Be Determined

TCA (Threshold-Crossing Alert)
A message type sent from a Network Element that indicates that a certain performance monitoring parameter has exceeded a specified threshold.

TDM (Time Division Multiplexing)
A technique for transmitting a number of separate data, voice, and/or video signals simultaneously over one communications medium by interleaving a portion of each signal one after another.

Through (or Continue) Cross-Connection
A cross-connection within a ring, where the input and output tributaries have the same tributary number but are in lines opposite each other.

Through Timing
Refers to a network element that derives its transmit timing in the east direction from a received line signal in the east direction and its transmit timing in the west direction from a received line signal in the west direction.

THz
Terahertz (10^{12} Hz)

TID (Target Identifier)
A provisionable parameter that is used to identify a particular Network Element within a network. It is a character string of up 20 characters where the characters are letters, digits, or hyphens (-).

TL1 (Transaction Language One)
A subset of ITU's human-machine language.

TMN
Telecommunications Management Network

TR
Technical Requirement

Transmit-Direction
The direction outwards from the Network Element.

Tributary
A signal of a specific rate (2 Mbit/s, 34 Mbit/s, 140 Mbit/s, VC12, VC3, VC4, STM-1 or STM-4) that may be added to or dropped from a line signal.

Tributary
A path-level unit of bandwidth within a port, or the constituent signal(s) being carried in this unit of bandwidth, for example, an STM-1 tributary within an STM-N port.

Tributary Unit Pointer
Indicates the phase alignment of the VC with respect to the TU in which it resides. The pointer position is fixed with respect to the TU frame.

True Wave™ Optical Fiber
Lucent Technologies' fiber generally called non-zero dispersion-shift fiber, with a controlled amount of chromatic dispersion designed for amplified systems in the 1550/1310 nm range.

TSA (Time Slot Assignment)
A capability that allows any tributary in a ring to be cross-connected to any tributary in any lower-rate, non-ring interface or to the same-numbered tributary in the opposite side of the ring.

TSB
Transport Service Bridge

TSI (Time Slot Interchange)
The ability of the user to assign cross-connections between any tributaries of any lines within a Network Element. Three types of TSI can be defined: Hairpin TSI, Interring TSI (between rings), and Intraring TSI (within rings).

TSO
Technical Support Organization

TTP
Trail Termination Point

TU (Tributary Unit)
An information structure which provides adaptation between the lower order path layer and the higher path layer. Consists of a VC-n plus a tributary unit pointer TU PTR.

TUG
Tributary Unit Group

Two-Way Point-to-Point Cross-Connection
A two-legged interconnection, that supports two-way transmission, between two and only two tributaries.

Two-Way Roll
The operation which moves a two-way cross-connection between tributary i and tributary j to a two-way cross-connection between the same tributary i and a new tributary k with a single user command.

U

UAS (Unavailable Seconds)
In performance monitoring, the count of seconds in which a signal is declared failed or in which 10 consecutively severely errored seconds (SES) occurred, until the time when 10 consecutive non-SES occur.

UITS (Unacknowledged Information Transfer Service)
Unconfirmed mode of LAPD operation.

UNEQ
Path Unequipped

Upstream
At or towards the source of the considered transmission stream, for example, looking in the opposite direction of transmission.

User Privilege
Permissions a user must perform on the computer system on which the system software runs.

UTC (Universal Coordinated Time)
A time-zone independent indication of an event. The local time can be calculated from the Universal Coordinated Time.

V

V
Volts

VAC
Volts Alternating Current

Value
A number, text string, or other menu selection associated with a parameter.

Variable
An item of data named by an identifier. Each variable has a type, such as int or Object, and a scope.

VBA
Variable Bandwidth Allocation

VC (Virtual Container)
Container with path overhead.

VDC
Volts Direct Current

VF
Voice frequency

Virtual
Refers to artificial objects created by a computer to help the system control shared resources.

Virtual Circuit
A logical connection through a data communication (for example, X.25) network.

Voice Frequency (VF) Circuit
A 64 kilobit per second digitized signal.

Volatile Memory
Type of memory that is lost if electrical power is interrupted.

VPN
Virtual Private Network

W

WAD
Wavelength Add/Drop

WAN (Wide Area Network)
A communication network that uses common-carrier provided lines and covers an extended geographical area.

Wander
Long term variations of amplitude frequency components (below 10 Hz) of a digital signal from their ideal position in time possibly resulting in buffer problems at a receiver.

Wavelength Interchange
The ability to change the wavelength associated with an STM-N signal into another wavelength.

WaveStar™ OLS 40G/80G/400G
WaveStar™ Optical Line System 40G/80G/400G

WDCS
Wideband Digital Cross-Connect System

WDM (Wavelength Division Multiplexing)
A means of increasing the information-carrying capacity of an optical fiber by simultaneously transmitting signals at different wavelengths.

Wideband Communications
Voice, data, and/or video communication at digital rates from 64 kbit/s to 2 Mbit/s.

Working
Label attached to a physical entity. In case of revertive switching the working line or unit is the entity that is carrying service under normal operation. In case of nonrevertive switching the label has no particular meaning.

Working State
The working unit is currently considered active by the system and that it is carrying traffic.

WRT (Wait to Restore Time)
Corresponds to the time to wait before switching back after a failure has cleared, in a revertive protection scheme. This can be between 0 and 15 minutes, in increments of one minute.

WS
Work Station

WTR (Wait to Restore)
Applies to revertive switching operation. The protection group enters the WTR state when all Equipment Fail (EF) conditions are cleared, but the system has not yet reverted back to its working line. The protection group remains in the WTR state until the Wait-to-Restore timer completes the WTR time interval.

X

X.25
An ITU standard defining the connection between a terminal and a public packet-switched network

X.25 Interface/Protocol
The ITU packet-switched interface standard for terminal access that specifies three protocol layers: physical, link, and packet for connection to a packet-switched data network.

Z

Zero Code Suppression
A technique used to reduce the number of consecutive zeros in a line-coded signal (B3ZS, B8ZS).

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