Microwave Radio System

Alcatel-Lucent 9500 MXC

Microwave Cross Connect

User Manual

3DB 23063 AEAA - Rev 005 - June 2008

9500 MXC User Manual

3DB 23063 AEAA - Rev 005 June 20087

This manual incorporates features and functions provided with 9500 MXC software release 4.3.

Warranty

Any warranty must be referred exclusively to the terms of the contact of sale of the equipment this manual refers to.

Alcatel-Lucent makes no warranty of any kind with regards to this manual, and specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Alcatel-Lucent will not be liable for errors contained herein or for damages, whether direct, indirect, consequential, incidental, or special, in connection with the furnishing, performance, or use of this material.

The product specification and/or performance levels contained in this manual are for information purposes only and are subject to change without notice. They do not represent any obligation on the part of Alcatel-Lucent.

Safety Recommendations

The safety recommendations below must be considered to avoid injuries on persons and/or damage to the equipment:

1) Service Personnel

Installation and service must be carried out by authorized persons that have the technical training and experience necessary to make them aware of hazardous operations during installation and service, and of measures to avoid any danger to themselves, to any other persons, and to the equipment.

2) Access to the Equipment

Access to equipment in use must be restricted to service personnel only.

3) Safety Norms

Recommended safety norms are indicated in this manual. Refer to Volume I.

Local safety regulations must be used if mandatory. Safety instructions in Volume I should be used in addition to the local safety regulations. In the case of conflict between safety instructions stated in this manual and those indicated in local regulations, mandatory local norms will prevail. Should not local regulations be mandatory, then safety norms in this manual will prevail.

4) Service Personnel Skill

Service Personnel must have received adequate technical training on telecommunications and in particular on the equipment this manual refers to.

Contact Information

For Customer Service, contact:

Europe	North America	North America
Alcatel-Lucent Customer Service Center Rue Albert Schweitzer, 1 Illkirch France	Alcatel-Lucent Customer Service Center (For 9500 MXC issues you may contact the WTD directly)	WTD (Wireless Transmission Division) CTAC Engineers Plano Texas USA
Tel. +33 3 90679722	Tel: 888-252-2832 or 613-784-6100 Fax: 613-784-8905	Fax: 972-477-7240
alcare.europe@alcatel.com	wstc.repair@alcatel.com	ml-tac.support@alcatel.com

For other regions/countries, please refer to your service contract.

For service returns, please address units to:

USA	Canada
Alcatel-Lucent Repair and Return 1227 West Marshall Longview, TX 75604 RA#:_______________	Alcatel-Lucent Repair and Return 349 Terry Fox Drive Kanata, Ontario K2K 2V6 Canada RA#:_______________

Product Compliance Notes:

This equipment has been tested for and meets EMC Directive 89/336/EEC. The equipment was tested using screened cabling. If any other type of cable is used, it may violate compliance.

9500 MXC is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures. This equipment is intended to be used exclusively in telecommunications centers.

FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WEEE Directive

In accordance with the WEEE Directive (2002/96/EC), 9500 MXC is marked with the following symbol:

This symbol indicates that this equipment should be collected separately for the purposes of recovery and/or recycling. For information about collection and recycling of Alcatel-Lucent equipment, please contact your local Alcatel-Lucent sales office. If you purchased your product via a distributor, please contact the distributor for information regarding collection and recovery/recycling.

(WEEE is the acronym is for Waste Electrical and Electronic Equipment)

RoHS Directive

The RoHs (Restriction of Hazardous Substances) Directive (2002/95/EC) was implemented on 1 July, 2006. 9500 MXC meets the requirements of this directive, as at the implementation date.

RoHS Compliance: China

Marking Styles for Names and Contents of Toxic or Hazardous Substances of Elements
危险或有毒物元素的名称及内容标记式样

Part name 部件名	Toxic or Hazardous Substances and Elements 危险或有毒物质及元素					
	Lead (Pb) 铅	Mercury (Hg) 汞	Cadmium (Cd) 镉	Hexavalent Chromium (Cr (VI)) 铬	Polybrominated biphenyls (PBB) 联苯	Polybrominated diphenyl ethers (PBDE) 苯基苯
ODU	X	O	O	O	O	O
IDU	X	O	O	O	O	O
RAC card	X	O	O	O	O	O
DAC card	X	O	O	O	O	O
Aux card	X	O	O	O	O	O
NPC card	X	O	O	O	O	O
IDC	X	O	O	O	O	O
IDCe	X	O	O	O	O	O
NCC card	X	O	O	O	O	O
Fan card	X	O	O	O	O	O

O: Indicates that this toxic or hazardous substance contained in all of the homogenous materials for this part is below the limit requirement in SJ/T11363-2006.
O：表示此部件所有同质的原料包含的这种危险或有毒物质在 SJ/T11363-2006 限度之下。
X: Indicates that this toxic or hazardous contained in at least one of the homogenous materials used for this part is above the limit requirement in SJ/T11363-2006.
X：表示此部件至少一种同质的原料包含的这种危险或有毒物质在 SJ/T111363-2006 限度之上。

Alcatel·Lucent

DECLARATION OF CONFORMITY

We,

ALCATEL-LUCENT ITALIA S.P.A.
Piazza della Repubblica, 25
20124 MILANO
Italy

Following the provisions of the:

DIRECTIVE 1999 / 5 / EC of 9 March 1999
Radio and Telecommunications Terminal Equipment (Annex IV)

declare, under our sole responsibility that the equipment:

9500 MXC L6, U6, 7, 8, 10.5, 11, 13, 15, 18, 23, 26, 28, 38 GHz

4 – 16 – 32 – 64 – 128 QAM

Radio-Link used in L6, U6, 7, 8, 10.5, 11, 13, 15, 18, 23, 26, 28, 38 GHz band

Interfaces: 2 ÷ 75E1; 1 ÷ 8E3; 1 ÷ 4 10/100/1000 BT; 1000 B-X; 1 ÷ 2xSTM-1 electrical or optical

provided that it is installed, maintained and used in the application for which it is made, with respect of the "professional practices, relevant installation standards and manufacturer's instructions":

This declaration is based on the "CE" EC-R&TTE CERTIFICATE (Registration N° A103682V, A103683V, A103684V, A103686V, A103697V, A103698V, A103701V, A103702V, A103703V, A103704V, A103705V, A103706V, A103707V) issued by the Notified Body EMCC DR. RASEK (Identification number **0678**).

• Safety requirements:	EN 60950-1:2001		
	EN 50385:2002		
• EMC requirements:	EN 301 489-1	V1.4.1	(08/2002)
	EN 301 489-4	V1.3.1	(08/2002)
• Spectrum requirements:	EN 302 217-2-2	V1.1.3	(12/2004)

Vimercate, 11 May 2007

Business Development
&
Global Support

(Function of the authorised person)

A. VALSECCHI

(Name of the authorised person)

(Signature)

ED	04				
WTD				3DB 23119 0000 EU ZZ A	2/2

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WTD
DECLARATION OF CONFORMITY TO CE MARKING

ED	DATE	CHANGE NOTE	APPRAISAL AUTHORITY	ORIGINATOR
04	070511	UP-DATE	CORTINOVIS E. - ITAVE COZZI M. - ITAVE	PASTORI S. - ITAVE
03	070201	UP-DATE		
02	061102	UP-DATE		

DECLARATION OF CONFORMITY TO CE MARKING
9500 MXC
4 – 16 – 32 – 64 – 128 QAM
Radio-Link used in L6, U6, 7, 8, 10.5, 11, 13, 15, 18, 23, 26, 28, 38 GHz band

ED	04	CE CONFORMITY OF 9500 MXC SYSTEM		
WTD			3DB 23119 0000 EU ZZ A	1/2

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About

Welcome to 9500 MXC

The 9500 MXC Microwave Radio System comprises the Node and the Terminal. Both are split-architecture radios with an antenna-mounted outdoor unit and a rack-mounted indoor unit.

The 9500 MXC Node supports multiple point-to-point radios for PDH, SDH and/or Ethernet on a single rack-mounted platform, to form a complete network node for star or ring configurations on frequency bands 5 to 38 GHz.

The 9500 MXC Terminal is optimized for single-link installations or where back-to-back network connection of terminals is preferred. Terminals may also be used to spur from a 9500 MXC Node. Different versions are available for PDH, SDH or Ethernet, on frequency bands 5 to 38 GHz.

About the 9500 MXC Manual

This manual provides information on installing, commissioning and troubleshooting a 9500 MXC microwave Radio system. Technical descriptions are at a module and system level.

Intended Audience

The information in this manual is for use by trained technicians or engineers. It does not provide information or instruction on basic technical procedures. Alcatel-Lucent recommends you read the relevant sections of this manual thoroughly before beginning any installation or operational procedures on the 9500 MXC.

Organization

This manual is divided into six volumes:

- Health and Safety Requirements
- System Description
- Installation
- Configuration and Diagnostics
- Commissioning and Troubleshooting
- Appendices

What You Need To Know

To install and commission a 9500 MXC, we recommend you have the following knowledge and skills:

- A basic understanding of the principles of microwave transmission.

- Installation and maintenance experience on PDH and SDH digital microwave radio systems.
- Familiarity with Ethernet and/or SDH multiplexing where these traffic options are to be employed on the 9500 MXC.
- Familiarity with the operation of a PC using the Windows operating system.

Conventions and Terminology

Graphical Cues

The following icons function as graphical cues used to characterize particular types of associated supporting information:

A warning icon denotes danger to life and/or limb.

A caution icon denotes important information pertaining to damage to equipment, loss of data, or corruption of files.

A *note* icon denotes additional information you may require to complete the procedure or understand the function.

Volume I

9500 MXC Health and Safety Requirements

Chapter 1. Health and Safety

This volume includes the following health and safety information:

- General Health and Safety
- Operator Health and Safety
- General Hazards

All personnel must comply with the relevant health and safety practices when working on or around the 9500 MXC radio equipment.

The 9500 MXC has been designed to meet relevant US and European health and safety standards as outlined in IEC Publication 60950-1.

Local safety regulations must be used if mandatory. Safety instructions in this Volume should be used in addition to the local safety regulations. In the case of conflict between safety instructions stated herein and those indicated in local regulations, mandatory local norms will prevail. Should not local regulations be mandatory, then safety norms herein will prevail.

General Health and Safety

The following table describes general health and safety information about the 9500 MXC radio.

Topic	Information
Flammability	The equipment is designed and constructed to minimize the risk of smoke and fumes during a fire.
Hazardous Materials	No hazardous materials are used in the construction of the equipment.
Hazardous Voltage	The 9500 MXC system meets global product safety requirements for safety extra-low voltage (SELV) rated equipment where the input voltage ***must*** be 48 V nominal, 60 V maximum.
Safety Signs	External warning signs or other indicators on the equipment are not required.
Surface Temperatures	The external equipment surfaces do become warm during operation due to heat dissipation. However, the temperatures reached are not considered hazardous.

Operator Health and Safety

The following table describes the precautions that relate to installing or working on the 9500 MXC radio.

Topic	Information
Equipment Protrusions	The equipment has been designed to be free of unnecessary protrusions or sharp surfaces that may catch or otherwise cause injury during handling. However, always take care when working on or around the equipment.
Laser and Fiber Optic Cable Hazards	9500 MXC fiber optic transmitters are IEC60825-1 / 21CFR1040-1 Class I compliant and present no danger to personnel in normal use. However: Do not look into active unterminated optical ports or fibers. If visual inspection is required ensure the equipment is turned off or, if a fiber cable, disconnect the far end. Follow the manufacturer's instructions when using an optical test set. Incorrect calibration or control settings could result in hazardous levels of radiation. Protect/cover unconnected optical fiber connectors with dust caps. Place all optical fiber cuttings in a suitable container for safe disposal. Bare fibers and fiber scraps can easily penetrate the skin and eyes.
Lifting Equipment	Be careful when hoisting or lifting the ODU or its antenna during installation or maintenance. The ODU is nominally 10 kg (22 lb). However, antennas with their mounting hardware can weigh in excess of 100 kg (220 lb) and require specialized lifting equipment and an operator trained and certified in its use.
Protection from RF Exposure: 9500 MXC	The 9500 MXC radio does not generate RF fields intense enough to cause RF burns. However, when installing, servicing or inspecting an antenna always comply with the Protection from RF Exposure guidelines under General Hazards.
Safety Warnings	When a practice or procedure poses implied or potential harm to the user or to the radio equipment, a warning is included in this manual.

General Hazards

The following table describes the general hazards that must be addressed when planning and installing a 9500 MXC system.

Topic	Information
Airflow Requirements	Rack installations must be made so the airflow required for safe and correct operation of 9500 MXC is not compromised. For the 9500 MXC Node, unobstructed air passage must be maintained to each side of the indoor unit, which requires a minimum of 50 mm (2 inches) of side spacing to any rack panels, cable bundles or similar.
Circuit Overloading	When connecting the 9500 MXC, determine the effect this will have on the power supply, circuit protection devices, and supply wiring. Check 9500 MXC power consumption specifications and the supply capability of the power supply system. This check of capacity must extend to the dc power supply and not just to an intermediate connection point.
9500 MXC Indoor Unit Earthing	The 9500 MXC indoor unit earth must be connected directly to the dc supply system earthing conductor, or to a bonding jumper from an earthing terminal bar, or bus to which the dc supply system earthing is connected.
ESD	ESD (electrostatic discharge) can damage electronic components. Even if components remain functional, ESD can cause latent damage that results in premature failure. Always wear proper ESD grounding straps when changing or handling the plug-in cards and avoid hand contact with the PCB back-plane and top-plane. Connect your ESD grounding strap to the combined ESD and ground connector on the INU rack ear. Spare plug-in cards or cards to be returned for service must be enclosed in an anti-static bag. When removing a card from the anti-static bag for installation in an INU, or placing a card in a bag, do so at the INU and only when connected to the INU via your ESD grounding strap.

Topic	Information
Protection from RF Exposure	When installing, servicing or inspecting an antenna always comply with the following: • Locate the antenna such that it does not infringe the RF exposure guidelines for general public. Refer to General Public Compliance Boundary in RF Exposure Guidelines on page 1-6. • Stay aware of the potential risk of RF exposure and take appropriate precautions. Refer to Occupational Compliance Boundary in RF Exposure Guidelines on page 1-6. • Do not stand in front of or look into an antenna without first ensuring the associated transmitter or transmitters are switched off. • At a multi-antenna site ask the site owner or operator for details of other radio services active at the site and for their requirements/recommendations for protection against potentially harmful exposure to RF radiation. • When it is not possible to switch transmitters off at a multi-antenna site and there is potential for exposure to harmful levels of RF radiation, wear a protective suit. • Do not look into the waveguide port of an ODU when the radio is active.
Fiber Optic Cables	Handle optical fibers with care. Keep them in a safe and secure location during installation. Do not attempt to bend them beyond their minimum bend radius. Protect/cover unconnected optical fiber connectors with dust caps.
Ground Connections	Reliable grounding of the 9500 MXC system must be maintained. Refer to instructions in the manual for grounding of the ODU, ODU cable, lightning surge suppressor, and indoor unit.
Lightning Surge Suppressor	All 9500 MXC ODU cables must be fitted with the specified surge suppressor(s).
Mains Power Supply Routing	9500 MXC dc power, IF, tributary, auxiliary and NMS cables are not to be routed with any AC mains power lines. They are also to be kept away from any power lines which cross them.
Maximum Ambient Temperature	The maximum ambient temperature (Tmra) for a 9500 MXC indoor unit is +45° C (113° F), and +55° C (131° F) for an ODU. To ensure correct operation and to maximize long term component reliability, ambient temperatures must not be exceeded. Operational specification compliance is not guaranteed for higher ambients.

Topic	Information
Mechanical Loading	When installing an indoor unit in a rack, ensure the rack is securely anchored. Ensure that the additional loading of a 9500 MXC indoor unit or units will not cause any reduction in the mechanical stability of the rack.
Power Supply Connection	The 9500 MXC radio has the +ve pin on its dc power supply connector fastened directly to the chassis. It must be used with a -48 Vdc power supply which has a +ve earth; the power supply earth conductor is the +ve supply to the radio. • There must be no switching or disconnecting devices in this earth conductor between the dc power supply and the point of connection to a 9500 MXC system. • The power supply must be located in the same premises as the 9500 MXC system.
Power Supply Disconnect	An appropriate power supply disconnect device should be provided as part of the building installation.
Rack Mount Temperature Considerations	If the 9500 MXC indoor unit is installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient. The maximum ambient temperature (Tmra) of +45° Celsius (113° F) applies to the immediate operating environment of the 9500 MXC indoor unit, which, if installed in a rack, is the ambient within the rack.
Restricted Access	The 9500 MXC system must be installed in restricted access sites. The indoor unit and associated power supply must be installed in restricted areas, such as dedicated equipment rooms, closets, cabinets, or the like. Access to the tower and ODU/antenna location must be restricted **Note:** For USA: In restricted access areas install the 9500 MXC system in accordance with articles 110-26 and 110-27 of the 2002 National Electrical Code ANSI/NFPA 70.

RF Exposure Guidelines

The following MPE (maximum permissible exposure) calculations have been produced in accordance with the guidelines of EN 50383/EN 50385. These calculations represent examples only and do not include every possible combination of output power and antenna gain.

Occupational is defined as: “The occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions”.

Table 1-1. MPE Guidelines

5GHz (4.4 – 5.0GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
30.5	39.3	8.77	3.91
30.5	32.6	4.06	1.81
0.5	39.3	0.28	0.12
0.5	32.6	0.13	0.06
L6/U6GHz (5.925 – 7.11GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
30.5	41.5	11.30	5.03
30.5	31.2	3.45	1.54
0.5	41.5	0.36	0.16
0.5	31.2	0.11	0.05
7/8GHz (7.125 – 8.5GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
30.5	42.9	13.28	5.91
30.5	30.4	3.15	1.40
5.0	42.9	0.71	0.31
5.0	30.4	0.17	0.07
10GHz (10.0 – 10.68GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
26.0	34.3	2.94	1.31
26.0	33.7	2.74	1.22
-4.0	34.3	0.09	0.04
-4.0	33.7	0.09	0.04
11GHz (10.7 – 11.7GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
25.0	46.2	10.31	4.59
25.0	27.7	1.23	0.55
2.5	46.2	0.77	0.34
2.5	27.7	0.09	0.04
13GHz (12.75 – 13.25GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
28.0	47.3	16.53	7.36
28.0	29.6	2.15	0.96
0.0	47.3	0.66	0.29
0.0	29.6	0.09	0.04

15GHz (14.4 – 15.35GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
27.0	46.4	13.28	5.91
27.0	30.8	2.20	0.98
-1.0	46.4	0.53	0.24
-1.0	30.8	0.09	0.04
18GHz (17.7 – 19.7GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
21.5	48.0	8.48	3.77
21.5	32.8	1.47	0.66
-3.0	48.0	0.50	0.22
-3.0	32.8	0.09	0.04
23GHz (21.2 – 23.632GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
21.5	49.2	9.73	4.33
21.5	34.4	1.77	0.79
-3.0	49.2	0.58	0.26
-3.0	34.4	0.11	0.05
26GHz (24.52 – 26.483GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
15.5	46.0	3.37	1.50
15.5	35.9	1.05	0.47
-4.5	46.0	0.34	0.15
-4.5	35.9	0.11	0.05
28GHz (27.5 – 29.5GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
15.0	48.1	4.06	1.81
15.0	36.5	1.07	0.48
-5.0	48.1	0.41	0.18
-5.0	36.5	0.11	0.05
32GHz (31.8 – 33.4GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
17.5	43.5	3.19	1.42
17.5	37.5	1.60	0.71
-5.0	43.5	0.24	0.11
-5.0	37.5	0.12	0.05
38GHz (37.0 – 39.46GHz)			
Transmit Power (dBm)	Antenna Gain (dBi)	Compliance Boundary General Public (m)	Compliance Boundary Occupational (m)
17.5	48.1	5.41	2.41
17.5	39.3	1.96	0.87
-5.0	48.1	0.41	0.18
-5.0	39.3	0.15	0.07

Volume II

9500 MXC System Description

Chapter 1. 9500 MXC System Overview

This chapter introduces the features and capabilities of the 9500 MXC. Refer to:

- 9500 MXC Platforms on page 1-1
- Craft Terminal Configuration and Diagnostics on page 1-13
- Antennas on page 1-13
- Power Supply on page 1-13

Click the following links for more information on:

- 9500 MXC Terminals on page 2-1
- 9500 MXC Nodes on page 3-1
- Outdoor Units on page 4-1
- Configuration and Diagnostics on page 5-1
- 9500 MXC Performance and Diagnostic Features on page 6-1

9500 MXC Platforms

9500 MXC is available on two platform types, Terminal and Node. Both employ a split-mount architecture with a rack-mounted indoor unit and direct-mounted ODUs connected by a single coaxial cable. Refer to:

- 9500 MXC Terminal on page 1-1
- 9500 MXC Node on page 1-5
- 9500 MXC ODUs on page 1-12

9500 MXC Terminal

9500 MXC Terminals are a single-link radios, comprising an IDU and ODU.

- Terminals may be operated as single links, or networked where IDUs are back-to-back connected via their tributary ports at intermediate sites, or for the IDU 20x, via its expansion port.
- Most Terminals can be paired for protected link operation.
- Terminals may also be over-air interfaced to the 9500 MXC Node.

Figure 1-1. 9500 MXC Terminal

Terminal Indoor Units

IDUs are available in variants to transport PDH, SDH or Ethernet on ETSI and ANSI bands. See Table 1-1.

Table 1-1. IDU Variants

Application	Variant	Capacities	Modulation
E1 / DS1	IDU 20x	5xE1 to 75xE1, or 4xDS1 to 100xDS1	QPSK to 128QAM
STM1 / OC3	IDU 155o	STM1/OC3 (optical SC interface)	16/64/128QAM
Ethernet	IDU ES	10/100Base-T to 200 Mbps with up to 8xE1/DS1	QPSK to 128 QAM

ODU options support operation on bands 5 to 38 GHz:

- 5 to 23 GHz with ODU 300ep
- 7 to 38 GHz with ODU 300hp

IDU Overview

IDU 20x

IDU 20x supports 20 tributaries on individual RJ-45 connectors for E1 or DS1 operation, modulation options to 128 QAM, and over-air capacities to 40xE1 or 32xDS1. Features include:

- Capacities to 20xE1 / 16xDS1 for single link non-protected operation.
- Capacities to 20xE1 or 16xDS1 for hot-standby or space diversity operation.
- Capacities to 40xE1 or 32xDS1 for hot-standby operation
  - IDUs are paired for protected/diversity operation.
  - For capacities to 20xE1 / 16xDS1 normal IDU equipment and path protection applies, with Y cables used on the tribs.

- For higher capacities, traffic from the standby IDU is routed to the online IDU to support termination of up to 40xE1 or 32xDS1 tribs. In this configuration trib and PSU protection is not supported, however RAC/ODU and path protection functions are retained.
- Tx switching is not hitless.
- Rx path switching (voting) is hitless (errorless) for capacities to 20xE1 /16xDS1. It is not hitless when configured for 40xE1 / 32xDS1 operation.

Figure 1-2. IDU 20x

IDU 20x is capacity licensed. The base configuration supports 20xE1/28xDS1, with higher capacities to 40xE1 or 32xDS1 obtained by requesting additional capacity upgrades at time of order or as field-downloadable software licenses. See IDU 20x License on page 4-4 of Volume IV.

Synchronous or asynchronous auxiliary data and alarm I/O options are included.

IDU 20x supports ODU 300ep or ODU 300hp.

IDU 20x can be over-air interfaced to a 9500 MXC Node comprising the INU, DAC 16x and ODU 300. An AUX is included where auxiliary channel services are also required. This applies only to non-protected 1+0 (20xE1 / 16xDS1 max) link operation. Where 1+1 IDU operation is required, protected IDUs must be installed at both link ends.

IDU 155o

IDU 155o supports a single 155 Mbps STM1/OC3 tributary on optical SC connectors. Modulations options are 16, 64 or 128 QAM.

Figure 1-3. IDU 155o

IDUs are paired to support hot-standby or space diversity operation. Optical Y cables provide a single Tx and Rx interface.

- Tx switching is not hitless.
- Rx switching (voting) is hitless (errorless).

Synchronous or asynchronous auxiliary data and alarm I/O options are included.

Supports ODU 300ep or ODU 300hp.

IDU 155o can be over-air interfaced to a 9500 MXC Node comprising the INU, DAC 155o, 2x155o, or 2x155e, and ODU 300. An AUX is included where auxiliary channel services are also required. This applies only to non-protected 1+0 link operation. Where 1+1 IDU operation is required, protected IDUs must be installed at both link ends.

IDU ES

IDU ES supports Fast Ethernet to 200 Mbps to provide an uncomplicated and cost effective alternative to fiber. Its Layer 2 switch supports four customer 10/100base-T ports, two over-air transport channels and comprehensive VLAN and QoS options.

Data throughputs range from 20 to 200 Mbps, and depending on throughput channel bandwidth ranges from 7 to 56 MHz, with modulation options from 16 to 128 QAM.

Link capacity may be fully assigned to Ethernet traffic, or between Ethernet and up to 8 wayside E1/DS1 circuits.

Capacity is licensed. The base configuration supports 50 Mbps data throughputs, with higher capacities to 200 Mbps obtained by requesting additional capacity upgrades at time of order or as field-downloadable software licenses.

Protected 1+1 operation is not supported.

Figure 1-4. IDU ES

Synchronous or asynchronous auxiliary data and alarm I/O options are included.

Supports ODU 300ep or ODU 300hp.

IDU ES can be over-air interfaced to a 9500 MXC Node comprising the INU, DAC ES and ODU 300. Where E1/DS1 side channels are required a DAC 4x or DAC 16x is included. Similarly an AUX is included where auxiliary channel services are required.

For more information on 9500 MXC Terminals, refer to Chapter 2.

9500 MXC Node

9500 MXC Node replaces the traditional terminal or single-link based approach to networking with a *nodal* solution. One 9500 MXC platform directly supports up to six links, on frequency bands from 5 to 38 GHz.

Radio paths and customer interfaces are customized by plug-in cards, with interconnection of traffic and services supported by a backplane bus.

Figure 1-5 shows a 9500 MXC Node comprising an INU (Indoor Node Unit) with three ODUs.

Figure 1-5. 9500 MXC Node: INU with Three ODUs

The Node is software configurable for Ethernet, PDH or SDH link capacities of:

- 10 to 300 Mbps Ethernet.
- 5 to 100xE1, or 4 to 127xDS1.
- 1 to 4xDS3.
- 1xSTM1/OC3 or 2xSTM1/OC3.

Where higher capacities are needed, two or more nodes are co-located for parallel-path operation.

Link options include:

- 1+0 non-protected operation
- Hot-standby, space diversity, frequency diversity, or ring protection.
- Dual protection options of:
  - Hot-standby over frequency diversity
  - Frequency diversity over hot-standby
  - Frequency diversity over space diversity
- Co-channel XPIC operation.

For information on the indoor units and plug-in cards, refer to:

- Node Indoor Units on page 1-6
- Node Plug-in Cards on page 1-7

Node Indoor Units

There are two indoor units, the INU, and INUe (Extended INU). The INU is a 1RU chassis, the INUe is 2RU.

Mandatory plug-ins are the NCC (Node Control Card) and FAN (Fan card). The optional plug-ins comprise RAC (Radio Access Card), DAC (Digital Access Card), AUX (Auxiliary) and NPC (Node Protection Card).

INU

The INU requires one NCC and one FAN, and has provision for up to four option plug-ins. It supports a maximum of three ODUs for three non-protected links, or one protected/diversity link and one non-protected link. Each ODU is supported by a RAC via a single coax cable.

Figure 1-6. INU

INUe

The INUe requires one NCC and two FANs, and has provision for up to ten option cards. It supports a maximum of six ODUs for six non-protected links, or up to three protected/diversity links.

Figure 1-7. INUe

The current production IDCe (INUe chassis) accepts a 2RU FAN or two 1RU FANs.

One 2RU FAN is now supplied as standard with the IDCe.

Node Plug-in Cards

This section highlights the plug-in cards for an INU/INUe. For more information on plug-ins, refer to Chapter 3.

NCC

The NCC is a mandatory plug-in for an INU/INUe. It performs key node management and control functions, and provides various dc rails from the -48 Vdc input. It also incorporates a plug-in flash card, which holds node configuration and license data.

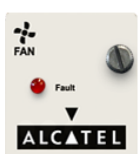
Figure 1-8. NCC

FAN

The FAN is a mandatory plug-in. There are two variants, 2RU and 1RU. Each is fitted with two long-life axial fans plus monitoring and control circuits.

- One 1RU FAN is fitted in an INU, two in an INUe.
- One 2RU FAN is now fitted in the INUe. It will also accept two 1RU FANs. Earlier INUes require two 1RU FANs.

Figure 1-9. FAN



RAC 30V3

RAC 30v3 interfaces to an ODU 300 for channel bandwidths up to 28 MHz (ETSI) or 30 MHz (ANSI) for capacities of:

- 10 to 150 Mbps Ethernet
- 5x to 75xE1
- 4x to 100xDS1
- 1x, 3x, 4xDS3
- 1xSTM1/OC3

Where transport of E3 rates is required, the DAC 3xE3/DS3M is used in E13 mode to multiplex the E3 data to NxE1 on the backplane bus.

Figure 1-10. RAC 30V3

RAC 3X

RAC 3X interfaces to an ODU 300hp or ep for channel bandwidths from 28 to 56 MHz (ETSI), or 30 to 50 MHz (ANSI), for capacity options of:

- 50 to 300 Mbps Ethernet
- 64/75/93/106xE1
- 32/70/84/100xDS1
- 4xDS3
- 1/2xSTM1/OC3

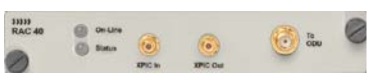
Figure 1-11. RAC 3X

RAC 40

RAC 40 interfaces to an ODU 300hp or ep to support co-channel XPIC operation for:

- Two 100, 130, or 150 Mbps Ethernet links on one 28 MHz or 30 MHz channel.
- Two STM1, 75xE1, 64xE1 or 52xE1 links on one 28 MHz channel.
- Two OC3, 100xDS1, 84xDS1 or 70xDS1 links on one 30 MHz channel.

Figure 1-12. RAC 40



DAC 4X

DAC 4x supports 4xE1 or DS1 tributaries on RJ-45 connectors.

Figure 1-13. DAC 4X

DAC 16X

DAC 16x supports 16xE1 or DS1 tributaries on Mini RJ-21 connectors.

Figure 1-14. DAC 16x

DAC 3xE3/DS3M

DAC 3xE3/DS3M supports four operational modes:

- Normal E3/DS3 tributary operation (as for DAC 3xE3/DS3)
- E13 multiplexer mode. One or two E3 interfaces are multiplexed to an NxE1 backplane.
- M13 multiplexer mode. One or two DS3 interfaces are multiplexed to an NxDS1 backplane.
- 34 Mbps transparent E3 mode for video (MPEG) transport. One or two transparent E3 tributaries are each mapped to a 34xE1 backplane.

Figure 1-15. DAC 3xE3/DS3M

DAC 2x155e

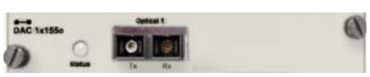
DAC 2x155e supports two STM1 electrical tributaries on BNC connectors.

Figure 1-16. DAC 2x155e

DAC 1x155o

DAC 1x155o supports one STM1/OC3 single-mode optical tributary on SC connectors.

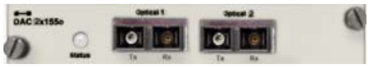
Figure 1-17. DAC 1x155o



DAC 2x155o

DAC 2x155o supports two STM1/OC3 single-mode optical tributaries on SC connectors.

Figure 1-18. DAC 2x155o



DAC 155oM

DAC 155oM multiplexes an SDH/OC3 single-mode optical tributary to an NxE1 or NxDS1 backplane.

Figure 1-19. DAC 155oM

DAC ES

DAC ES supports four low-latency 10/100Base-T Ethernet ports over one or two radio and/or fiber transport channels. Features include:

- Advanced QoS settings.
- Transparent, VLAN and mixed modes of operation.
- Throughputs to 100 Mbps per transport channel.
- Assignment to radio or fiber links.
- Assignment of total link capacity to Ethernet, or split between Ethernet and E1/DS1 traffic.
- Compatibility with DAC GE and IDU ES.

Figure 1-20. DAC ES

DAC GE

DAC GE supports three low-latency 10/100/1000Base-T electrical ports and one 1000Base-LX optical port, over one or two transport channels. Features include:

- Advanced QoS settings.
- Transparent, VLAN and mixed modes of operation.
- Enhanced, fast-switched RSTP.
- Layer 2 and layer 1 link aggregation.
- VLAN tagging.
- Throughputs to 300 Mbps per transport channel.
- Assignment to radio or fiber links.
- Assignment of total link capacity to Ethernet, or split between Ethernet and E1/DS1 traffic.
- Compatibility with DAC ES and IDU ES.

Figure 1-21. DAC GE

AUX

AUX provides synchronous and/or asynchronous auxiliary data channels, NMS porting, and alarm input and output functions. Data options are sync at 64 kbps or async up to 19.2 kbps.

Figure 1-22.

NPC

NPC provides redundancy for the NCC TDM bus management and power supply functions.

Figure 1-23. NPC

For more information on the 9500 MXC Node, refer to Chapter 3.

9500 MXC ODUs

There are two mechanically similar ODUs, the ODU 300ep and ODU 300hp.

- ODUs are band specific and supplied with diplexers for Tx high *or* Tx low working.
- ODUs are designed for direct-antenna mounting, but can be remote mounted.

Channel bandwidths range from 3.5 to 56 MHz depending on the ODU, bandplan, and capacity/modulation option selected.

Within their band limitations the ODU 300ep and ODU 300hp are over-air compatible.

ODU 300ep availability is now limited to 13 and 15 GHz.

ODU 300hp supports:

- 6 to 38 GHz
- High power transceiver
- 4x to 106x E1 or 4x to 100xDS1
- 4xDS3
- 1/2x STM1/OC3
- Up to 300 Mbps Ethernet
- QPSK to 256QAM modulation
- RAC 30, RAC 40, RAC 3X, IDUs

ODU 300ep supports:

- 6 to 23 GHz
- Extended high power transceiver
- 4x to 106x E1 or 4x to 100x DS1
- 4x DS3
- 1/2x STM1/OC3
- Up to 300 Mbps Ethernet
- QPSK to 256QAM modulation
- RAC 30, RAC 40, RAC 3X, IDUs

For more information on 9500 MXC ODUs, refer to Chapter 4.

Craft Terminal Configuration and Diagnostics

9500 MXC is a software-driven product; there are no manual controls. Configuration and diagnostics are achieved using the 9500 MXC CT, the PC based craft terminal.

9500 MXC CT (CT) is supported in the 9500 MXC system software, such that once installed on a PC, it automatically downloads support from the radio as needed to ensure CT always matches the version of system software supplied, or subsequently downloaded in any radio upgrade.

CT has the look and feel of a Windows environment with screen-based views and prompts for all configuration and diagnostic attributes.

A CT PC connects to an INU/INUe/IDU using Ethernet or V.24 options.

For more information on 9500 MXC CT, refer to Chapter 5.

Antennas

Antennas for direct mounting an ODU are available in diameters from 0.3m (1ft) to 1.8m (6ft), depending on the frequency band. These antennas are high performance, low profile shielded types and are supplied complete with a customized 9500 MXC ODU collar and feed-point.

A polarization rotator is included within the antenna collar, and direct-mounting equal or unequal loss couplers are available for single antenna protected operation.

Antenna mounts are designed for use on industry-standard 115 mm OD (4.5 inch) pipe-mounts.

A 9500 MXC ODU can also be used with standard antennas via a remote-mount kit and flexible waveguide.

Power Supply

9500 MXC is designed to operate from a -48 Vdc power supply (+ve earth) but will operate to specification over a voltage range of -40.5 to -60 Vdc.

The dc power supply must be UL or IEC compliant for a -48 Vdc SELV (Safety Extra Low Voltage) output (60 Vdc maximum limited).

Chapter 2. 9500 MXC Terminals

This chapter describes features and capabilities of 9500 MXC Terminals. Refer to:

- PDH and SDH IDUs on page 2-1
- Ethernet IDU on page 2-8
- IDU Protection on page 2-23
- Platform Layout and Interoperation Data on page 2-27
- Configuration and Diagnostics on page 2-28

For information on 9500 MXC ODUs refer to Chapter 4.

PDH and SDH IDUs

This section introduces traffic and auxiliary interfaces and functions for:

IDU	Capacity
IDU 20x	5xE1 to 75xE1, or 4xDS1 to 100xDS1
IDU 155o	STM1/OC3 (optical SC interface)

Refer to:

- Capacity and Bandwidth Options on page 2-1
- Traffic and Auxiliary Interfaces on page 2-3
- Front Panel Layout on page 2-5

Capacity and Bandwidth Options

Depending on the IDU and its capacity/bandwidth options, modulation rates are programmed for QPSK, 16QAM, 32QAM, 64QAM, or 128QAM:

- Table 2-1 lists the ETSI capacity, modulation, and bandwidth options for **IDU 20x.** Table 2-2 lists the options for North American (ANSI) Common Carrier.
- Table Table 2-3 on page 2-2 lists ETSI and ANSI capacity, modulation, and bandwidth options for **IDU 155o**.

ETSI band plans for 55/56 MHz channeling and ANSI band plans for 50 Mhz channeling are generally restricted to bands 18 GHz and higher.

Table 2-1. IDU 20x ETSI System Options

Capacity	Channel Bandwidth	Modulation
5xE1	7 MHz	QPSK
10xE1	13.75 / 14 MHz	QPSK
20xE1	27.5 / 28 MHz	QPSK
10xE1	7 MHz	16QAM
16xE1	7 MHz	64 QAM
20xE1	13.75 / 14 MHz	16 QAM
32xE1	13.75 / 14 MHz	64 QAM
40xE1	27.5 / 28 MHz	16 QAM

Please check the Product Release Notes to confirm the availability of modem profiles.

Table 2-2. IDU 20x ANSI System Options

Capacity	Channel Bandwidth	Modulation
4xDS1	2.5 MHz	16 QAM
8xDS1	10 MHz	QPSK
8xDS1	5 MHz	16 QAM
8xDS1	3.75 MHz	32 QAM
16xDS1	20 MHz	QPSK
16xDS1	10 MHz	16 QAM
16xDS1	5 MHz	128 QAM
28xDS1	30 MHz	QPSK
28xDS1	10 MHz	64 QAM
32xDS1	20 MHz	16 QAM

For the SDH IDU 155o, the 128 QAM and 64 QAM modulation options support ETSI and ANSI channel bandwidths, but for 16 QAM the resulting 55 MHz bandwidth is only applicable on ETSI bands (ETSI bands 18 GHz and above).

Table 2-3. IDU 155o System Options

Capacity	Channel Bandwidth	Modulation
STM1/OC3	28 MHz	128 QAM
STM1/OC3	40 MHz	64 QAM
STM1	55 MHz	16 QAM

Traffic and Auxiliary Interfaces

Data is provided for:

PDH Trib Ports on page 2-3

SDH Trib Ports on page 2-3

Aux Data Port on page 2-4

Ethernet IDU on page 2-8

PDH Trib Ports

IDU 20x trib ports are on individual RJ-45 connectors.

- E1 trib options are 75 ohm unbalanced or 120 ohms balanced.
- DS1 trib encoding options are AMI or B8ZS. Line impedance is fixed at 100 ohms balanced and line length is selectable.

Trib cable options include:

- An RJ-45 to 2xBNC cable assembly.
- An RJ-45 to RJ-45 straight cable assembly for extension to an RJ-45 patch panel.
- An RJ-45 to RJ-45 cross-over cable assembly for use between IDUs at repeater or branch sites.
- An RJ-45 to wire-wrap cable assembly.
- Splitter Y-cables for protected hot-standby operation.

For more information on cable assemblies and connector pin-outs refer to Appendix C.

SDH Trib Ports

The IDU 155o supports one STM1/OC3 optical tributary. The connectors are SC type, and cable options are available, as accessories, for extension to SC, FC or LC types.

The receive-level range is -31 dBm (max sensitivity) to -7 dBm (max input power). Transmit output is within limits of -15 dBm to -8 dBm.

For protected operation two optical splitter Y-cables are fitted to provide extensions from SC to SC, FC or LC connectors.

The SDH optical line code is Binary Scrambled NRZ (Non Return to Zero).

Auto Insertion of AIS or PRBS on Tribs

When a link demodulator-unlock occurs, it inserts an alarm signal (AIS or PRBS15) on all trib circuits *towards* the customer. (Demodulator unlock may occur under severe fading or an equipment fault).

- For E1 or DS1 tribs AIS is inserted.
- For STM1/OC3 tribs a PRBS15 pattern (15 bit pseudo-random bit sequence) is inserted.

An on-board master clock maintains customer-facing clocking references when the expected signal input and associated clocking reference from its link is missing, or below the minimum level required.

AIS/PRBS15 may be *forced* onto a tributary using the System Control screen.

Aux Data Port

The IDUs support synchronous or asynchronous auxiliary data via a DB-9 female connector.

- **Synchronous** conforms to TIA/EIA-422 / V.11 at 64kbps, with selectable clock. The source of the transmit clock can be set to internal (provided by the auxiliary card) or external (provided by the user). For an external clock, channel synchronization is supported by a selectable clock phase (rising or dropping edge of the clock pulse).
- **Asynchronous** conforms to TIA/EIA-562 (electrically compatible with RS-232 / V.24)
- **Asynchronous** baud rates are 1200, 2400, 4800, 9600, or 19200bps, with parity and stop bit selection.

Auxiliary data is transported within the link overhead, which is shared with NMS data.

Aux Data cable options include:

- Async DB-9 to wire-wrap.
- Sync DB-9 to wire-wrap.
- Async DB-9 to DB-9 crossover.
- Sync DB-9 to DB-9 crossover.

For more information on cable assemblies refer to Appendix C.

Alarm I/O Port

The IDUs include an alarm I/O function, which supports two TTL alarm inputs and four Form C relay outputs via an HD-15 female connector.

Input events are mapped to outputs:

- Individual AUX alarm inputs or internal alarm events may be mapped to any output within the network.
- Multiple input or internal events may be mapped to a common output.

Mapping is achieved using IP addressing for the destination Terminal, or if the destination is a 9500 MXC Node, to its IP address plus the slot location and output number for the AUX plug-in.

Individual alarm inputs and relay outputs can be named. A severity level can also be assigned to alarm inputs.

An HD-15 to wire-wrap Alarm I/O cable assembly is available as an option. For cable details refer to Appendix C.

Alarm Inputs

The active state of each TTL alarm input is configurable to be active if the voltage on the input is high, or active if the voltage is low. The alarm software detects a change in the state of each input circuit, and raises or clears an input accordingly. The nominal alarm polling rate is 1 second. Fleeting changes are ignored.

- Input state changes are captured in the event log as an alarm.
- TTL input thresholds are specified at 2V min high, and 0.8V min low. High voltage (spike) protection to 48V is included.

Alarm Outputs

The output relays may be configured to be energized or de-energized on receipt of an alarm event. A user can also select on the Alarm I/O connector a normally closed, or normally open contact pair.

The relay contacts are specified at:

Maximum Voltage	250 Volts
Maximum Current	2 Amps (applies up to 30 Volts)
Maximum Power	60 Watts

Note: These are maximum values, which require de-rating if the relay is to be used for frequent-switch applications.

The contact voltage must be restricted to less than 60 Volts for compliance with SELV regulations.

Front Panel Layout

- Figure 2-1 shows the IDU 20x front panel.
- Figure 2-2 shows the IDU 155o front panel.
- Refer to Table 2-4 for names and descriptions of numbered components.

Figure 2-1. IDU 20x Front Panel Layout

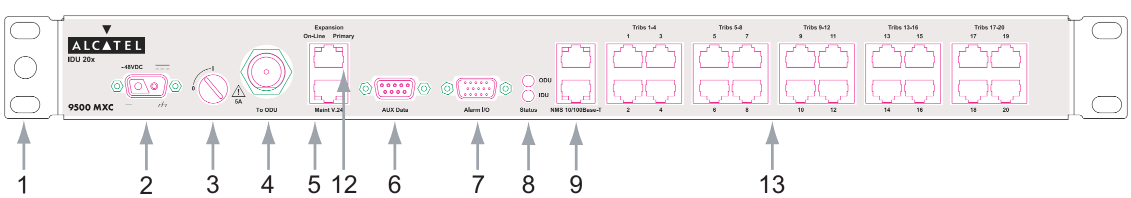


Figure 2-2. IDU 155o Front Panel Layout

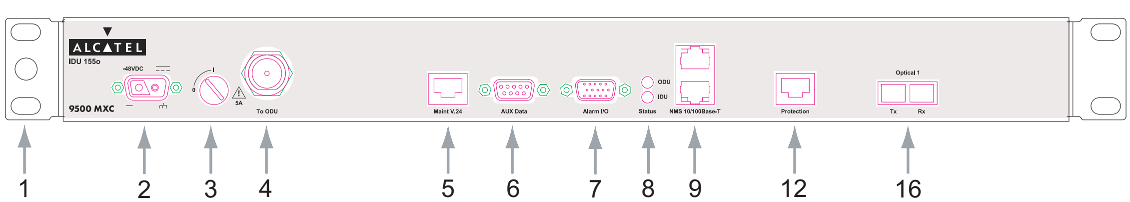


Table 2-4. Front Panel Layout Description

No	Item/Label	Description	
1	Rack Ear and Grounding Stud	Rack attachment bracket for the IDU. One ear has a grounding stud for IDU grounding. The ears can be fitted either side and provide flush-with-rack-front mounting.	
2	-48 Vdc	2-pin D-series 2W2C power connector. Includes screw fasteners.	
3	Fuse	5A time-lag fuse and power on/off switch. ON is when the fuse head is in the vertical position; OFF is when the head is rotated to the horizontal ‘0’ position.	
4	To ODU	Type N female connector for jumper cable connection to the surge suppressor located at the cable entry point to the building.	
5	Maint V.24	RJ-45 connector provides a V.24 serial interface option for 9500 MXC CT (CT) connection. It supports a default IP address, which means knowledge of the Terminal IP address is not required at login.	
6	Aux Data	DB-9 connector provides one synchronous or asynchronous data service channel. Selection of synchronous (64 kbps) or asynchronous (max 19.2 kbps) is via 9500 MXC CT.	
7	Alarm I/O	HD-15 connector provides access to two TTL alarm inputs and four form C relay outputs. Connections are mapped in CT.	
8	ODU	ODU Status LED provides indications of:	
		Off	IDU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, software/ hardware incompatible, or diagnostic mode selected, such as Tx Mute.
		Red	Critical alarm (traffic affecting)
	IDU	IDU Status LED provides indications of:	
		Off	IDU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, software/ hardware incompatible, or diagnostic mode selected, such as tributary loopbacks.
		Red	Critical alarm (traffic affecting): LOS on a commissioned trib or a SW/HW failure.

No	Item/Label	Description
9	NMS 10/ 100Base-T	RJ-45 connector provides a port for Ethernet network management access: Unless DHCP has been configured, Ethernet CT login requires entry of a LAN compatible IP address on your PC. For protectable IDUs a dual RJ-45 connector assembly is fitted to support NMS connectivity to its protection partner, and to a CT PC. Port is also used to provide NMS connectivity to other co-located Alcatel-Lucent or third party radios. Built-in orange flashing LED indicates Ethernet connection status; on for a valid Ethernet connection, off for no connection or an invalid connection. Built-in green LED indicates Ethernet activity. The LED flashes to indicate Ethernet traffic on the port. It does not flash (is solid on) when there is no traffic activity. (Activity LED is off when the connection status LED is off).
12	Protection/ expansion port	RJ-45 connector. For IDU 20x and IDU 155o it provides bus interconnection between paired IDUs for hot-standby or space diversity operation. Tx switching is not hitless, Rx path switching (voting) is hitless. Tx/Rx online and primary/secondary status is indicated by the protection connector LEDs as: • Green Online LED is on for an online Tx and/or Rx. (Normally the online IDU is online for Tx and Rx). • Green Online LED is off for the offline IDU (IDU is not transmitting or controlling the Rx diversity bus. • Orange Primary LED is on for the primary IDU. (The primary designated IDU is default online for Tx and Rx). • Orange Primary LED is off for the secondary IDU.
13	Trib ports 1 to 20	RJ-45 connector assemblies for tributary connection; one RJ-45 port per E1/DS1. E1 termination is set for unbalanced or balanced in 9500 MXC CT. DS1 is 100 ohms balanced with options for AMI or B8ZS, and trib cable length. Cable options provide extension to BNC connectors for unbalanced, or to RJ-45 plugs or to unterminated wires for balanced.
16	Optical 1	SC type single mode optical trib connector assembly. The receive-level range is -31 dBm (max sensitivity) to -7 dBm (max input power). Transmit output is within limits of -15 dBm to -8 dBm. Cable options are available to provide extensions to SC, FC or LC connectors. With protected IDUs, Y-cables are fitted to provide common Tx and Rx optical interfaces.

Ethernet IDU

This section introduces the IDU ES. Refer to:

- IDU ES Link on page 2-8
- IDU ES Capacity and Bandwidth Options on page 2-8
- Ethernet Module on page 2-12
- Wayside Traffic Module on page 2-16
- Auxiliary Data and Alarm I/O Module on page 2-17
- IDU ES Layout on page 2-18
- IDU ES Applications on page 2-20
- More Information on page 2-22

IDU ES Link

IDU ES supports Fast Ethernet connections to 200 Mbps with up to 8xE1/DS1 wayside circuits. Depending on the ODU and required capacity, over-air channel bandwidths are selected using modulation options from QPSK to 256 QAM.

The IDU ES includes a Layer 2 switch to support four customer 10/100base-T ports, two over-air transport channels and comprehensive VLAN and QoS options.

Base capacity licences apply, with access to the higher capacities provided by an additional software-keyed license.

IDU ES can be used with the ODU 300ep or ODU 300hp.

- For information on capacity, bandwidth, and Ethernet and wayside payload options refer to IDU ES Capacity and Bandwidth Options on page 2-8.
- For information on license operation and license steps, refer to IDU ES License on page 4-3 in Volume IV.

IDU ES may be used in single-link and networked applications, and can be over-air interfaced to 9500 MXC Node comprising the INU, DAC ES or DAC GE, DAC 4x/16x, and ODU 300.

IDU ES Capacity and Bandwidth Options

ETSI options are indicated in Figure 2-3 and detailed in Table 2-5.

ANSI options are in Figure 2-4 and Table 2-6.

- For IDU ES with ODU 300ep or ODU 300hp the base license is 50 Mbps. Upgrades are available to 100 Mbps, 150 Mbps, or 200 Mbps.
- IDU ES licenses are up-to licences. For example:
  - ETSI IDU ES throughputs may be reduced by configuring lower link capacities; 10xE1 for 20 Mbps or 20xE1 for 40 Mbps.
  - Similarly, an ETSI IDU ES with a 100 Mbps license may be configured for 40xE1 to support an 82 Mbps throughput.

- The maximum throughput for each IDU ES licensed option may be used for Ethernet traffic, or assigned between Ethernet and wayside E1/DS1 circuits. For configurations where available link capacity is fully assigned to Ethernet, Ethernet throughput is reduced by 2 Mbps (2.048 Mbps) for each E1 assigned, or by 1.5 Mbps (1.544 Mbps) for each DS1 assigned up to a maximum 8xE1/DS1 waysides.
- With a 200 Mbps license, maximum Ethernet throughput is constrained to the 96xE1 or 127xDS1 channel maximums of the Ethernet module to provide 196.6 Mbps or 196 Mbps respectively. For *ETSI* IDU ES the balance of the available 217 Mbps capacity may be assigned to waysides without impacting maximum Ethernet throughput; a 200 Mbps license supports 196.6 Mbps Ethernet throughput *and* up to 8xE1 waysides.

Figure 2-3. IDU ES ETSI: Nominal Capacity and Channel BW Options

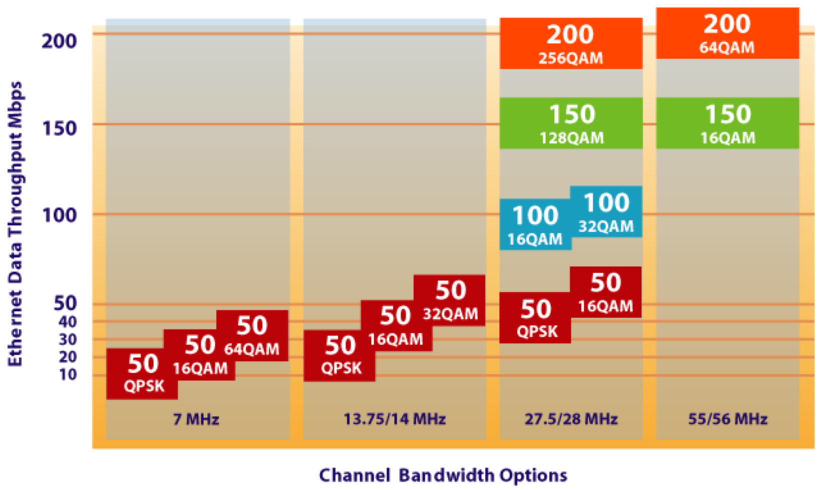


Table 2-5. IDU ES ETSI Options

IDU ES License Option	Ethernet Mbps	Channel BW, MHz	Modulation	License
50 Mbps	10	7	QPSK	Base
50 Mbps	20	7	16 QAM	Base
50 Mbps	20	14	QPSK	Base
50 Mbps	32	7	64QAM	Base
50 Mbps	40	28	QPSK	Base
50 Mbps	40	14	16QAM	Base
50 Mbps	55	14	32QAM	Base
50 Mbps	64	28	16 QAM	Base
100 Mbps	82	28	16 QAM	Upgrade 1
100 Mbps	106	28	32 QAM	Upgrade 1
150 Mbps	150	28	128 QAM	Upgrade 2
150 Mbps	150	56	16 QAM	Upgrade 2

IDU ES License Option	Ethernet Mbps	Channel BW, MHz	Modulation	License
200 Mbps	190	28	256QAM	Upgrade 3
200 Mbps	196	56	64 QAM	Upgrade 3

Please check the Product Release Notes to confirm the availability of modem profiles.

Figure 2-4. IDU ES ANSI: Nominal Capacity and Channel BW Options

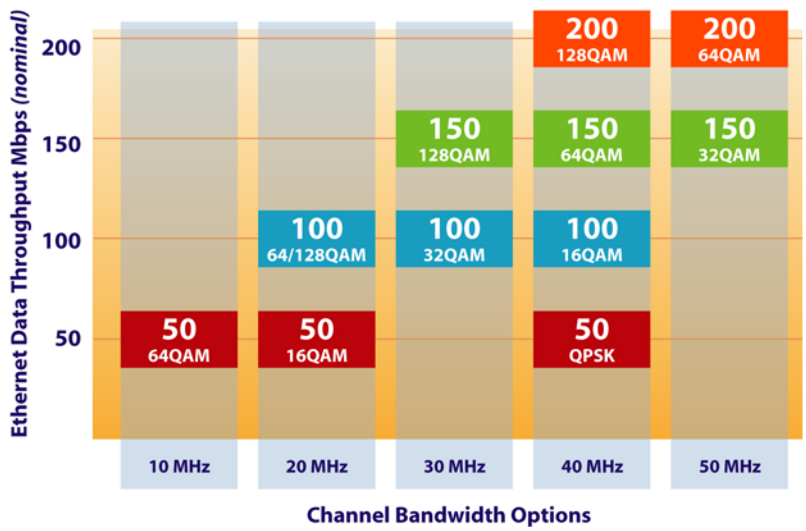


Table 2-6. IDU ES ANSI Options

IDU ES License Option	Ethernet Mbps	Channel BW, MHz	Modulation	License
50 Mbps	43	10	64 QAM	Base
50 Mbps[1]	49	20	16 QAM	Base
50 Mbps[1]	49	40	QPSK	Base
100 Mbps	94	20	64 QAM	Upgrade 1
100 Mbps	108	20	128 QAM	Upgrade 1
100 Mbps[1]	108	30	32 QAM	Upgrade 1
100 Mbps[1]	108	40	16 QAM	Upgrade 1
150 Mbps	154	30	128 QAM	Upgrade 2
150 Mbps	154	40	32 QAM	Upgrade 2
150 Mbps	154	50	16 QAM	Upgrade 2

IDU ES License Option	Ethernet Mbps	Channel BW, MHz	Modulation	License
200 Mbps	196	40	128 QAM	Upgrade 3
200 Mbps	196	50	64 QAM	Upgrade 3

1. FCC frequency efficiency restrictions mean these options are not available for use in the 6 and 11 GHz Common Carrier bands.
2. Please check the Product Release Notes to confirm the availability of modem profiles.

IDU ES Compatibility

IDU ES can be over-air interfaced to an INU/INUe fitted with a RAC 30v3 or RAC 3X.

Table 2-7 indicates current compatibility for ETSI rates; Table 2-8 indicates ANSI rates. Other rates may be supported, check with Alcatel-Lucent or your supplier.

At the INU/INUe:

- Ethernet traffic is terminated on a DAC ES or DAC GE.
- E1/DS1 traffic is terminated on a DAC 16x or DAC 4x.
- Auxiliary data traffic and/or alarm I/O actions are terminated on an AUX.

Table 2-7. IDU ES / RAC Compatibility: ETSI

Ethernet Assignment	BW MHz	Modulation	IDU ES	RAC30v3	RAC3X
10 Mbps	7 MHz	QPSK	X	X	N/A
20 Mbps	7 MHz	16QAM	X	X	N/A
20 Mbps	14 MHz	QPSK	X	X	N/A
32 Mbps	7 MHz	64QAM	X	X	N/A
40 Mbps	28 MHz	QPSK	X	X	N/A
40 Mbps	14 MHz	16QAM	X	X	N/A
80 Mbps	28 MHz	16QAM	X	X	N/A
106 Mbps	28 MHz	32QAM	X	X	N/A
150 Mbps	56 MHz	16QAM	X	N/A	X
150 Mbps	28 MHz	128QAM	X	X	N/A
190 Mbps	28 MHz	256QAM	X	N/A	X
196 Mbps	56 MHz	64QAM	X	N/A	X

Table 2-8. IDU ES / RAC Compatibility: ANSI

Ethernet Assignment	BW	Modulation	IDU ES	RAC30v3	RAC3X
43 Mbps	10 MHz	64 QAM	X	X	N/A
49 Mbps	20 MHz	16 QAM	X	X	N/A
49 Mbps	40 MHz	QPSK	X	N/A	X

Ethernet Assignment	BW	Modulation	IDU ES	RAC30v3	RAC3X
108 Mbps	30 MHz	16 QAM	X	X	N/A
108 Mbps	40 MHz	32 QAM	X	N/A	X
154 Mbps	30 MHz	128 QAM	X	X	N/A
154 Mbps	40 MHz	32 QAM	X	N/A	X
154 Mbps	50 MHz	16 QAM	X	N/A	X

Ethernet Module

The Ethernet module incorporates an intelligent layer 2 (L2) switch, to provide the switching, prioritization and queuing functions between ports and transport channels, C1 and C2. It supports address learning for efficient management of Ethernet traffic in multi-host situations, and advanced layer 3 and layer 2 settings for traffic prioritization.

A gate array supports channel assignment and mux/demux to the digital baseband.

The MAC address register supports 2048 entries.

Preamble stripping is used; the frame preamble (8 bytes) is stripped at the Tx end of the link and re-inserted at the far end. It's benefit is most noticeable with small frame sizes where the preamble represents a more significant part of the total frame size.

The four 10/100Base-T Fast Ethernet ports may be connected to the transport channels in transparent, VLAN or mixed operational modes. Channel capacity is incremented in 2 Mbps (2.048 Mbps) or 1.5 Mbps (1.544 Mbps) steps.

Refer to:

- Ethernet Traffic Configuration on page 2-12
- Transport Channel Configuration on page 2-13
- Basic Port Settings on page 2-14
- Priority Mapping on page 2-14
- Flow Control on page 2-15
- Disable Address Learning on page 2-15
- Maximum Frame Size on page 2-15
- Latency on page 2-15
- Ethernet Diagnostics on page 2-16

Ethernet Traffic Configuration

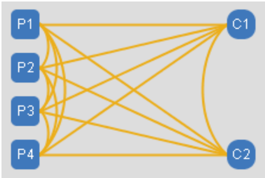
IDU ES is configured using CT, the 9500 MXC craft terminal. User-friendly screens prompt for channel size (Ethernet bandwidth), modes of operation, QoS settings, and interface options.

Three modes of operation are supported, which define LAN connection options between the ports and channels. These options are Transparent, VLAN or Mixed:

Transparent Mode

This is the default, broadcast mode; all ports and channels are interconnected. It supports four customer connections (ports 1 to 4) with bridging to and between the two transport channels (C1, C2).

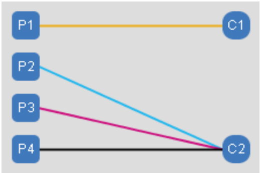
Figure 2-5. Transparent Mode Port and Channel Assignment



VLAN Mode

VLAN or transport mode supports four separate LAN connections. Port 1 is dedicated to channel 1, and ports 2 to 4 are multiplexed to channel 2 to provide three virtual LANs (VLANs 2, 3 and 4). Internal VLAN port tagging of packets provides correct end-to-end matching of port traffic over the channel 2 link. Tags are removed before port egress at the far end.

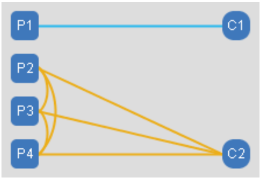
Figure 2-6. VLAN Mode Port and Channel Assignment



Mixed Mode

Mixed or hybrid mode provides a two-LAN connection solution. The first provides a dedicated port 1 to channel 1 connection. The second provides a transparent (broadcast) connection, tying ports 2, 3 and 4 to channel 1. Packets received on any of these ports will be allowed to broadcast to the other three ports, but not to port 1 or channel 1.

Figure 2-7. Mixed Mode Port and Channel Assignment



Transport Channel Configuration

Selection is provided for channel capacity on a per-channel basis:

Channel capacity is selected in multiples of 2.048 Mbps or 1.544 Mbps.

- For an ETSI selection each channel supports a maximum 98 Mbps. Where both channels are used the combined maximum extends to 196 Mbps.
- For an ANSI selection one channel (either) can be configured to support a maximum 100 Mbps. Both channels can be configured to support a combined total of 196 Mbps.

- Both channels can be sent over the same radio path. Each can operate as separate fast Ethernet VLANs, or aggregated (combined) using an external L2 switch.

Basic Port Settings

Customer selection/confirmation is provided for the following port parameters:

Enabled

A port must be enabled to allow traffic flow.

Name

A port name or other relevant port data can be entered.

Speed-Duplex

Provides selection per-port of auto or manual settings for half or full duplex operation on speeds of 10 Mbps or 100 Mbps. In auto a connection is set based on the traffic type detected.

Interface Type

Provides selection per port of auto or manual settings for the interface type; Mdi or MdiX (straight or cross-over respectively).

Port Priority

Provides selection per-port of priority options low, medium low, medium high, and high. This prioritization only has relevance to ports using a shared channel. Ports with a higher priority have their data accepted by the queue controller ahead of the lower priority ports on a 8:4:2:1 weighted basis where, for example, 8 high priority packets are sent for every one low priority packet.

Port Up

Indicates that a valid Ethernet connection with valid Ethernet framing has been detected.

Resolved

Indicates a port connection has been resolved for an auto speed-duplex setting.

Priority Mapping

Provides selection of queue-controller operation for the following options. A selection applies to *all* ports.

- Port Default enables the Port Priority option - see Basic Port Settings above. It ignores any 802.1p VLAN CoS priority tags or IP DiffServ priority values.
- 802.1p provides prioritization based on the three-bit CoS field within a VLAN tag. Each of the possible eight tag priority values are mapped into a four-level (2-bit) IDU ES priority level.
- DiffServ provides prioritization based on the six bits of the IP packet DiffServ or Type of Service byte. Each of the possible 64 levels are mapped into a four-level (2-bit) priority level.
- 802.1p-then-DiffServ provides prioritization based first on the 802.1p VLAN tag, and then on the DiffServ or Type of Service byte.
- DiffServ-then-802.1p provides prioritization based first on the IP packet DiffServ or Type of Service byte, then on the 802.1p VLAN tag.

Flow Control

Flow Control is an option for full-duplex links only. It is implemented through use of IEEE 802.3x PAUSE frames, which tell the remote node to stop or restart transmission to ensure that the amount of data in the receive buffer does not exceed a 'high water mark'. The receiver will signal to the transmitter to stop transmitting until sufficient data has been read from the buffer, triggered by a 'low water mark', at which point the receiver signals to the transmitter to resume transmission. To be effective, flow control must be established from the originating source through to the end point, and vice versa, which means the equipment connected to the IDU ES ports and beyond should also be enabled for flow control.

Disable Address Learning

MAC Address Learning is default implemented to support efficient management of Ethernet traffic in multi-host situations. The option to disable Address Learning is primarily for use in an Ethernet ring network where protection is provided by an external RSTP switch. To avoid conflict between the self-learning function within IDU ES and the external RSTP switch during path failure situations, the IDU ES capability *must* be switched off.

Maximum Frame Size

Maximum Frame Size sets the largest size frame for the interface, which determines the largest datagram than can be transmitted without it being broken down into smaller units (fragmented). The IDU ES supports two maximum frame sizes, 1518/1522 bytes (1518 for non-tagged frames, 1522 for tagged frames) or 1536 bytes.

Latency

Network latency refers to the time taken for a data packet to get from source to destination. For an IP network it is particularly relevant to voice (VoIP) or video conferencing; the lower the latency, the better the quality.

For phone conversations a one-way latency of 200 ms is considered acceptable. Other applications are more tolerant; Intranet access should be less than 5 seconds, whereas for non real-time applications such as email and file transfers, latency issues do not normally apply.

Other contributors to overall latency are the devices connected to the 9500 MXC network, which for a VoIP circuit will include the external gateway processes of voice encoding and decoding, IP framing, packetization and jitter buffers. Contributing to external network latency are devices such as routers and firewalls.

Table 2-9 lists typical one-way performance over a 100 Mbps IDU ES link.

Table 2-9. Typical Performance for a 100 Mbps Hop

Frame Size	Latency	Throughput
64	240 uSec	72 Mbps
128	250 uSec	83 Mbps
256	270 uSec	88 Mbps
512	300 uSec	93 Mbps

Frame Size	Latency	Throughput
1024	390 uSec	95 Mbps
1518	460 uSec	95.5 Mbps

Ethernet Diagnostics

CT diagnostics screens capture Ethernet performance and history. The data for IDU ES includes:

- Port/channel status.
- Configured capacities.
- Graphed current Rx and Tx throughputs and discards per port and channel.
- Graphed historical Rx and Tx throughputs, frame type and discards per port and channel.
- Historical statistics per port and channel.
- Comprehensive RMON performance statistics per port and channel.
- Event history.

For more information refer to Volume IV, Chapter 15:

- DAC ES and DAC GE Menu
- Ethernet Performance
- History Screen: Ethernet

Wayside Traffic Module

The Wayside Traffic Module supports 8xE1 or 8xDS1 tributary circuits. Each is accessed on an RJ-45 connector.

- For an E1 selection options are provided for 75 ohms unbalanced or 120 ohms balanced.
- For a DS1 selection options are provided for AMI or B8ZS encoding and line length. Line impedance is 100 ohms balanced.
- The module supports trib and radio facing loopbacks plus AIS insertion, and a PRBS generator and receiver for trib BER measurement.
- Line isolation and surge protection are included.

Auxiliary Data and Alarm I/O Module

This module supports sync or async data, and TTL alarm inputs and relay outputs:

Auxiliary Data

The DB-9 AUX Data connector supports one synchronous or asynchronous auxiliary data channel, which may be used to transport 3rd party NMS (or other data):

- Synchronous conforms to TIA/EIA-422 / V.11 at 64kbps, with selectable clock. The source of the transmit clock can be set to internal (provided by IDU ES) or external (provided by the user). For an external clock, channel synchronization is supported by a selectable clock phase (rising or dropping edge of the clock pulse).
- Asynchronous conforms to TIA/EIA-562 (electrically compatible with V.24)
- Asynchronous rates are 1200, 2400, 4800, 9600, or 19200 bps, with parity and stop bit selection.

Auxiliary data is transported within the link overhead, which is shared with NMS data.

Alarm I/O

The HD-15 Alarm I/O connector supports two TTL alarm inputs and four Form-C relay outputs.

- Individual alarm inputs are mapped to any output within a 9500 MXC network. Similarly, individual internal events can be mapped to any output.
- Multiple input or internal events may be mapped to a common output. Mapping is achieved using IP addressing for the destination IDU ES terminal, or if the destination is a 9500 MXC Node, to its IP address plus the slot location and output number for the AUX plug-in.
- Individual alarm inputs and relay outputs can be named. A severity level can also be assigned to alarm inputs.

Alarm Inputs

The active state of each TTL alarm input is configurable to be active if the voltage on the input is high, or active if the voltage is low. The alarm software detects a change in the state of each input circuit, and raises or clears an input accordingly. The nominal alarm polling rate is 1 second.

Alarm Outputs

Outputs are user configurable to be normally high or normally low. Default is normally low (relay inactive). Additionally, a user can select on the Alarm I/O connector, a normally closed or normally open contact pair.

For information on TTL input limits and relay output voltage and current maximums, refer to Alarm I/O Port on page 2-4.

IDU ES Layout

Figure 2-8 illustrates IDU ES front panel layout and interfaces. Refer to Table 2-10 for a description of numbered items.

Figure 2-8. IDU ES Front Panel Layout

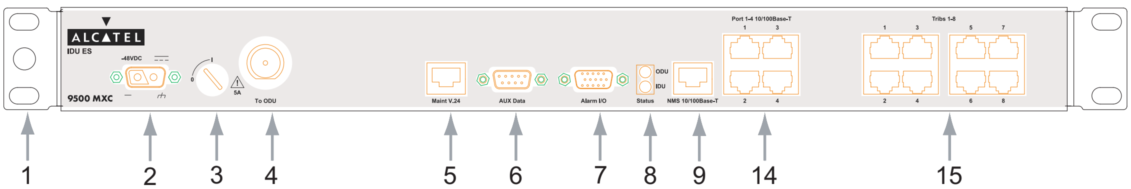


Table 2-10. Front Panel Layout Description

No	Item/Label	Description	
1	Rack Ear and Grounding Stud	Rack attachment bracket for the IDU. One ear has a grounding stud for IDU grounding. The ears can be fitted either side and provide flush-with-rack-front mounting.	
2	-48 Vdc	2-pin D-series 2W2C power connector for all IDUs. Includes screw fasteners.	
3	Fuse	5A time-lag fuse and power on/off switch. ON is when the fuse head is in the vertical position; OFF is when the head is rotated to the horizontal '0' position.	
4	To ODU	Type N female connector for jumper cable connection to the surge suppressor located at the cable entry point to the building.	
5	Maint V.24	RJ-45 connector provides a V.24 serial interface option for 9500 MXC CT. It supports a default IP address, which means knowledge of the Terminal IP address is not required at login.	
6	Aux Data	The DB-9 connector provides one synchronous or asynchronous data service channel. Selection of synchronous (64 kbps) or asynchronous (max 19.2 kbps) is via CT.	
7	Alarm I/O	HD-15 connector provides access to two TTL alarm inputs and four form C relay outputs. Connections are mapped in CT.	
8	ODU	ODU Status LED provides indications of:	
		Off	IDU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, software/ hardware incompatible, or diagnostic mode selected, such as Tx Mute.
		Red	Critical alarm (traffic affecting)
	IDU	IDU Status LED provides indications of:	
		Off	IDU power off
		Green	Normal operation

No	Item/Label	Description
		Orange flashing: Configuration not supported, software/hardware incompatible, or diagnostic mode selected. Red: Critical alarm (traffic affecting)
9	NMS 10/100Base-T	RJ-45 connector provides a port for Ethernet network management access. Unless DHCP has been configured, Ethernet CT login requires entry of a LAN compatible IP address on your PC. Port may also be used to provide NMS connectivity to other co-located Alcatel-Lucent or third party radios. The green connection-status LED is on for a valid Ethernet connection. Off indicates no connection or an invalid connection. The orange activity LED flashes to indicate Ethernet traffic on the port. The LED does not flash (is solid on) when there is no traffic activity. (Activity LED is off when the connection status LED is off).
14	Ethernet traffic ports 1 to 4	RJ-45 connector assembly for 10/100Base-T Ethernet traffic connection. Port connection-status and activity LED indications are as for the NMS port.
15	Trib 1-4 and Trib 5 to 8	RJ-45 connector assemblies for wayside tributary connections; one RJ-45 port per E1/DS1. E1 termination is set for unbalanced or balanced in 9500 MXC CT. DS1 is 100 ohms balanced with options for AMI or B8ZS, and trib cable length. Cable options provide extension to BNC connectors for unbalanced, or to RJ-45 plugs or unterminated wires for balanced.

IDU ES Applications

IDU ES may be used to provide single-hop connections or used as a radio backbone in multiple-hop star or ring networks.

Refer to:

- Basic Network Applications on page 2-20.
- Ring Applications on page 2-22

Basic Network Applications

Simple Link

Figure 2-9 illustrates basic link operation where the IDU ES directly supports up to 4 hosts, which may all be on a common LAN, or prioritized in VLAN mode on up to four LANs over two independent link transport channels, C1 and C2.

Figure 2-9. Basic IDU ES Link

Using one transport channel, IDU ES supports Ethernet capacities to 98 Mbps. Using both channels, IDU ES supports two separate LANs to a combined Ethernet maximum of 196 Mbps (IDU ES 200 Mbps option).

Link capacity may be configured to support Ethernet together with E1 or DS1 wayside tribs, up to a maximum 8 waysides in 1xE1/DS1 increments. For example, a radio configured for a throughput of 106 Mbps (IDU ES 100 Mbps ETSI option) may be used to support:

- 106 Mbps Ethernet using both transport channels and no E1 tribs. The split between channel (LAN) assignments may be 53/53 Mbps through to 98/8 Mbps.
- 104 Mbps Ethernet and 1xE1, through to 90 Mbps Ethernet and 8xE1.

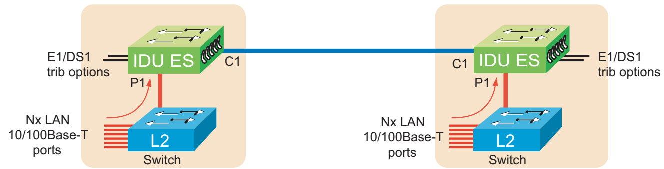
LANs supported on transport channels C1 and C2 cannot be paralleled without use of an external aggregation or trunking switch, as doing so will create an IP loop.

Simple Link With External Switching

While IDU ES provides comprehensive layer 2 switch functionality, it can only support a maximum of four directly connected hosts, which for most office applications is insufficient, bearing in mind each device on the LAN must be directly connected to its own port on the switch (star connected).

The solution is provided by a 3rd party industry-standard multi-port layer 2 switch, as shown in Figure 2-10

Figure 2-10. IDU ES with External Switch: Single Channel

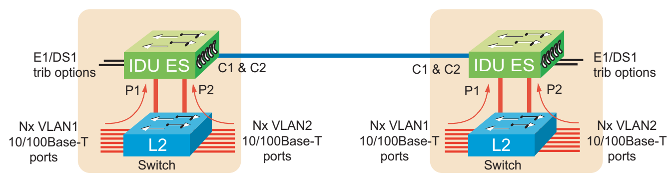


When used in this way, the LAN mode and QoS settings would normally be configured within the external switch, and a single port connection used to the IDU ES.

With just one channel in use (C1 or C2), the maximum Ethernet capacity supported is 98 Mbps. For this throughput an optimum link solution is provided by the IDU ES 100 Mbps option.

Higher throughputs are provided by IDU ES 150 (~150 Mbps) and IDU ES 200 (~200 Mbps), but to make use of such capacity both IDU ES channels must be used, as shown in Figure 2-11. The IDU ES is configured for Mixed Mode to support two independent LANs/VLANs on transport channels C1 and C2, and each is separately ported to the external switch.

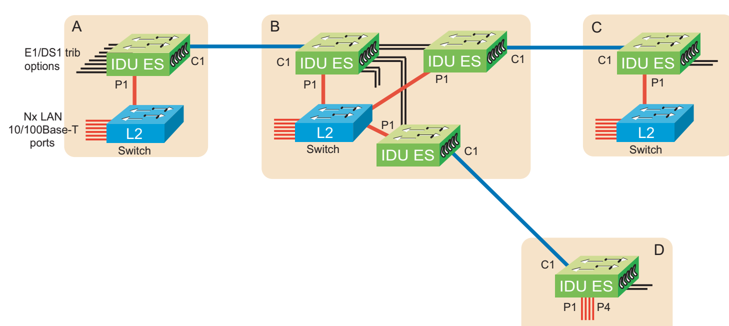
Figure 2-11. IDU ES Link with External Switch: Both Channels



Where IDU ES links are to be networked, they must be physically interconnected at intermediate sites. Figure 2-12 shows a typical small network with back-to-back IDU ES installations at site B.

- External layer 2 multi-port switches are used where more than four host devices are locally connected on the LAN: sites A, B and C.
- Site D shows no external switch. For a small office where no more than four host devices are connected, the IDU ES provides a complete solution.
- Trib circuits are trib-cabled as for a standard E1/DS1 link.
- NMS visibility between all IDU ES terminals requires linking of the Ethernet NMS ports at each site. As the IDU ES has a single Ethernet NMS port, where three or more are grouped at a site, as at Site B, a simple external hub must be used to provide the required porting capacity.

Figure 2-12. Network-connected IDU ES Links

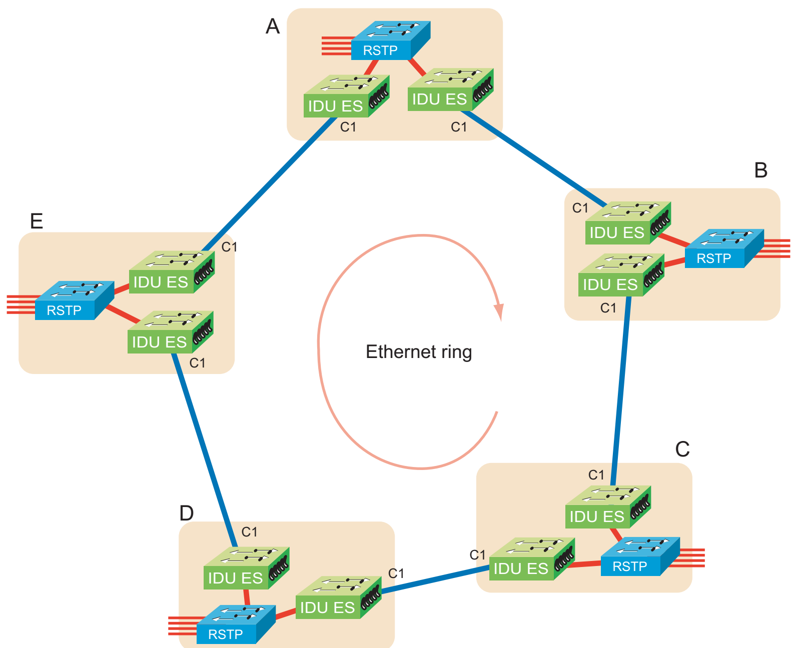


Ring Applications

IDU ES is a 1+0 platform; it does not offer hot-standby or diversity options. However, IDU ES links can be installed in a ring network topology to support alternate-path protection of Ethernet traffic using external RSTP switches.

- Using one channel, as illustrated in Figure 2-13, ring capacities to 98 Mbps are supported.
- Using both channels, C1 and C2, two concentric rings are supported, each up to 98 Mbps.
- Where concentric rings are used, link aggregation may be used in the external switch to provide a single LAN interface.
- For NMS visibility around ring, IDU ES terminals are interconnected at each site via their Ethernet NMS ports.
- E1/DS1 circuits can also be configured on each link as pt-to-pt connections (not ring protected).

Figure 2-13. IDU ES Links in a Ring



More Information

For more information on IDU ES:

- For capacity licensing see Capacity Licensing on page 4-1 of Volume IV.
- For configuration see Configuring Node and Terminal Plug-ins on page 7-1of Volume IV.

IDU Protection

This section describes IDU protection options:

IDU	Protection Options
IDU 20x	Hot-standby, Space Diversity, Ring
IDU 155o	Hot-standby, Space Diversity

Tx switching is not hitless; Rx switching (voting) between the two receive data streams is hitless (errorless) on hot-standby and space diversity.

Refer to:

- Protected IDUs on page 2-23
- IDU Protection Switch Conditions and Criteria on page 2-24
- IDU Service Restoration Times on page 2-27

Protected IDUs

A protected terminal comprises two IDUs with companion ODUs, and inter-connecting RJ-45 protection and NMS cables. 'Y' cables are available for trib split/merge. Figure 2-14 illustrates cable options for IDU 20x.

An exception to standard protected IDU operation is provided by the IDU 20x using the 'Hot Standby: Non-protected Tributary' mode which applies to capacities above 20xE1 / 16xDS1:

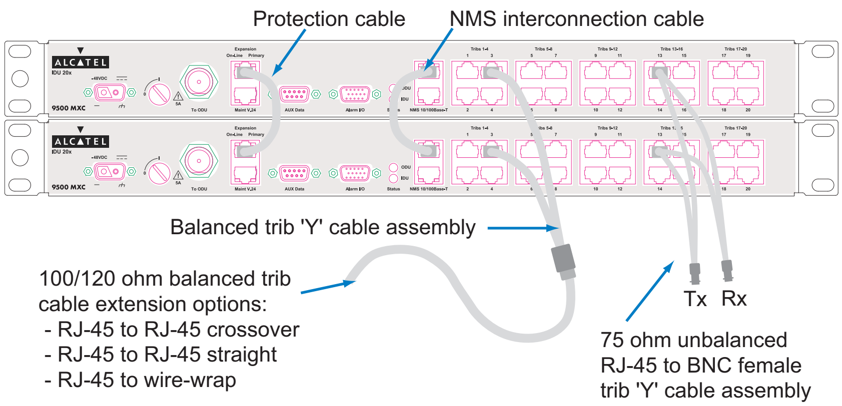
- Normal equipment and path protection attributes apply for capacities to 20xE1 / 16x DS1. Two modes are supported: 'Hot Standby: Tributary Y-cable', or Hot Standby: Tributary Always-On', which support hitless Rx path switching (voting) for hot-standby or space diversity applications.
- For higher capacities traffic from the standby IDU is routed to the online IDU to support termination of 40xE1 or 32xDS1 tribs; 20/16 tribs from each IDU. In this configuration trib and PSU protection is not supported, however RAC/ODU and path protection functions are retained. This protection mode is called 'Hot Standby: Non-protected Tributary'.
    - Protection is provided for all 40/32 tribs for a path / ODU failure. Each IDU normally takes its Rx data from its directly connected ODU. For a path/ODU failure, data is restored from its partner ODU/IDU via the IDU-IDU expansion cable.

      Switching on a *failed path* is not hitless; the 20/16 tribs assigned on the failed path are restored from the remaining path (via the expansion cable) within 200 ms, the 20/16 tribs assigned on remaining path are not affected.
    - Protection is not provided for all 40/32 tribs for a *tributary module or PSU equipment failure*. Tribs terminated on the failed IDU (20/16 tribs) will be lost; tribs terminated on the partner IDU will not be affected, providing the recommended (default) protection configuration is used where each IDU is taking Rx data from its directly connected ODU.
    - For more information on protected operation, refer to Additional Procedures for IDU 20x, Volume 1V, Chapter 8.

- A license is required for 40xE1 or 32xDS1 operation, one license per terminal. (The base capacity maximums of 20xE1 or 16xDS1 do not require a license). For more information, refer to Volume IV, Chapter 4.

Protected operation between IDUs and an INU is not supported. Where protected IDUs are to be used, they must be at both ends of the link.

Figure 2-14. Protected IDU Terminal



Equal or unequal couplers are available for single antenna operation:

- Equal has a nominal 3.5/3.5 dB insertion loss split, and is recommended for protected IDU operation.
- Unequal has a nominal 1.6/6.4 dB loss split.

Next:

- IDU Protection Switch Conditions and Criteria
- IDU Service Restoration Times

IDU Protection Switch Conditions and Criteria

Tx and Rx are switched separately except for a Tx online switch event where the Rx Online function will follow the Tx to put Tx Online and Rx Online on the same IDU. This occurs *providing there is no blocking condition to prevent an RX online switch*[1].

The primary-designated IDU is default online for Tx and Rx[2].

- Online for Tx means that it is transmitting.
- Online for Rx means that it is controlling the Rx protection switch function and is sending Rx data to the trib ports.

The protection cable must be correctly installed between protected IDUs for protection to operate.

Data is provided for:

1 *An Rx blocking condition will occur if there is an Rx path alarm on the partner IDU or if the current IDU is locked online for Rx.*

2 *Except for IDU 20x when operated in the Hot-standby: Non-protected Tributary mode. In this mode both IDUs are online to receive data from its directly-connected ODU.*

- Switching Guard Times
- Switch Conditions: IDU 20x and IDU 155o
- Tx Switch Criteria
- Rx Switch Criteria: IDU 20x and IDU 155o

Switching Guard Times

To prevent protection switch oscillation a *switch oscillation guard time* mechanism applies to all forms of Tx and Rx *online* protection switching[3]. The mechanism is described below.

- A period of guard time begins immediately after each protection switch occurs.
- No protection switches are permitted during the guard time. Protection switching may resume once the guard time has elapsed.
- To damp possible oscillations in the system the guard time is regularly adjusted, using the following rules:
  - The guard time doubles after each switch (up to the maximum).
  - The guard time halves after each period of guard time during which no switching occurs (down to the minimum).
  - When the guard time decays to its minimum, subsequent switch requests are actioned immediately.
- There are two independent guard timers for each protection context, one associated with TX switching and one associated with RX switching.
- The switch guard time has a minimum period of 5 seconds and a maximum period of 320 seconds (5 x 26 events).
- The guard time mechanism is disabled in protection diagnostic modes.

Switch Conditions: IDU 20x and IDU 155o

This data is applicable to hot-standby and space diversity.

- Tx switching is not hitless.
- Rx switching between the two receive paths is hitless (errorless) for *Rx path alarm events* - except for IDU 20x when operated in the Hot-standby: Non-protected Tributary mode.
  - Receiver voting is used between the two receiving IDUs such that the least errored data stream is selected on a frame-by-frame basis *within the online Rx IDU*. This voting action is hitless (errorless).
  - The online Rx IDU controls the Rx protection switch function (Rx diversity bus), and is default assigned to be with the online Tx IDU (the primary IDU of the protected pair is default online for Tx and Rx).
  - An Rx path alarm will not cause an Rx online switch (Rx path alarms are not included in the IDU 20x and IDU 155o switch conditions).
  - For the IDU 20x in Hot-standby: Non-protected Tributary mode, switching on a *failed path* is not hitless; the 20/16 tribs assigned on the failed path are restored from the remaining path (via the IDU-IDU expansion cable) within 200 ms, the 20/16 tribs assigned on remaining path are not affected.

3 *It does not apply to Rx diversity-bus (hitless) path switching.*

- When a Tx online switch occurs, the Rx online function is switched to be with the new Tx online *providing* there is no blocking condition on the partner Rx path, and providing there are no System/Controls locks in place. This switching of the Rx *online* function, as for a Tx switch, is not hitless.
- In the event of a switch of Rx online function, the Tx online will not be switched, meaning one IDU will be online receiving, the other online transmitting. Such a switch of online Rx function is not hitless and should only occur when forced by an Rx lock command in the Systems/Controls screen.
- Protection switch oscillation is prevented by the guard time mechanism. It applies to Tx and Rx *online* switch events.

Tx Switch Criteria

Switching from the online Tx to standby is initiated for the following *local* alarm conditions:

- Software load failure
- Tx path failure:
  - Tx synthesizer not locked
  - Transceiver Tx failure
  - Tx power failure
  - Tx IF synthesizer not locked
  - Tx cable IF synthesizer not locked
  - ODU Tx cable IF synthesizer not locked
  - ODU cable unplugged
- Tributary LIU failure. Except for IDU 20x when configured for capacities above 20xE1 / 16xDS1 using ‘Hot Standby: Non-protected Tributary’.
- Tributary ‘n’ LOS failure (subject to no trib ‘n’ LOS on partner IDU trib). Except for IDU 20x when configured for capacities above 20xE1 / 16xDS1 with ‘Hot Standby: Non-protected Tributary’.

A transmitter switch is also forced for an undetected ‘silent transmitter’ failure. This occurs when both *remote* online IDUs are in *receive* alarm (path failure), whereupon a switching command is returned to the local-end transmitter[4].

Rx Switch Criteria: IDU 20x and IDU 155o

This data is applicable to hot-standby and space diversity.

Switching from the online Rx to standby Rx is initiated for the following alarm conditions:

- Software load failure
- Tributary LIU failure. Except for IDU 20x when configured for capacities above 20xE1 / 16xDS1 using ‘Hot Standby: Non-protected Tributary’.
- Tributary output failure. Applies to IDU 20x, except when configured for capacities above 20xE1 / 16xDS1 using ‘Hot Standby: Non-protected Tributary’. This alarm condition does not apply to IDU 155o.

[4] *Where both RF modules are in receive path alarm because of a path problem, no signal is received in either direction. In such situations the ‘silent Tx’ switch command will be prompted by receive path alarms at both ends of the link, but will not be received at the transmit ends of the link, hence no silent Tx switch will occur on a complete (both-way) path failure.*

IDU Service Restoration Times

Service restoration times for a transmit or receive switch are:

IDU Transmit Switch:

- Within 200ms for a local alarm Tx switch.
- Within 20 seconds nominally for a silent Tx switch.

IDU Receive Switch:

- Rx switching is hitless (errorless) for all events except for an *online* Rx switch.
- For an online Rx switch, service restoration is within 200 ms. (The online Rx controls the hitless protection mechanism - the protection switch. When the protection switch function is changed from one IDU to its partner, the switching is not hitless).

Platform Layout and Interoperation Data

This section includes data on platform layout, operational parameters, and interoperation.

Figure 2-15 illustrates support for:

- Protected operation.
- ODU options.
- Capacity and modulation.

Table 2-11 on page 2-28 summaries IDU/ODU options and over-air compatibility.

Figure 2-15. 9500 MXC IDU Platforms

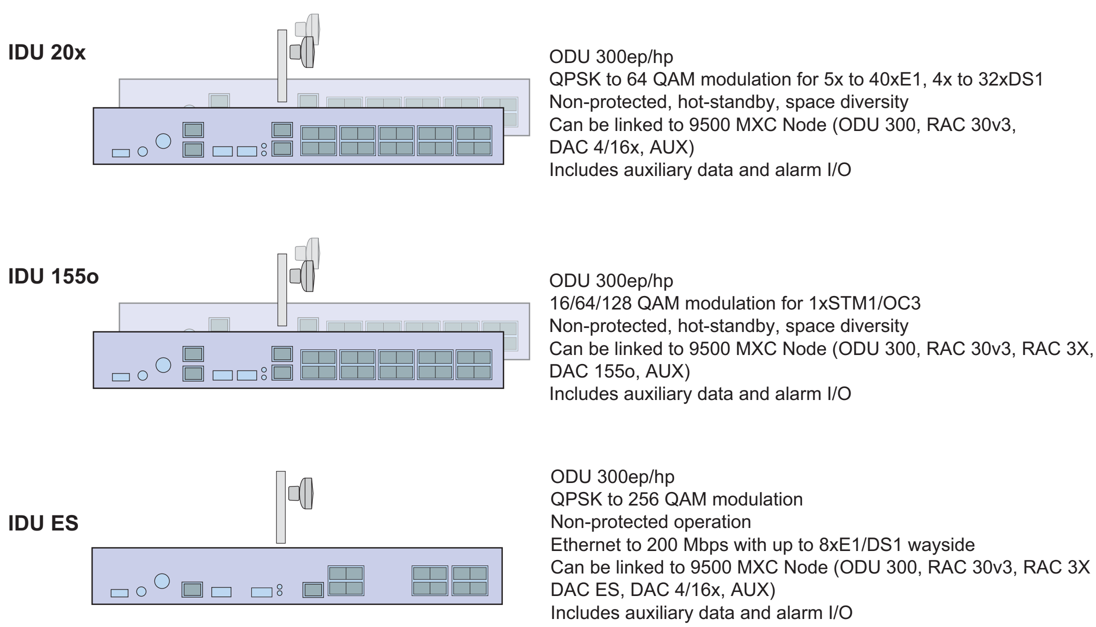


Table 2-11. 9500 MXC IDU and ODU Parameters

IDU	ODU	Capacity	Modulation	Protection	Over-Air Compatibility[1]
IDU 20x	ODU 300ep/hp 6 to 38 GHz[2]	5 to40xE1 4 to 32xDS1 (20xE1/DS1 trib access)	QPSK to 64 QAM	Hot standby, space diversity	INU, RAC 30v3
IDU 155o	ODU 300ep/hp 6 to 38 GHz[2]	1xSTM1/OC3	16/64/128QAM	Hot standby, space diversity	INU, RAC 30v3[2], RAC 3X
IDU ES	ODU 300ep/hp 6 to 38 GHz[2]	Up to 196 Mbps Ethernet with up to 8xE1/DS1	QPSK to 256 QAM	Non-protected	INU, RAC 3X, RAC 30v3

1. Over-air compatibility for like capacity with INU/INUe. IDU E1/DS1 tribs are end-end compatible with INU DAC 4x and DAC 16x plug-ins. The auxiliary function provided on IDUs is end-end compatible with the INU/INUe AUX plug-in. Over-air interoperability is supported between ODU 300ep and hp. IDU-to-INU compatibility **does not apply to protected operation**; where protected IDUs are to be installed they must be at both ends of the link.
2. Compatible with RAC 30v3 at STM1/OC3 using 128 QAM (27.5-30 MHz channel BW).

Configuration and Diagnostics

This section provides an overview of the 9500 MXC CT screens provided for IDU/ODU configuration and diagnostics. Refer to:

- 9500 MXC CT Log-in on page 2-28
- Configuration on page 2-29
- Diagnostics on page 2-29
- Software Reset on page 2-30

For more information on configuration and management, refer to Chapter 5.

9500 MXC CT Log-in

The IDUs include Ethernet and V.24 front-panel NMS ports for CT connection.

Ethernet: For Ethernet (10/100Base-T NMS port) there are two connection options:

- Direct addressing using the TCP/IP properties window to set a LAN compatible address on your CT PC. It requires knowledge of the IP address of the connected radio. Where not provided, it is discovered using CT address auto-discovery.
- DHCP server connection, where a server function in the IDU provides an IP address to the CT PC client. This option is enabled in the Networking screen. It does not require operator knowledge of the IP address for the connected radio.
- **V.24**. V.24 connection does not require knowledge of a radios' IP address. IDUs fitted with a V.24 maintenance port include a V.24 cable in their installation kit.

For information on CT PC connection, Refer to Volume IV, Chapter 2.

To enable 9500 MXC CT access on a new (unconfigured) IDU a V.24 connection is normally used at the outset. Once connected, an IP address can be configured, from which point Ethernet access can be used. DHCP can also be configured at this time.

An Ethernet connection is recommended as it provides a much faster connection and running speed compared to V.24. Ethernet must be used for remote-end and network-wide access.

Configuration

CT configuration screens for the IDUs are identical to those for the INU/INUe (where service functionality is the same).

- For information on CT PC connection, refer to Setting Up 9500 MXC CT, Chapter 2 of Volume III.
- For information on a recommended configuration process for a new IDU, refer to Procedure Overview for a New Installation on page 3-7 of Volume III.
- For detail configuration data, refer to the relevant screens in Volume IV.

Diagnostics

The CT Diagnostics screen functions include:

- Event browser with report options.
- History, graphed and report, with capture options for 7 days worth of 15 minute data bins, or one month of daily bins. Screens are provided for RACs and Ethernet IDUs/DACs. The RAC screen captures G.826, G.821, RSL and event data. The Ethernet history screen captures throughputs, frame types, discards, errors and events.
- Alarms, with context-sensitive Helpset support for alarm description, probable cause and recommended remedial actions (For context sensitive help '9500 MXC Help' must be loaded on your PC).
- G.826 link performance data and G.821 BER - with built-in BER test function on PDH and SDH tribs.
- Ethernet performance with comprehensive RMON statistics per port and channel.
- System Controls, with safety timers, for setting loopbacks, AIS, protection locks, Tx mute. For the Ethernet modules data dashboard screens present Tx and Rx throughputs, discards and errors for each of the ports and channels.
- Information on serial number, part number, and time in service.
- Software reset and history-clear functions:

Refer to Diagnostics on page 15-1, Volume IV.

For a list of troubleshooting processes supported within the Diagnostic screens, refer to Using CT Diagnostics Screens on page 2-30 of Volume V.

Software Reset

A software reset is equivalent to a power-down reboot (power off - pause - power on), with one important difference; a copy of the Helpdesk Data File is automatically saved to a default folder on your CT PC at C:\Program Files\9500 MXC CT\Reset Logs\.

For information on the software reset function, refer to Advanced Management on page 15-61 of Volume IV.

Chapter 3. 9500 MXC Nodes

This chapter details features and capabilities of the INU and INUe, and their ODU options. Refer to:

For information on 9500 MXC ODUs, refer to Chapter 4.

Platforms

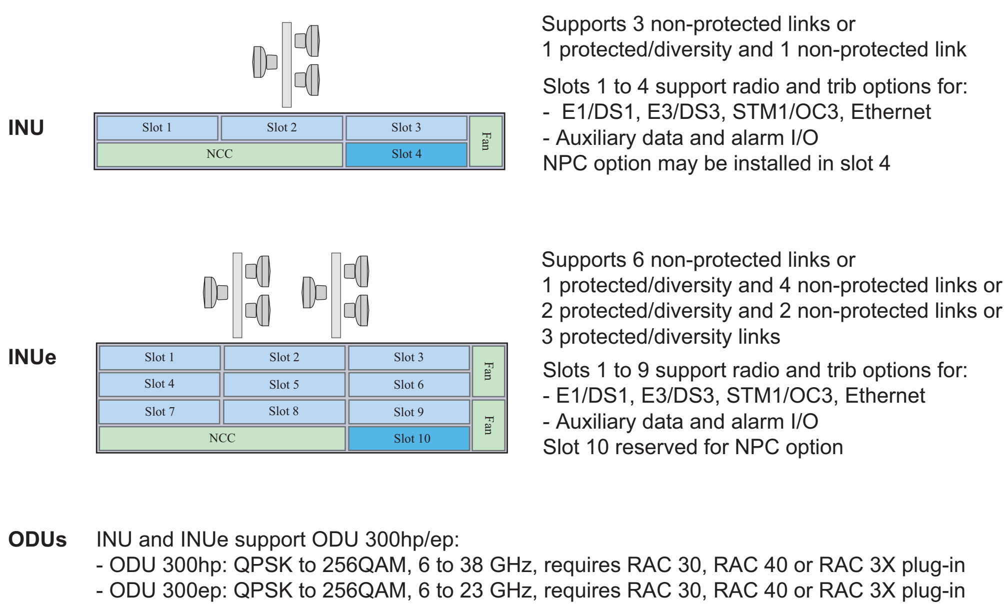
This section introduces the INU and INUe platforms for slot location and usage, cross-connects, capacity, and RAC/ODU parameters. Refer to:

Platform Layout

Figure 3-1 illustrates platform support for:

- Non-protected and protected/diversity links
- Slot availability for option plug-ins
- Over-air data types supported
- ODU options

Figure 3-1. INU and INUe Platforms



The current production IDCe chassis accepts a 2RU FAN as well as the original 1RU FANs. The updated IDCe is form-fit-function compatible with the previous IDCe, and retains its 002 part number extension.

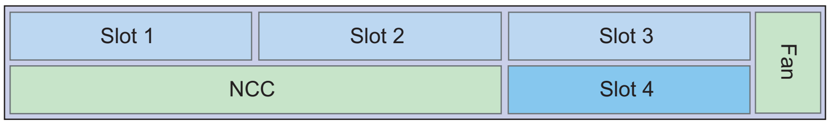
One 2RU FAN is now supplied as standard with the IDCe.

Slot Assignments

Figure 3-2 illustrates INU and INUe slot assignment rules.

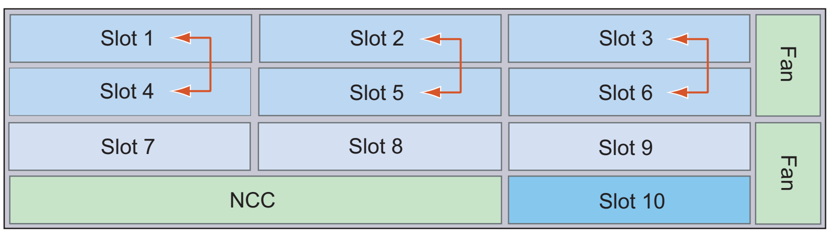
Figure 3-2. INU and INUe slot assignments

INU



Slots 1, 2, 3, 4 are universal: any RAC, DAC or AUX plug-in
Slot 4 is NPC or universal: NPC or any RAC, DAC, AUX
NCC and FAN slots are dedicated
For protected operation the RAC, or RAC/DAC 155oM pairings can be installed in any of the universal slots

INUe



Slots 1, 2, 3, 4, 5, 6 are universal: any RAC, DAC or AUX plug-in
Slots 7, 8, 9 are restricted: any DAC or AUX (except DAC 155oM and AUX*)
Slot 10 is restricted: NPC option only
NCC and FAN slots are dedicated

For protected operation the RAC, or RAC/DAC 155oM pairings must be installed in the positions indicated by the arrows

* Internal (backplane) NMS access is only provided for slots 1 to 6. Do not install DAC 155oM or AUX in slots 7 to 9 if an NMS connection is required in their configuration.

Cross-Connects

All cards plug into a backplane, which carries a high-speed parallel bus to provide the cross-connect and end-to-end circuit connectivity for traffic channels, auxiliary data, NMS, and protection switching.

The backplane bus can operate in one of five user-programmable configurations, NxE1 (2.048 Mbps), NxDS1 (1.544 Mbps), NxDS3 (44.736 Mbps), or NxSTM1/OC3 (155.52 Mbps).

In this way, a 9500 MXC Node can be configured to be an Ethernet, NxE1, NxDS1, NxE3, NxDS3, or NxSTM1/OC3 radio. Ethernet operation can be with or without companion TDM traffic.

The traffic-handling capacity limit of the backplane for each rate is:

- 20o Mbps Ethernet for an Nx2 Mbps or Nx1.544 Mbps setting
- 300 Mbps Ethernet for an Nx150 Mbps setting
- 100 x E1 (204.8 Mbps)

- 128 x DS1 (197.6 Mbps)
- 8 x E3 (275 Mbps)
- 6 x DS3 (268 Mbps)
- 2xSTM1/OC3 (311 Mbps)

Where a mix of different rates is required, such as NxE1 *and* STM1/OC3, a multiplexer DAC enables STM1/OC3 mapping to an E1 configured bus. In this way E1 *and* STM1/OC3 interfaces are supported on the same INU without the need for a stand-alone SDH mux.

Where Ethernet data is transported capacity (bandwidth) is assigned in 2.048 Mbps, 1.544 Mbps or 155.52 Mbps steps to align with the capacity needed for E1, DS1 or STM1/OC3 waysides. 9500 MXC incorporates a universal modem design that does not distinguish between the type of data to be transported, Ethernet or TDM; data is simply mapped into byte-wide frames to provide a particularly efficient and flexible wireless transport mechanism, with the result that when configured for Ethernet data, or Ethernet and TDM data, the full configured capacity is available for user throughput. *The data is transported natively over the wireless link, whether Ethernet or TDM*.

Figure 3-3 illustrates the relationship of the plug-ins with the cross-connect function of the backplane bus, which is managed by the NCC. An NPC option is available to provide redundancy for this bus management and power supply functions.

Table 3-1 summarizes PDH and SDH link capacity options against the backplane maximums.

Table 3-2 summarizes the Ethernet link data and backplane maximums.

While each RF path from a 9500 MXC Node can be configured support the capacities shown, where multiple RF paths are to be established the combined total from each path must not exceed the backplane bus maximum as defined under above.

Where more capacity is required, two or more INU/NUes are co-located and interconnected using the DAC options.

Figure 3-3. Relationship of Plug-in Cards to the Backplane

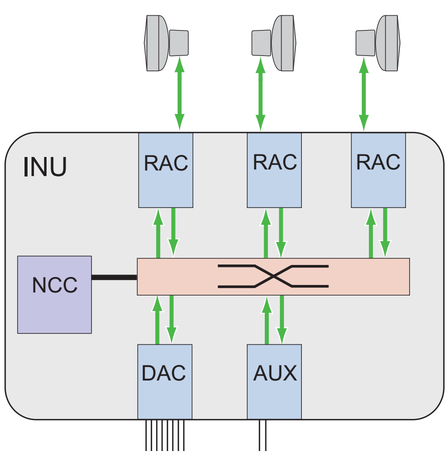


Table 3-1. PDH and SDH Link Options and Backplane Maximums[1]

Bus Rate	Link Capacity Options	Backplane Max.
E1	5x, 10x, 16x, 20x, 32x, 40x, 52x, 64x, 75x, 93x, 100x	100x
DS-1	4x, 8x, 14x, 16x, 28x, 32x, 56x, 70x, 84x, 100x, 127x	128x
DS-3	1x, 2x, 3x, 4x	6x
STM1/OC-3	1x, 2x	2x

Table 3-2. Ethernet Link and Backplane Maximums

Bus Rate	Link Capacity Options	Backplane Max.
Nx2.048 Mbps	8 to 204[1] Mbps	204 Mbps
Nx1.544 Mbps	6 to 154 Mbps	198 Mbps
Nx155.52 Mbps	155.5 or 311 Mbps	311 Mbps

1. A link can be configured for a maximum 217 Mbps to support over-air linking to an IDU ES when configured for its maximum, but the most that can be *terminated* on an INU backplane is 204 Mbps.

For more information on the traffic handling maximums of a Node when used in linear and ring network configurations, refer to Node Capacity Rules, Appendix E.

[1] *The Link/RAC options do not support NxE3. Where E3 trib connections are required, use the E13 mode on the DAC 3xE3/DS3M.*

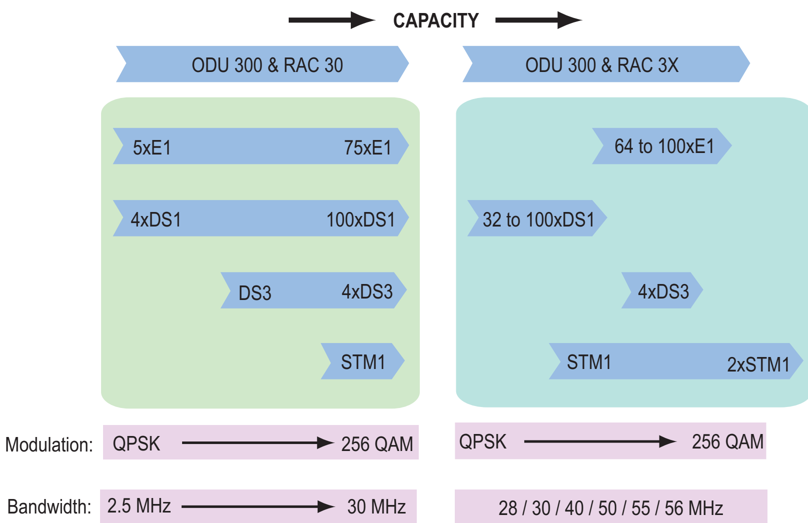
Capacity and Bandwidth: PDH and SDH

The 9500 MXC INU and INUe provide configurable link (over-air) capacity and bandwidth options up to 100xE1[2], 127xDS1, 4xDS3, 2xSTM1/OC3.

Figure 3-4 shows the capacity migration options and in particular the broad coverage provided by ODU 300 and RAC 30v3/3X combinations. Table 3-1 on page 3-5 shows the capacity steps.

Node capacity licensing is introduced on page 11.

Figure 3-4. 9500 MXC Capacity Ranges with RAC 30 and RAC 3X



ODU 300 with RAC 40

RAC 40 supports Co-channel, Dual Polarized (CCDP) operation using a built-in Cross-polarized Interference Cancellation (XPIC) function. Two links are operated on the same radio channel, with one using the vertical polarization, the other the horizontal.

RAC 40 operates with ODU 300hp or ODU 300ep.

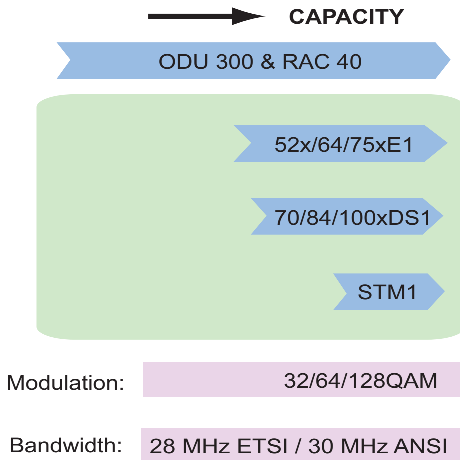
RAC 40 supports:

- Two 52xE1, 64xE1, 75xE1, or STM1 links on one 28 MHz channel.
- Two 70xDS1, 84xDS1, 100xDS1 or OC3 links on one 30 MHz channel.

Figure 3-5 illustrates the capacity and bandwidth options.

[2] To achieve a 100xE1 link capacity the RAC 3X 106xE1 capacity option (modem profile) is used, but a maximum 100xE1 circuits are accessible on the backplane. The 106xE1 modem profile is used to support INU to IDU ES link compatibility.

Figure 3-5. 9500 MXC ODU 300 Capacity Ranges with RAC 40



Capacity and Bandwidth: Ethernet

This section introduces the capacity and bandwidth options for the transport of Ethernet data, or Ethernet data and companion PDH or SDH traffic.

The same RAC and ODU combinations used to transport PDH or SDH traffic are used to transport 9500 MXC fast Ethernet and gigabit Ethernet options. These are enabled on the DAC ES and DAC GE plug-in cards, which incorporate a layer 2 (L2) switch with four user ports and two transport channels. The transport channels (one or both) are cross-connected on the backplane bus to a RAC for radio transport, or to a DAC 155oM for fiber transport.

DAC ES

DAC ES supports 10/100Base-T connections for Ethernet capacities up to100 Mbps on one channel, or to 196 Mbps using both channels. Each channel can be mapped to a different radio or fiber link, or to the same link.

DAC GE

DAC GE supports three 10/100/1000Base-T and one 1000Base-LX Ethernet connections, with capacities up to 300 Mbps.

- For an Nx2 Mbps or Nx 1.5 Mbps backplane selection it supports a maximum of 200 Mbps on one channel, or a total of 200 Mbps using both channels.
- For an Nx150 Mbps backplane selection it supports 300 Mbps on one channel, or 150 Mbps per channel.
- Each channel can be mapped to a different radio or fiber link, or to the same link. (A fiber link requires an Nx2 Mbps or Nx1.5 Mbps backplane selection).

Capacity Assignment

The backplane bus setting of Nx2 Mbps (2.048 Mbps), Nx1.5 Mbps (1.544 Mbps) or Nx150 Mbps (155.52 Mbps) determines the capacity multiples used to configure the required Ethernet capacity.

The Ethernet capacities selected, along with any TDM capacity, must in turn be supported within the radio or fiber link capacities that the traffic is cross-connected to.

The total capacity must also be supported by the backplane bus, which is particularly relevant where two or more links are operated from one INU. One INU supports maximums of 204 Mbps for an Nx2 Mbps selection, 154 Mbps for Nx1.5 Mbps, or 311 Mbps for Nx150 Mbps.

2 Mbps or 1.5 Mbps Backplane Selection

On a radio link multiples of 2 Mbps or 1.5 Mbps assignments are configured to transport Ethernet, with or without E1 or DS1 side traffic, to a 200 Mbps nominal maximum for an NxE1 backplane, or 150 Mbps for an NxDS1 backplane.

On a fiber link it is to a maximum of 130 Mbps.

This link capacity assignment between Ethernet and E1/DS1 traffic is fully scalable in 2 Mbps or 1.5 Mbps steps to optimize throughput granularity for network planning.

Figure 3-6 illustrates bandwidth assignment on a radio link for an Nx2 Mbps backplane, demonstrating how for a selected aggregate link capacity the scaling is used to assign Ethernet and companion E1 capacity.

Figure 3-7 illustrates the equivalent bandwidth assignment options for an Nx1.5 Mbps backplane selection.

Figure 3-6. Ethernet versus E1 Bandwidth Assignment

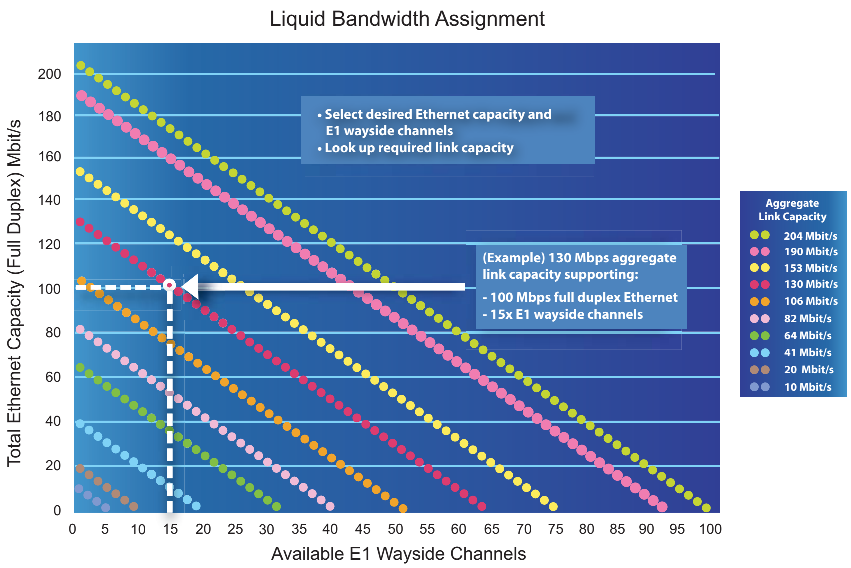
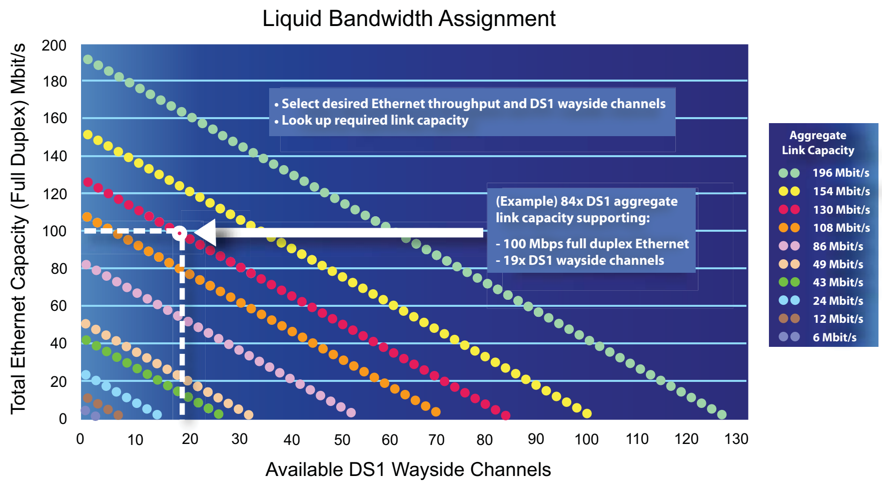


Figure 3-7. Ethernet versus DS1 Bandwidth Assignment



150 Mbps Backplane Selection

The DAC GE is required for an Nx150 Mbps backplane selection. Radio link capacity is scalable for 1x150 Mbps, or 2x150 Mbps to support 150 Mbps or 300 Mbps Ethernet, or 150 Mbps Ethernet with 150 Mbps assigned to an STM1/OC3 circuit.

Higher Capacities

With an Nx2 Mbps backplane one INU/INUe with one DAC ES or DAC GE supports Ethernet capacities to 200 Mbps; 200 Mbps represents the backplane maximum and the maximum that can be transported over one radio link. For Nx1.5 Mbps, 200 Mbps (128x1.544 Mbps) is the backplane maximum, but 150 Mbps is the maximum that can be transported over one radio link.

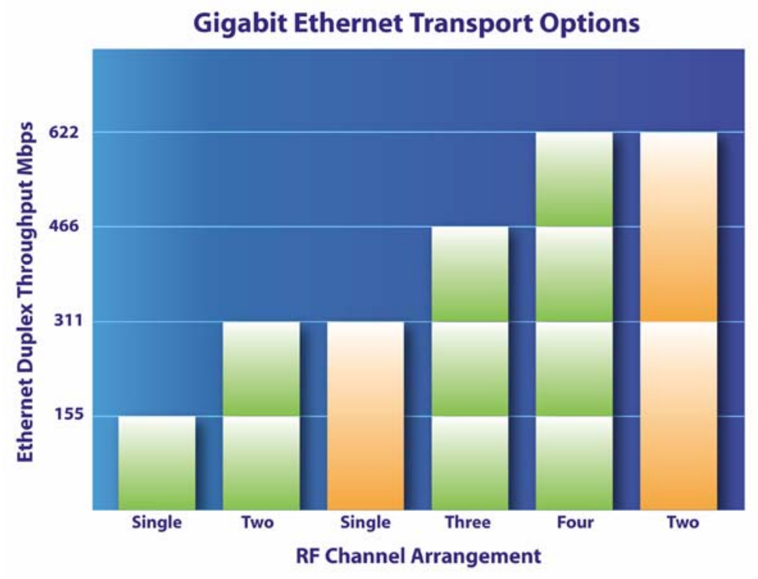
With an Nx150 Mbps backplane one INU/INUe with one DAC GE supports Ethernet capacities to 300 Mbps, which represents the backplane maximum for Nx150 Mbps, and the maximum that can be transported over one radio link.

Where higher Ethernet capacities are required two or more INUs are co-located to provide parallel-path links.

The Ethernet data from each link can be held separate or link-aggregated to provide a single high speed user interface. Such link aggregation is enabled within the DAC GE, or on an external L2 switch. For information on DAC GE link aggregation, refer to DAC GE on page 3-42.

Figure 3-8 summarizes the radio channel (link) options for an Nx150 Mbps selection for Ethernet capacities from 150 to 600 Mbps. Up to 300 Mbps a single INU is used, for higher capacities two co-located INUs are used.

Figure 3-8. Ethernet Radio Path Options for 150 to 600 Mbps



Ethernet Capacity and RF Channel Bandwidths

Table 3-3 and Table 3-4 summarize ETSI and ANSI RF channel bandwidth options for Ethernet capacity assignments from 40 to 300 Mbps. Nominal Ethernet capacities are used.

With the RAC 40 CCDP XPIC cards, two links are operated on the *same* frequency channel, one using the vertical polarization, the other the horizontal.

Table 3-3. Bandwidth, Modulation and RAC Type: ETSI

Ethernet Capacity Mbps	RF Ch. BW MHz	Modulation	RAC
40	14	16 QAM	RAC 30
40	28	QPSK	RAC 30
65	14	64 QAM	RAC 30
80	28	16 QAM	RAC 30
100	28	32 QAM	RAC 30
130	28	64 QAM	RAC 30 RAC 40
130	56	16 QAM	RAC 3X
150	28	128 QAM	RAC 30 RAC 3X RAC 40
150	40	64 QAM	RAC 3X
150	56	16 QAM	RAC 3X
190	28	256 QAM	RAC 3X
200	56	64 QAM	RAC 3X
300	56	128 QAM	RAC 3X

Table 3-4. Bandwidth, Modulation and RAC Type: ANSI

Ethernet Capacity Mbps	RF Ch. Bandwidth MHz	Modulation	RAC
40	10	64	RAC 30
40	20	16	RAC 30
40	30	QPSK	RAC 30
50	20	16	RAC 30
50	40		RAC 3X
85	30	32	RAC 30
105	20	128	RAC 30
105	30	32	RAC 30 RAC 40
105	40	16	RAC 3X
130	30	64	RAC 30
130	40	32	RAC 3X
130	50	16	RAC 3X
150	30 MHz	128 QAM	RAC 30 RAC 3X RAC 40
150	40 MHz	64 QAM	RAC 3X
150	40 MHz	32 QAM	RAC 3X
150	50 MHz	16 QAM	RAC 3X
300	50 MHz	256 QAM	RAC 3X

More Information

For DAC ES, refer to DAC ES on page 3-36

For DAC GE, refer to DAC GE on page 3-42

For RAC 30/3X, refer to RAC 30V3, RAC 3X on page 3-18.

For RAC 40, refer to RAC 40 on page 3-23.

Capacity License

Node capacity is licensed according to required RAC capacity. The license is software enabled within a compact flash card, which plugs into the right side of the NCC. The same flash card also holds the configuration for the node and the embedded system software.

It is the compact flash card, specifically its unique identifier, which identifies the serial number of the Node.

For ETSI rates the base license is 40xE1 for up to 6 RACs. For North American rates the base license is 16xDS1 for up to 6 RACs. Beyond this base, capacity is licensed on a per-RAC basis.

Licensed capacity is field upgradable. For information on upgrading refer to Licensing, Volume 4, Chapter 4.

RAC/ODU Parameters and Interoperation

Table 3-5 summarizes ODU/RAC parameters for:

- ODU type: ODU 300ep and ODU 300hp.
- RAC type: RAC 30V3, RAC 3X, RAC 40.
- Tx power profile by ODU type.
- Link capacity range.
- Modulation range.
- Bandwidth range.
- Over-air interoperation.

Table 3-5. 9500 MXC Node ODU/RAC Parameters

ODU[1]	Tx Power	Over-Air ODU Compatibility[2]	RAC	Link Capacity	Bandwidth	Modulation
ODU 300ep 6 to 23 GHz ODU 300hp 6 to 38 GHz	Extended High	ODU 300ep, hp ODU 300hp, ep	RAC 30	5xE1 to 75xE1 4xDS1 to 100xDS1 1/3/4xDS3 1xSTM1/OC3	3.5 to 30 MHz for ODU 300ep 7 to 30 MHz for ODU 300hp	QPSK to 256 QAM
			RAC 3X	64/75/93/ 100xE1 32/70/84/ 100xDS1 4xDS3 1/2xSTM1/OC3	28 to 56 MHz 30 to 50 MHz 40 MHz 28 to 56 MHz	QPSK to 256 QAM
			RAC 40	52/64/75xE1 70/84/ 100xDS1 1xSTM1/OC3	28 MHz 30 MHz 28/30 MHz	64/128 QAM 32/64/128 QAM 128 QAM

1. ODU 300ep availability is restricted to the 13 and 15 GHz bands.
2. For like band/capacity/modulation options.

For more information on Node link capacities refer to Capacity and Bandwidth: PDH and SDH on page 3-6, and to Capacity and Bandwidth: Ethernet on page 3-7.

Plug-in Cards

This section introduces the plug-in cards that provide Node management and service customization.

Refer to:

- Overview on page 3-13
- NCC on page 3-15
- FAN on page 3-17
- RAC on page 3-18
- DAC on page 3-26
- AUX on page 3-54
- NPC on page 3-58

Overview

Table 3-6 provides an overview of plug-in types and their function.

For detailed data, refer to the individual plug-ins in this section.

Table 3-6. Plug-ins Summary

Unit	Description
NCC Node Control Card	The NCC is a mandatory plug-in for each INU/INUe. It performs key node management and control functions, and provides various dc rails from the -48 Vdc input. It also incorporates a plug-in flash card, which holds node configuration and license data.
FAN Fan Card	To provide cooling, one 1RU FAN must be fitted in an INU, or one 2RU or two 1RU FANs in an INUe. Each FAN is fitted with two long-life axial fans plus monitoring and control circuits.

Unit	Description

RAC
Radio Access Card
	An INU may be populated with a maximum of three RACs, and the INUe up to six. Each RAC interfaces to a companion ODU via a single 50-ohm coaxial cable.
	• RAC 30 interfaces to ODU 300/hp/ep for channel bandwidths to 28/30 MHz and capacities of 4xE1 to 75xE1, 4xDS1 to 100xDS1, 1xE3 to 4xE3, 1xDS3 to 3xDS3, or 1xSTM1/OC3.
	• RAC 3X interfaces to ODU 300 for channel bandwidths 28/30 MHz to 50/56 MHz and capacity options of:
	  • 64/75/93/100xE1
	  • 32/70/84/100xDS1
	  • 4xDS3
	  • 1/2xSTM1/OC3
	• RAC 40 interfaces with ODU 300hp/ep for co-channel XPIC operation on a channel bandwidth of 28 MHz (ETSI) or 30 MHz (ANSI), for capacities:
	  • 52/64/75xE1
	  • 70/84/100xDS1
	  • 1xSTM1/OC3

DAC Digital Access Card	DACs provide customer line interface options for E1, E3, DS1, DS3, STM1/OC3, or Ethernet: • DAC 4x supports up to 4xE1 or DS1 tributaries. • DAC 16x supports up to 16xE1 or DS1 tributaries. • DAC 3xE3/DS3M supports three E3/DS3 tributaries, 2xE13 or 2xM13 multiplexer trib connections, or 2x34 Mbps E3 transparent mode connections. • DAC 1x155o supports one STM1/OC3 optical tributary. • DAC 2x155o supports two STM1/OC3 optical tributaries. • DAC 155oM multiplexes one STM1/OC3 tributary to/from a 9500 MXC backplane configured for NxE1 or DS1, to support concurrent SDH and PDH tributary access. • DAC 2x155e supports two STM1 electrical tributaries. • DAC ES supports four 10/100Base-T Ethernet ports over one or two radio and/or fiber NxE1/DS1 transport channels • DAC GE supports.three 10/100/1000Base-T electrical ports and one 1000Base-LX optical port, over one or two transport channels.Channels are configured for Nx2 Mbps, Nx1.5 Mbps, or Nx150 Mbps capacities.

Unit	Description
AUX Auxiliary Card	AUX provides synchronous and asynchronous auxiliary data channels, NMS porting, and alarm inputs and outputs. Sync data at 64 kbps and async to 19.2 kbps.
NPC Node Protection Card	NPC provides redundancy for the NCC TDM bus management and power supply functions.

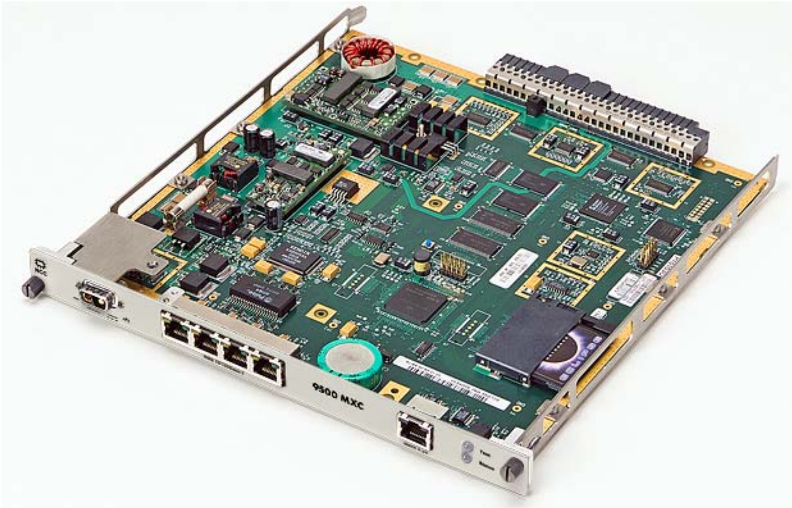
A *minimum* configured 9500 MXC Node would typically consist of an ODU, and an INU populated with an NCC, FAN, RAC, and DAC.

NCC

The NCC plugs into a dedicated slot in an INU/INUe. Although the NCC is field replaceable, it is not hot swappable unless an NPC is installed. Refer to:

- NCC Functions on page 3-15
- NCC User Interfaces on page 3-16

Figure 3-9. NCC Plug-in



NCC Functions

The NCC provides the following primary functions:

- TDM bus clock and signaling distribution
- Microprocessor control and management
- DC/DC converter
- Boot (start-up) flash
- License and configuration flash
- Network management access
- Voltage and temperature levels management

NCC User Interfaces

Figure 3-10 shows the NCC front panel layout.

Table 3-7 on page 3-16 describes the front panel interfaces.

User access is also provided on the NCC PCB for:

- A fast acting 25A tubular ceramic fuse, located behind the -48 Vdc connector.
- CompactFlash card on the right side of the PCB.

Figure 3-10. NCC Front Panel Layout

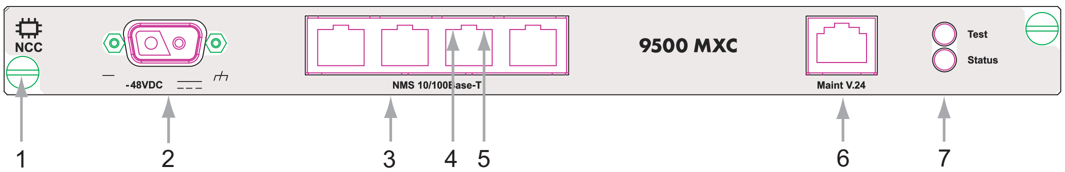


Table 3-7. NCC Front Panel Descriptions

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	-48 Vdc	2-pin polarized D-series 2W2C power connector with captive screw fasteners.	
3	NMS 10/ 100Base-T	The four RJ-45 connectors provide Ethernet network management access. 9500 MXC CT login to these ports requires entry of the IP address for the INU/INUe. Ports may also used to provide NMS connectivity to co-located 9500 MXC INU/INUes and other Alcatel-Lucent and third party radios. Ports auto-resolve for straight or cross-over cables.	
4	Ethernet orange LED	Orange flashing LED indicates Ethernet receive activity. Off indicates no receive activity. (Fitted to each RJ-45 NMS connector)	
5	Ethernet green LED	Green LED indicates connection of an Ethernet link. Off indicates no Ethernet link connection. (Fitted to each RJ-45 NMS connector)	
6	Maint V.24	RJ-45 connector provides a V.24 serial interface option for CT access. Includes a default IP address, which means knowledge of the INU/INUe IP address is not required at login.	
7	Test LED	Provides indications of:	
		Off	INU/INUe power off.
		Green	Normal operation.
		Orange flashing	INU/INUe is in a test/diagnostic mode, for example, loopbacks are set.
	Status LED	Status LED provides indications of:	
		Off	INU/INUe power off
		Green	Normal operation

No	Item/Label	Description	
		Orange flashing	Configuration not supported or software / hardware incompatible
		Red	Critical alarm

FAN

One 1RU FAN card is required for an INU.

One 2RU or two 1RU FAN cards are required for an INUe.

- The current production IDCe (INUe chassis) supports both 1RU and 2RU FANs but is supplied standard with a 2RU FAN.

The FAN is field replaceable and can be hot swapped. Its removal will not interrupt user traffic.

The FAN plug-in holds two long-life axial fans. Fan operation is temperature controlled and is performance monitored by the NCC. Under normal conditions one fan operates, cycled between the two fans. Both fans will operate if the first fan fails to keep the temperature below a preset threshold.

The LED is off (no illumination) for normal operation. Red indicates a critical FAN alarm.

Figure 3-11. Fan Plug-in

RAC

Different RAC versions provide support for capacity and bandwidth options up to 2xSTM1/OC3.

- Available are RAC 30V3, RAC 3X, and RAC 40.
- Up to three RACs can be fitted in the INU universal slots, and six in the INUe.
- Paired RACs/ODUs are used for protected and co-channel operation.
- RACs are field replaceable and hot swappable. They are not frequency dependent.
- An INU/INUe can be installed with a mix of RAC versions (RAC 30V3, RAC 3X, RAC 40)

Refer to:

- RAC 30V3, RAC 3X on page 3-18
- RAC 40 on page 3-23

RAC 30V3, RAC 3X

RAC 30V3 is the intermediary between the digital baseband and ODU 300 for capacities from 5xE1/4xDS1 to STM1/OC3, with channel bandwidths up to 28/30 MHz. It incorporates Reed Solomon FEC encoding with interleaving, and adaptive equalization.

RAC 3X is physically similar to RAC 30V3 and is the intermediary between the digital baseband and ODU 300 for channel bandwidths from 28/30 to 50/56 MHz, for capacity options of:

- 64/75/93/100xE1, 1/2xSTM1
- 32/70/84/100xDS1, 4xDS3, 1/2xOC3

RAC 3X FEC incorporates Reed Solomon encoding with interleaving, Viterbi encoding, and adaptive equalization.

Refer to:

- RAC Capacity and Bandwidth Options
- Typical Link Delay Times
- RAC Front Panel Layout

Figure 3-12. RAC 30V3 Plug-in

Figure 3-13. RAC 3X Plug-In

RAC Capacity and Bandwidth Options

Depending on capacity/bandwidth options, modulation rates are programmed for QPSK, 16QAM, 32QAM, 64QAM, 128QAM, or 256QAM.

Table 3-8 on page 3-20 lists the ETSI capacity, modulation, and bandwidth options for RAC 30V3 and RAC 3X.

Table on page 3-20 lists North American (ANSI) Common Carrier options.

Table 3-8. RAC ETSI System Options

Capacity	Modulation	Channel BW MHz	RAC 30v2	RAC 30v3	RAC 3X
4xE1	QPSK	7	X		
5xE1	QPSK	7	X	X	
8xE1	QPSK	13.75 / 14	X		
10xE1	QPSK	13.75 / 14	X	X	
16xE1, 1xE3	QPSK	27.5 / 28	X		
20xE1	QPSK	27.5 / 28	X	X	
4xE1	16QAM	3.5	X		
5xE1	16QAM	3.5	X	X	
8xE1	16QAM	7	X		
10xE1	16QAM	7	X	X	
16xE1, 1xE3	16 QAM	13.75 / 14	X		
20xE1	16 QAM	13.75 / 14	X	X	
32xE1, 2xE3	16 QAM	27.5 / 28	X		
40xE1	16 QAM	27.5 / 28	X	X	
64XE1	16 QAM	55 / 56			X
75xE1, 1xSTM1	16 QAM	55 / 56			X
48xE1, 3xE3	32 QAM	27.5 / 28	X		
52xE1	32 QAM	27.5 / 28	X	X	
16xE1, 1xE3	64 QAM	7	X	X	
32xE1	64 QAM	13.75 / 14	X	X	
64xE1	64 QAM	27.5 / 28	X	X	
100xE1 [1]	64 QAM	55/56			X
1xSTM1	64 QAM	40			X
75xE1, 1xSTM1 [2]	128 QAM	27.5 / 28	X	X	X
4xE3	128 QAM	27.5 / 28	X		
100xE1	128 QAM	40			X
2xSTM1	128 QAM	55 / 56			X
93xE1	256 QAM	27.5/28			X

1. The actual over-air capacity is 106xE1, but the backplane bus limits terminations to 100xE1. The 106xE1 capability supports over-air compatibility with the IDU ES.
2. For RAC 30v3 an enhanced gain option is provided for this capacity (STM1). See below.

RAC 30v3 Enhanced System Gain Option for STM1 and OC3

An enhanced system gain option is provided for RAC 30v3 for 1xSTM1/128 QAM and 1xOC3/128 QAM. This is in addition to the standard option provided for this capacity/bandwidth.

- The enhanced system gain option improves Rx threshold and system gain by 1.5dB compared to the standard 1xSTM1 option.

- The enhanced system gain option only applies to the RAC 30v3.
- The enhanced system gain option requires compatible 9500 MXC software at both ends of the link. For STM1, the SW must be release 3.7 or later. For OC3 the software must be release 4.3 or later. If the software is not compatible, use the standard option.

Table 3-9. RAC ANSI Common Carrier System Options

Capacity	Modulation	Channel BW MHz	RAC 30v2	RAC 30v3	RAC 3X
4xDS1	QPSK	5	X	X	
8xDS1	QPSK	10	X	X	
16xDS1	QPSK	20	X	X	
28xDS1	QPSK	30	X	X	
32xDS1	QPSK	40			X
1xDS3	QPSK	30	X		
4xDS1	16 QAM	2.5	X		
8xDS1	16 QAM	5	X	X	
16xDS1	16 QAM	10	X	X	
28xDS1, 1xDS3	16 QAM	20	X	X	
32xDS1	16 QAM	20	X	X	
70xDS1	16 QAM	40			X
84xDS1	16 QAM	50			X
100xDS1	16 QAM	50			X
1xOC3	16 QAM	50			X
8xDS1	32 QAM	3.75	X	X	
56xDS1	32 QAM	30	X		
70xDS1	32 QAM	30	X	X	
84xDS1	32 QAM	40			X
100xDS1	32 QAM	40			X
28xDS1/1xDS3	64 QAM	10	X	X	
84xDS1, 3xDS3	64 QAM	30	X	X	
4xDS3	64 QAM	40			X
1xOC3	64 QAM	40			X
16xDS1	128 QAM	5	X	X	
100xDS1	128 QAM	30	X	X	
1xOC3	128 QAM	30	X	X	X
4xDS3	256 QAM	30		X	
2xOC3	256 QAM	50			X

Typical Link Delay Times

The delay times listed in the following tables reflect typical one-way link delays.

Table 3-10. Link Delay Times for RAC 30V3: ETSI Rates

RAC 30V3	ms
5E1,7M,QPSK	1.1
10E1,14M,QPSK	0.63
10E1,7M,16Q	0.63
20E1,28M,QPSK	0.41
20E1,14M,16Q	0.42
40E1,28M,16Q	0.3
52E1,28M,32Q	0.27
64E1,28M,64Q	0.26
75E1,28M,128Q	0.25
1STM1,28M,128Q	0.13

Table 3-11. Link Delay Times for RAC 3X: ETSI Rates

RAC3X	ms
64E1,56M,16Q	0.34
75E1,56M,16Q	0.31
1STM1,56M,16Q	0.19
1STM1,40M,64Q	0.19
1STM1,28M,128Q	0.19
2STM1,56M,128Q	0.13
2STM1,50M,256Q	0.13

Table 3-12. Link Delay Times for RAC 3X: ANSI Rates

RAC3X	ms
32DS1,40M,QPSK	0.65
70DS1,40M,16Q	0.45
84DS1,50M,16Q	0.45
84DS1,40M,32Q	0.45
100DS1,50M,16Q	0.4
100DS1,40M,32Q	0.4
1OC3,50M,16Q	0.19
1OC3,40M,64Q	0.19

RAC3X	ms
1OC3,30M,128Q	0.19
2OC3,50M,256Q	0.13

RAC Front Panel Layout

Figure 3-14 shows the front panel layout. Table 3-13 describes the interfaces.

Figure 3-14. RAC 30V3 Front Panel Layout

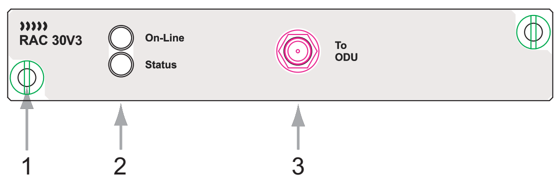


Table 3-13. RAC 30V3 and RAC 3X Front Panel Description

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	On-Line LED	On-Line LED provides indications of:	
		Off	INU off-line or ODU transmit muted
		Green	RAC is online with transmit or receive active[1]
		Red	No receive signal from the ODU
	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[2]
		Red	Critical RAC or ODU alarm[3]
3	ODU connector	SMA type for ODU jumper cable connection	

1. The transmit active *or* receive active criteria supports all configurations including diversity where one RAC is transmitting and receiving and the other receiving only.
2. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.
3. Includes alarm situations caused by component or power supply failure and transmit or receive path failure.

RAC 40

With the exception of its CCDP XPIC capability and the capacity/bandwidth options supported, RAC 40 operation is similar to RAC 30.

RAC 40 SW Compatibility

From SW 4.0 a modem profile selection capability supports over-air compatibility between Standard and Legacy RAC 40 operation.

- For SW release 3.4 the modem profile for the RAC 40 in the horizontal plane was changed to improve performance. It was also changed in the vertical plane, but only for a 64xE1 capacity selection.
  - A RAC 40 operating with SW prior to 3.4 has a 'Legacy' modem profile.
  - A RAC 40 operating with SW from 3.4 has a 'Standard' modem profile.
  - A RAC 40 with a Legacy profile will not communicate with a RAC 40 that has a Standard modem profile.
- With 4.0 SW and later a capability is provided to support over-air compatibility by allowing selection between Legacy or Standard modem profiles.
  - This is capability is only used during the SW upgrade process where the INU/INUe at one end is loaded with 4.0 or later, and the other end is still running 3.3 or earlier.
  - When both ends are running 4.0 SW or later, RAC 40s auto-configure both ends to Standard.

From SW release 4.0 the 'Standard' RAC 40 modem profile is used in all instances, except where operation with an INU/INUe running SW 3.3 or earlier is required.

Protected RAC 40 operation is essentially the same as for non-protected, but where a conflict occurs, the decision falls in favour of the Standard modem profile.

For more information, refer to RAC 40 under Link/Ring Configuration Procedure, Volume IV, Chapter 7.

RAC 40 System Options

Refer to Table 3-14 for system options. Note that the capacity supported *on one RF channel* is double the capacity listed in the table; one RAC 40 link is operated on the vertical polarization, the other on the horizontal.

Table 3-14. RAC 40 System Options: ETSI and ANSI

Capacity	Channel Bandwidth	Modulation
52xE1	27.5 / 28 MHz	32 QAM
64xE1	27.5 / 28 MHz	64 QAM
75xE1	27.5 / 28 MHz	128 QAM
1xSTM1	27.5/28 MHz	128 QAM
70xDS1	30 MHz	32 QAM
84xDS1	30 MHz	64 QAM
100xDS1	30 MHz	128 QAM
1xOC3	30 MHz	128 QAM

When used to transport Ethernet data the nominal equivalent Ethernet capacity per RAC 40 is:

- Nx 2 Mbps to 150 Mbps for ETSI, or
- Nx1.5 Mbps to 150 Mbps for ANSI, or
- 150 Mbps for 1xSTM1 or OC3.

XPIC typically provides up to a 20+ dB improvement in polarization discrimination. The actual improvement will depend on the native discrimination provided at antenna alignment, and any reduction of this discrimination caused by atmospheric effects (fading). RAC 40s may also be used in 2+2 hot standby or diversity configurations to provide protected co-channel paths using paired RACs and ODUs on the horizontal and vertical polarizations. Equal-loss couplers must be used with the protected ODUs.

For information on RAC 40 operation and applications refer to Co-channel Operation on page 3-84

RAC 40 FEC incorporates Reed-Solomon encoding with interleaving, plus Viterbi encoding.

Figure 3-15. RAC 40 Plug-in

Figure 3-16 shows the front panel layout. Table 3-15 describes the interfaces.

Figure 3-16. RAC 40 Front Panel Layout

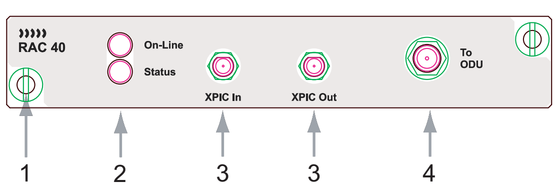


Table 3-15. RAC 40 Front Panel

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2)	
2	On-Line LED	On-Line LED provides indications of:	
		Off	INU off-line or ODU transmit muted
		Green	RAC is online with transmit or receive active[1]
		Red	No receive signal from the ODU
	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[2]
		Red	Critical RAC or ODU alarm[3]
3	XPIC In/Out connectors	SMB type for XPIC cross-connect cables	
4	ODU connector	SMA type for ODU jumper cable connection	

1. The transmit active *or* receive active criteria supports all protected configurations where one RAC is transmitting and receiving and the other receiving only.
2. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.
3. Includes alarm situations caused by component or power supply failure and transmit or receive path failure.

DAC

DACs provide the intermediary between customer interfaces and the digital backplane.

- Different DACs support different circuit rates and formats. Refer to:
  - DAC 4x on page 3-27
  - DAC 16x on page 3-28
  - DAC 3xE3/DS3M on page 3-29
  - DAC 1x155o and DAC 2x155o on page 3-31
  - DAC 155oM on page 3-32
  - DAC 2x155e on page 3-35
  - DAC ES on page 3-36
  - DAC GE on page 3-42
- DACs can be installed in any of the universal slots in an INU or INUe, and in restricted slots in the INUe.
- DACs are field replaceable and hot-swappable.
- Most DACs can be protected. The protectable DACs are DAC 3xE3/DS3M, DAC 1x155o, DAC 2x155o, DAC 155oM, DAC 2x155e. Not protectable are DAC 4x, DAC 16x and the Ethernet DACs. For information on DAC protection, refer to:

   - DAC/Tributary Protection on page 3-76
   - Tributary Protection, Volume IV, Chapter 7.
   - Node Protection Configuration, Volume IV, Chapter 8.
- For data on trib cable wiring and connector pin-outs, refer to Appendix C.
- For information on DAC loopbacks refer to Loopback Points in Volume IV, Chapter 15.
- For information on the integrated PRBS generator and BER test function refer to PRBS Generationin Volume IV, Chapter 15.
- For information on auto AIS/PRBS15 insertion in LOS (loss of signal) conditions, refer to Auto Insertion of AIS or PRBS on Tribs, Volume IV, Chapter 15.

DAC 4x

DAC 4x supports up to 4xE1 or 4xDS1 tributaries.

- E1 options are 75 ohm unbalanced or 120 ohms balanced.
- DS1 encoding options are AMI or B8ZS. Line impedance is fixed at 100 ohms balanced.

Each tributary is accessed via an RJ-45 connector, and cable sets are available, as accessories, to provide:

- RJ-45 to BNC male unbalanced.
- RJ-45 to RJ-45 balanced, straight or crossover.
- RJ-45 to unterminated for balanced wire wrap or punch-down insulation displacement connection.

Figure 3-17 shows the DAC 4x front panel layout. Table 3-16 describes the interfaces.

Figure 3-17. DAC 4x front panel layout

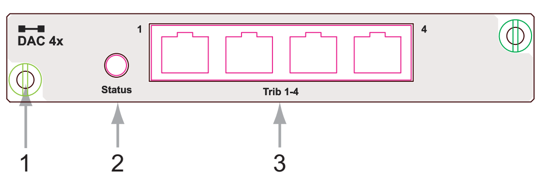


Table 3-16. DAC 4x Front Panel Description

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical alarm: Trib LOS or SW/HW failure
3	Trib. connector assembly	4xRJ-45 type connectors for tributary cable connection	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.

DAC 16x

DAC 16x provides up to 16xE1 or 16xDS1 tributaries.

- E1 options are 75 ohm unbalanced or 120 ohms balanced.
- DS1 encoding options are AMI or B8ZS. Line impedance is fixed at 100 ohms balanced.

Two Mini RJ-21 connectors provide the customer interface, and cable sets are available, as accessories, to provide:

- Mini RJ-21 to sixteen BNC male, unbalanced. Provides connection for eight tribs.
- Mini RJ-21 to eight RJ-45, balanced, straight, or crossover. Provides connection for eight tribs.
- Mini RJ-21 to unterminated tails for balanced wire wrap or punch-down insulation displacement connection. Provides connection for eight tribs.

Figure 3-18. DAC 16x Plug-in

DAC 16x plugs into any of the INU/INUe universal slots. However, because the tributary cables extend to the right (viewed from front), it is recommended that slots to the right side of the INU/INUe are used to avoid impairing access to other plug-ins.

Figure 3-19 shows the DAC 16x front panel layout. Table 3-17 describes the interfaces.

Figure 3-19. DAC 16x Front Panel Layout

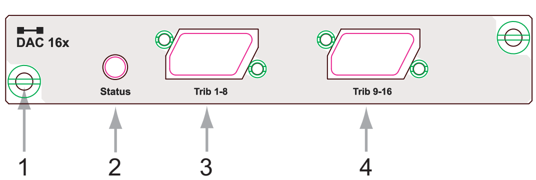


Table 3-17. DAC 16x Front Panel Description

No	Item / Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical alarm: Trib LOS or SW/HW failure
3, 4	Trib. connector	RJ-21 type connectors for tributary cable connection	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.

DAC 3xE3 / DS3M

A DAC 3xE3/DS3M may be configured for:

- 3xE3/DS3 trib access.
- An E13 or M13 multiplexer to multiplex 1x/2x E3 or 1/2x DS3 customer interfaces to/from an E1 or DS1 backplane.
- Transparent (unframed) E3 operation to support 1/2x34 Mbps interfaces.

Operational functions supported include:

- E3 or DS3 transport. Supports one, two or three E3 or DS3 tribs on a backplane bus setting of E3 or DS3 respectively.
- E13 multiplexer, where one or maximum two E3 tributaries (Tx/Rx 1 and Tx/Rx 2) are multiplexed to an E1 backplane bus, each as 16xE1, in accordance with G.703, G.742 and G.751. Operation is compatible with industry standard E13 multiplexers, meaning that at the E3 destination a 3rd party E13 multiplexer can be used. Allows side-by-side transport with other E1 traffic over a 9500 MXC link.
- M13 multiplexer, where one or maximum two DS3 tributaries (Tx/Rx 1 and Tx/Rx 2) are multiplexed to a DS1 backplane bus, each as 28xDS1, in accordance with T1.102 and T1.107. Operation is compatible with industry standard M13 multiplexers, meaning that at the DS3 destination a 3rd party M13 multiplexer can be used. Allows side-by-side transport with other DS1 traffic over a 9500 MXC link
- E3 transparent, unchannelised transport for ATM and video (e.g. MPEG2 video) E3 streams. Each of the two transparent E3 interfaces (Tx/Rx 1 and Tx/Rx 2) provides a 34.368 Mbps connection for transport as 17xE1 over a 9500 MXC NxE1 network. Allows side-by-side transport with other E1 traffic over a 9500 MXC link.

The three E3/DS3 trib ports are presented as paired 75 ohm, unbalanced, mini BNC female connectors.

Trib cables are available, as accessories, to provide:

- Mini BNC male to mini BNC male; two required per trib.
- Mini BNC male to standard BNC male; two required per trib.

DAC 3xE3/DS3M plugs into any of the INU/INUe universal slots. (Within an INUe but where access to NMS overhead is required for a ring-closure application, it must be fitted in slots 1 to 6).

Where protection of the DAC is required (line protection), two DAC 3xE3/DS3M plug-ins can be installed and splitter Y-cables fitted to provide extensions to BNC male connectors.

Figure 3-20 shows the DAC 3xE3/DS3M front panel layout. Table 3-18 describes the interfaces.

Figure 3-20. DAC 3xE3/DS3M Front Panel

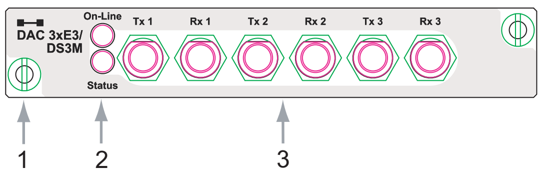


Table 3-18. DAC 3xE3/DS3M Front Panel Description

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	On-Line LED	On-Line LED provides indications of:	
		Off	INU power off
		Green	DAC is online communicating with a remote DAC 3xE3/DS3M
		Red	DAC is off-line
	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical alarm: Trib LOS or SW/HW failure
3	Trib Connectors	Three mini-BNC Tx/RX female connector pairings for 75 ohm unbalanced tributary connection.	
		For E13/M13 Mux and E3 Transparent the two trib interfaces are provided on Tx1/Rx1 and Tx2/Rx2. Tx3/Rx3 is not used - is not active.	
		The standard E3 format is HDB3, and the electrical interface meets requirements defined in ITU G.703.	
		The standard DS3 format is B3ZS, and the electrical interface meets requirements defined in ITU G.703 and ANSI T1.102.	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.

DAC 1x155o and DAC 2x155o

DAC 1x155o provides access for one STM1/OC3, 155 Mbps optical tributary.

DAC 2x155o is identical except it supports two 155 Mbps tribs for twice the capacity.

Operation is transparent to SDH or SONET frame information:

- They incorporate a transparent, non-regenerative architecture; there is no internal clock source / re-synchronization implementation. They are intended for ADM-to-ADM linking where the ADMs provide the clock recovery and signal re-sync options.
  - DAC 1x155o and DAC 2x155o should not installed back-to-back (trib interconnected) over more than 2 hops of 9500 MXC (not more than one DAC-DAC repeated hop).
  - However, there is no practical limit to the number of radio link hops (RAC-to-RAC) between the DACs.

DAC 1x155o and DAC 2x 155o require an STM1/OC3 INU/INUe backplane bus setting.

It plugs into any of the INU/INUe universal slots, and in the INUe restricted slots.

The connectors are SC type, and cable options are available, as accessories, for extension to SC to FC types. SC-SC attenuator cables options are also available.

The receive-level range is -31 dBm (max sensitivity) to -7 dBm (max input power). The transmit level range is: Min -15 dBm to Max -8 dBm.

The SDH optical line code is Binary Scrambled NRZ (Non Return to Zero).

Where protection of the DAC is required (line protection), two DAC 1x155o or DAC 2x155o plug-ins can be installed and splitter Y-cables fitted to provide an extension to single SC Tx and Rx connectors.

Figure 3-21. DAC 155o Plug-in

Figure 3-22 shows the DAC 1x155o front panel layout. Table 3-19 on page 3-32 describes the interfaces.

Figure 3-22. DAC 1x155o Front Panel Layout

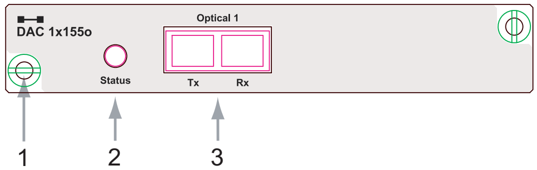


Table 3-19. DAC 1x155o Front Panel Description

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible
		Red	Critical alarm: Trib LOS or SW/HW failure
3	Trib. connector	SC type single mode optical connector	

DAC 155oM

The DAC155oM functions as a *terminal* multiplexer; it terminates or originates the SDH/SONET frame. It does not support *interconnection* of ADMs as there is no provision to transport the STM1/OC3 overheads nor ADM to ADM synchronization over the NxE1 or NxDS1 link transport circuits.

The primary applications are:

- Connection of a 9500 MXC Super-PDH network to an SDH core network.
- Ring closure on a 9500 MXC Super-PDH ring using optical cable.

DAC 155oM multiplexes one line-side STM1/OC3, 155 Mbps optical tributary to/from a 9500 MXC backplane configured for NxE1 or NxDS1.

- On the line side the DAC 150M supports interoperability with external SDH or SONET multiplexers.
- Options are provided for VC3 or VC4 mapping of lower-order backplane E1/DS1 traffic streams to/from STM1. SONET mapping is fixed.
  - SDH with VC3 framing: Three VC3s are mapped into an STM1 signal, each containing up to 21xVC12 or 28xVC11. In turn each VC12 contains 1xE1, and each VC11 1xDS1.
  - SDH with VC4 framing: VC4 directly maps up to 63xVC12 or 84xDS1 into an STM1 signal. In turn each VC12 contains 1xE1, and each VC11 1xDS1.
  - SONET with STS1 framing: Three STS1s are mapped into a SONET signal, each containing 28xVT1, or 21xVT2. In turn each VT1 contains 1xDS1, and each VT2 1xE1.
  - Trip port numbering within the STM1/OC3 frame conforms to G.707.

- Mapping options are provided for bit asynchronous or transparent virtual tributary (TVT) modes. Bit asynchronous is selected on all circuits except those carrying Ethernet data, where TVT mode is required.
- Clocking options are provided for recovered-clock and internal. These options apply to the external line-side connection of the DAC 155oM to another DAC 155oM or to an ADM.
- NMS may be transported within the MSOH or RSOH, access to which is provided within the NMS bytes on the INU backplane.

Figure 3-23. DAC 155oM Plug-in

The connector assembly is an LC type on an SFP (small formfactor pluggable) transceiver module, and cable options are available, as accessories, for extension to SC or FC types. LC-LC attenuator cable options are also available.

Where protection of the DAC is required (line protection), two DAC 1x155oM plug-ins can be installed and splitter Y-cables fitted to provide extensions to single Tx and Rx LC connectors.

When installed in an INUe, it must be located only in slots 1 to 6 when NMS transport over the DAC 155oM is required. If NMS access is not required (no NMS transport over the DAC 155oM), the DAC 155oM may also be installed in slots 7 to 9.

Figure 3-24 shows the DAC 155oM front panel layout. Table 3-20 describes the interfaces.

Figure 3-24. DAC 155oM Front Panel Layout

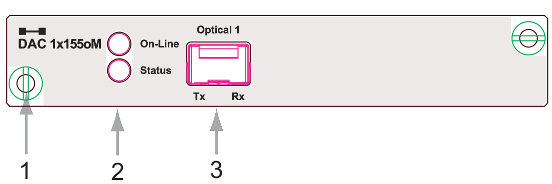


Table 3-20. DAC 155oM Front Panel Description

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).	
2	On-Line LED	On-Line LED provides indications of:	
		Off	INU power off
		Green	DAC is online communicating with a remote DAC 155oM
		Red	DAC is off-line
	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical: Trib LOS or SW/HW failure
3	Optical connector	LC type plug-in transceiver module	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.

The tributary port is provided on a pluggable, modular, single-mode LC transceiver. Two different modules are available; Short range and long range. Both are designed to meet Class 1 eye safety.

- Short range specifies a minimum input power of -34 dBm (max. sensitivity), and a maximum input power of -0 dBm (saturation). Transmit level is maintained between -15 dBm and -8 dBm limits. Center wavelength is maintained between 1261 and 1360 nm. It supports fiber spans up to 15 km.
- Long range specifies a minimum input power of -35 dBm (max. sensitivity), and a maximum input power of -0 dBm (saturation). Transmit level is maintained between -5 dBm and 0 dBm limits. Center wavelength is maintained between 1260 and 1355 nm. It supports fiber spans up to 40 km.

Figure 3-25 shows the plug-in optical transceivers.

Figure 3-25. Optical transceiver modules

DAC 2x155e

DAC 2x155e supports one or two STM1, 155 Mbps electrical tributaries. The trib interfaces are paired, 75 ohm, unbalanced, BNC female connectors.

Operation is transparent to SDH or SONET frame information:

- It incorporates a transparent, non-regenerative architecture; there is no internal clock source / re-synchronization implementation. It is intended for ADM-to-ADM linking where the ADMs provide the clock recovery and signal re-sync options.
  - DAC 2x155e should not installed back-to-back (trib interconnected) over more than 2 hops of 9500 MXC (not more than one DAC-DAC repeated hop).
  - However, there is no practical limit to the number of radio link hops (RAC-to-RAC) between the DACs.

BNC male to BNC male tributary cables are available, as accessories; two required per trib.

DAC 2x155e plugs into any of the INU/INUe universal slots.

Operation is transparent to SDH or SONET frame information.

The SDH electrical line code is CMI (Coded Mark Inversion) as defined in G703.

Where trib protection is required, two DAC 2x155e plug-ins can be installed and splitter Y-cables fitted to provide extensions to single BNC male connectors.

Figure 3-26. DAC 2x155e

Figure 3-27 shows the DAC 2x155e front panel layout. Table 3-21 describes the interfaces.

Figure 3-27. DAC 2x155e Front Panel Layout

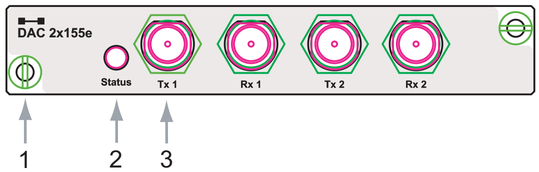


Table 3-21. DAC 2x155e Front Panel Description

No	Item/Label	Description
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).
2	Status LED	Status LED provides indications of: Off — INU power off Green — Normal operation Orange flashing — Configuration not supported, or software / hardware incompatible[1] Red — Critical alarm: Trib LOS or SW/HW failure
3	Trib connectors	Two BNC Tx/RX female connector pairings for 75 ohm unbalanced tributary connection.

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.

DAC ES

DAC ES is a Fast Ethernet plug-in. Refer to:

- DAC ES Description on page 3-36
- Mode of Operation on page 3-38
- Transport Channel Parameters on page 3-39
- Basic Port Settings on page 3-39
- Priority Mapping on page 3-40
- Flow Control on page 3-40
- Disable Address Learning on page 3-41
- Maximum Frame Size on page 3-41
- Diagnostics on page 3-41
- DAC ES Front Panel Layout on page 3-41

DAC ES Description

The DAC ES supports transport of Fast Ethernet traffic. Four 10/100Base-T ports are connected to one or two transport channels for transmission over a 9500 MXC link, with channel capacity configurable in increments of 1.5 Mbps or 2 Mbps to a maximum of 100 Mbps per channel.

DAC ES features include:

- Extremely low latency;

- Programmable switching fabric: transparent mode, VLAN (secure) mode, or mixed mode;
- Capacity increments of Nx1.5 Mbps or Nx2 Mbps;
- Mapping of traffic to radio or fiber links;
- Ethernet traffic can be configured to ride side by side with PDH E1/DS1 traffic, or the full capacity of a link can be dedicated to Ethernet.
- Comprehensive QoS policing and prioritization options (802.1p);
- Flow control through 802.3x pause-frame option;
- Frames sizes to 1536 bytes;
- Comprehensive RMON and performance indicators;
- Compatibility with the DAC GE (from SW release 3.6).

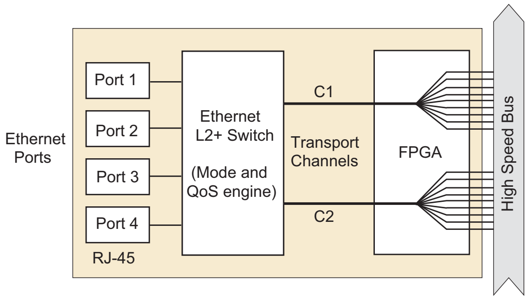
Figure 3-28. DAC ES Plug-in

Figure 3-29 illustrates basic operational blocks within the DAC ES. Four RJ-45 customer ports connect to an Ethernet switch, which provides the bridge/switch and queueing functions between the ports and two transport channels. The gate array (FPGA) provides signal framing and the interface to the backplane bus, with software selection of the number of E1 or DS1 circuits (Ethernet data capacity) used to transport the Ethernet traffic over each transport channel, which may be on a RAC or DAC 155oM.

TThe DAC ES MAC address register supports 2048 entries (from SW release 4.3).

Preamble stripping is used; the frame preamble (8 bytes) is stripped at the Tx end of the link and re-inserted at the far end. It’s benefit is most noticeable with small frame sizes where the preamble represents a more significant part of the total frame size.

Figure 3-29. DAC ES Block Diagram



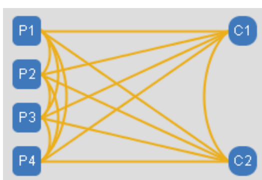
Mode of Operation

DAC ES supports three operational modes, transparent, mixed or VLAN:

Transparent Mode

This is the default, broadcast mode; all ports and channels are interconnected. It supports four customer connections (ports 1 to 4) with bridging to two separate transport channels (C1 or C2).

Figure 3-30. Transparent Mode Port and Channel Assignment

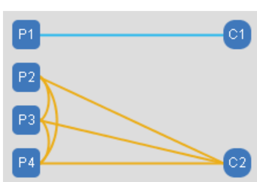


Use only C1 *or* C2 over the *same* radio or fiber path. C1 *and* C2 may be used to support two back-to-back links where each channel is assigned to its own RAC (or RAC and DAC 155oM). Transparent Mode is applicable to ring networks using 9500 MXC ring-wrap protection, with one channel is assigned to the east, the other to the west.

Mixed Mode

Mixed Mode supports two network interconnections where P1-C1 provides dedicated transport for P1 traffic. A second transparent/broadcast mode connection is provided with P1, P2, P3 and C2 interconnected.

Figure 3-31. Mixed Mode Port and Channel Assignment

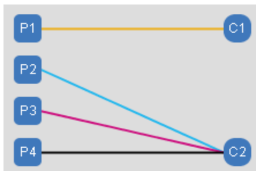


The two channels can be assigned on the same link or used to support separate links. Mixed Mode is particularly applicable to east and west links in an IP ring where alternate-path protection is provided by an external RSTP switch.

VLAN Mode

VLAN Mode supports four separate network interconnections - each is held separate from the other. VLAN 1 is the same as for Mixed Mode, where dedicated transport is provided for port 1 traffic. For Ports 2, 3 and 4, three separate VLANs (VLANs 2, 3 and 4) are supported over C2, with internal VLAN tagging of the packets ensuring correct end-to-end matching of ports over the link.

Figure 3-32. VLAN Mode Port and Channel Assignment



The two channels would normally be assigned on the same link, but can be used to support separate links.

Transport Channel Parameters

Selection is provided for channel type and capacity on a per-channel (C1, C2) basis:

- **Capacity Type** provides selection of NxE1 or NxDS1 transport channels, which must match the backplane bus configuration.
- **Channel Capacity** provides selection, per channel, of Ethernet capacity in multiples of 2 Mbps (2.048 Mbps) or 1.5 Mbps (1.544 Mbps):
  - For Nx2 Mbps the maximum capacity per channel is 98 Mbps.

    Both channels can be sent over the same link to support two separate LAN connections of up to 98 Mbps each, or used to support a ring network[3], with one 98 Mbps channel to the west, the other to the east.
  - For NxDS1 the maximum channel capacity for one channel is 100 Mbps.

    Using both channels the maximum configurable capacity is 172 Mbps due to a 112x circuit maximum within the DAC ES (112x1.544 Mbps).

    Both channels can be sent over the same link to support two separate LAN connections of up to 86 Mbps each, or used to support separate links in an 86 Mbps ring network.
  - Where both channels are to be sent over the same link, the aggregate total cannot exceed 150 Mbps for RAC 30 or RAC 40. For higher aggregate capacities (to the aggregate maximum of both DAC ES channels) use RAC 3X.

Basic Port Settings

Customer selection/confirmation is provided for the following port parameters:

Enabled

A port must be enabled to allow traffic flow.

Name

A port name or other relevant port data can be entered.

Connection Type and Speed

3 *Applies to RSTP protected ring/mesh networks using an external RSTP switch.*

Provides selection per-port of auto or manual settings for half or full duplex operation on speeds of 10 Mbps or 100 Mbps. In auto, the DAC ES self-sets these options based on the traffic type detected.

Interface Cable Type

Provides selection per port of auto or manual settings for the interface cable type; Mdi or MdiX (straight or cross-over cable respectively).

Priority

Provides selection per-port of priority options low, medium low, medium high, and high. This prioritization only has relevance to ports using a shared channel. Ports with a higher priority have their data accepted by the queue controller ahead of the lower priority ports on a 8:4:2:1 weighted basis where, for example, 8 high priority packets are sent for every one low priority packet.

Port Up

Indicates that a valid Ethernet connection with valid Ethernet framing has been detected.

Resolved

Indicates the DAC ES has resolved a connection for speed-duplex.

Priority Mapping

Provides selection of queue-controller operation for the following options. This selection applies to *all* ports.

- Port Default allows priority to be set on a per-port basis (priority options low to high - see Basic Port Settings above). It ignores any 802.1p VLAN priority tags or IP DiffServ priority values. This selection only has application where two or more ports share a common channel.
- 802.1p provides prioritization based on the three-bit priority field of the 802.1p VLAN tag. Each of the possible eight tag priority values are mapped into a four-level (2-bit) priority level.
- DiffServ provides prioritization based on the six bits of the IP packet DiffServ or Type of Service byte. Each of the possible 64 levels are mapped into a four-level (2-bit) priority level.
- 802.1p-then-DiffServ provides prioritization based first on the 802.1p VLAN tag, and then on the DiffServ or Type of Service byte.
- DiffServ-then-802.1p provides prioritization based first on the IP packet DiffServ or Type of Service byte, then on the 802.1p VLAN tag.

Flow Control

Flow Control is an option for full-duplex links only. It is implemented through use of IEEE 802.3x PAUSE frames, which tell the remote terminal to stop or restart transmission to ensure that the amount of data in the receive buffer does not exceed a ‘high water mark’.

- The receiver signals to the transmitter to stop transmitting until sufficient data has been read from the buffer, triggered by a ‘low water mark’, at which point the receiver signals to the transmitter to resume transmission.

- To be effective, flow control must be established from the originating source through to the end point, and vice versa, which means the equipment connected to the DAC ES ports and beyond should also be enabled for flow control.

Disable Address Learning

Address Learning is default implemented to support efficient management of Ethernet traffic in multi-host situations. The option to disable Address Learning is primarily for use in a ring network where protection for the Ethernet traffic is provided by an external RSTP switch. To avoid conflict between the self-learning functions within the DAC ES and the external RSTP switch during path failure situations, the DAC ES capability *must* be switched off.

Maximum Frame Size

Maximum Frame Size sets the largest size frame for the interface, which determines the largest datagram than can be transmitted without it being broken down into smaller units (fragmented). Although CT indicates settable frame sizes from 64 to 1536 bytes, it currently supports sizes of 1518/1522, or 1536 bytes (1518 for non-tagged frames, 1522 for tagged frames).

Diagnostics

CT diagnostics screens capture Ethernet performance and history. The data for DAC ES includes:

- Port/channel status.
- Configured capacities.
- Graphed current Rx and Tx throughputs and discards per port and channel.
- Graphed historical Rx and Tx throughputs, frame type and discards per port and channel.
- Historical statistics per port and channel.
- Comprehensive RMON performance statistics per port and channel.
- Event history.

For more information refer to Volume IV, Chapter 15 for:

- System/Controls DAC ES and DAC GE Menu
- Ethernet Performance
- History Screen: Ethernet

DAC ES Front Panel Layout

Figure 3-33 shows the DAC ES front panel layout. Table 3-22 describes the interfaces.

Figure 3-33. DAC ES Front Panel Layout

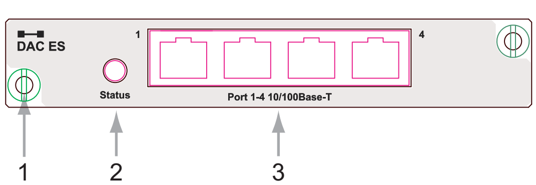


Table 3-22. DAC ES Front Panel Descriptions

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and plug-in pull (2).	
2	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical alarm[2]
3	RJ-45 Port Connector Assembly	Four RJ-45 connectors labelled Ports 1 to 4 provide 10/100Base-T access to customer networks. Internally, the interface implements an ethernet bridging/switching function. Each RJ-45 port connector includes Activity and Connection LEDs:	
	Ethernet orange LED	Orange flashing LED indicates Ethernet receive activity. Off indicates no receive activity.	
	Ethernet green LED	Green LED indicates connection of an Ethernet link. Off indicates no Ethernet link connection.	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.
2. Indicates a traffic-affecting hardware failure.

DAC GE

The DAC GE is a Gig-Ethernet plug-in. Refer to:

- DAC GE Description on page 3-42
- DAC GE Modes of Operation on page 3-45
- DAC GE Transport Channels on page 3-48
- DAC GE Basic Port Settings on page 3-48
- DAC GE Priority Mapping on page 3-49
- DAC GE Flow Control on page 3-49
- DAC GE Disable Address Learning on page 3-50
- DAC GE Maximum Frame Size on page 3-50
- Link Aggregation on page 3-50
- RWPR on page 3-52
- VLAN Tagging on page 3-53
- Ethernet Diagnostics on page 3-53
- DAC GE Front Panel Layout on page 3-53

DAC GE Description

The DAC GE plug-in supports transport of Gigabit Ethernet LAN traffic. Three 10/100/1000Base-T ports and one SFP 1000Base-LX optical transceiver port are connected to one or two 155 Mbps transport channels for transmission over a 9500 MXC link.

Features include:

- Extremely low latency, less than 360 microseconds for 2000 byte packets;
- Programmable switching fabric transparent mode, VLAN (secure) mode, or mixed mode;
- Capacity increments of Nx1.5 Mbps, Nx2 Mbps, or Nx150 Mbps;
- Mapping of traffic to radio or fiber links;
- Ethernet traffic can be configured to ride side by side with PDH E1/DS1 traffic, or the full capacity of a link can be dedicated to Ethernet.
- Comprehensive QoS policing and prioritization options (802.1p);
- VLAN tagging (VID and priority mapping).
- QinQ (802.1ad);
- RWPR^{TM} enhanced RSTP (802.1d);
- Layer 2 link aggregation (802.3ad), and layer 1 link aggregation;
- Flow control through 802.3x pause-frame option;
- Jumbo frames to 9600 bytes;
- Comprehensive RMON and performance indicators;
- Compatibility with the DAC ES for Nx1.5 Mbps and Nx2 Mbps traffic selections (from SW release 3.6).

Figure 3-34. DAC GE Plug-in

Figure 3-35 illustrates the DAC GE basic operational blocks. Three RJ-45 10/100/1000Base-T ports and one SFP (Small Form-factor Pluggable) Optical 1000Base-X port connect to an Ethernet switch, which provides the bridge/switch and queueing functions between the ports and two transport channels, C1 and C2. The gate array (FPGA) provides signal framing and the interface to the backplane bus, which provides the channel interconnection to a link (RAC or DAC 155oM). The backplane bus can be configured for E1, DS1 or STM1/OC3 operation. With E1 or DS1 selections Ethernet traffic can be configured to ride side by side with PDH E1/DS1 traffic, or the full capacity of a link can be dedicated to Ethernet. The DAC GE MAC address register supports 8192 entries.

- The switch analyzes the incoming Ethernet frames for source and destination MAC addresses and determines the output port/channel over which the frames will be delivered.
- Payload throughputs are determined by the configured port and channel speeds (bandwidth), QoS settings, and internal and external VLAN information.
- Ethernet throughputs supported on the two transport channels depend on the backplane bus setting:
  - For a 2 Mbps / E1 or 1.5 Mbps / DS1 backplane the channel capacity selections support:
    - A maximum of 200 Mbps on one channel (C1 or C2), or 200 Mbps total using both channels.
    - Capacity selections are made in multiples of 1.5 Mbps or 2 Mbps.
  - For an STM1 backplane the channel capacity selections support:
    - 150 Mbps on channel C1 or C2
    - 300 Mbps on channel C1 or C2
    - 150 Mbps on both C1 and C2

Figure 3-35. DAC GE Block Diagram

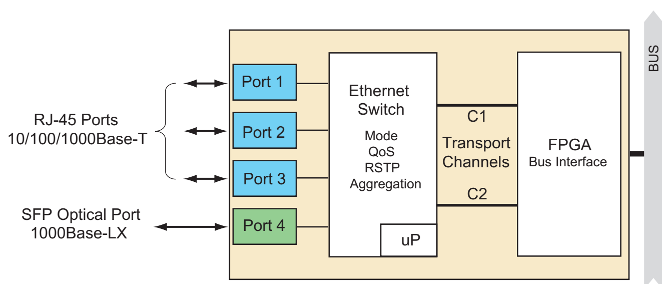


Table 3-23. SFP Optical Port Specifications

Wavelength:	1310 nm
Maximum launch power:	-3 dBm
Minimum launch power:	-9.5 dBm
Link distance	Distances to 10 km / 6 miles with 9/125 µm optical fiber; 550m / 600 yards with 50/125 µm or 62.5/125 µm fiber

NOTE: Nominal throughputs in Mbps are generally used. For example a 150 Mbps or 300 Mbps throughput has a measured maximum for a 1518 byte frame of 152 or 308 Mbps respectively.

DAC GE Modes of Operation

DAC GE supports three operational modes, transparent, mixed or VLAN, which determine the port-to-port and port-to-channel relationships within the L2 switch.

RWPR-enhanced RSTP may be enabled with transparent, mixed or VLAN modes, though for most applications transparent is selected.

Transparent Mode

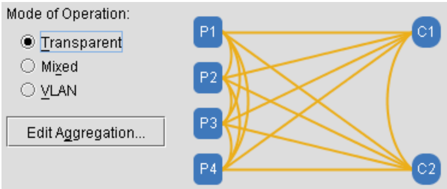
Transparent Mode supports options for layer 2 (L2) link aggregation, where traffic on transport channels, or on channels and ports is aggregated onto a common user interface with a capacity that is the sum of the individual link capacities.

For information on layer 2 and layer 1 link aggregation refer to Link Aggregation on page 3-50.

- **Transparent Mode with Aggregation Disabled**

  This is the default, broadcast mode. With link aggregation disabled all ports and channels are interconnected. It supports four customer LAN connections (ports 1 to 4) with bridging to two separate transport channels (C1 or C2).

  Figure 3-36. Transparent Mode with Aggregation Disabled

  To avoid a traffic loop only C1 *or* C2 is used over the same radio path. C1 *and* C2 may be used where the DAC GE supports two back-to-back ring links where one channel is assigned to the east, the other to the west.

- **Transparent with Aggregation**

  Options are provided to select channel and/or port aggregation.

  A channel selection applies where C1 and C2 to are each to be mapped to a RAC or DAC 155oM in the same INU as the DAC GE. A typical application is the co-channel XPIC assignment of two 150 Mbps links to provide a 300 Mbps aggregate capacity over one 28 MHz or 30 MHz radio channel.

  A channel plus port selection applies where the link or links to be aggregated are installed on separate, co-located INUs.

  - Two INUs, each with a DAC GE and a RAC 3X are used to provide a 600 Mbps aggregate capacity.
  - Three INUs are used to provide a 900 Mbps aggregate capacity.

  Aggregation weighting refers to the way the aggregation keying process allocates traffic between the aggregated link grouping. 16 keys are provided and traffic is randomly assigned to a key. With two aggregated links of equal capacity the weighting (number of keys) should be split 8/8. With three aggregated links of equal capacity the split should be 5/5/6. The aggregation weights must be assigned such that they always total 16.

  Balanced aggregation weights are default applied, but where one of the aggregated links is of different capacity, such as a 300 Mbps link aggregated with a 150 Mbps link, the weighting on the 300 Mbps link should be set to 11, and to 5 on the 150 Mbps link.

Figure 3-37 illustrates C1 and C2 aggregation; traffic on channels C1 and C2 is aggregated and bridged to ports P1 to P4 to support a common LAN on all ports. The default weighting applied is 8/8.

Figure 3-37. Transparent Mode with C1 and C2 Aggregation

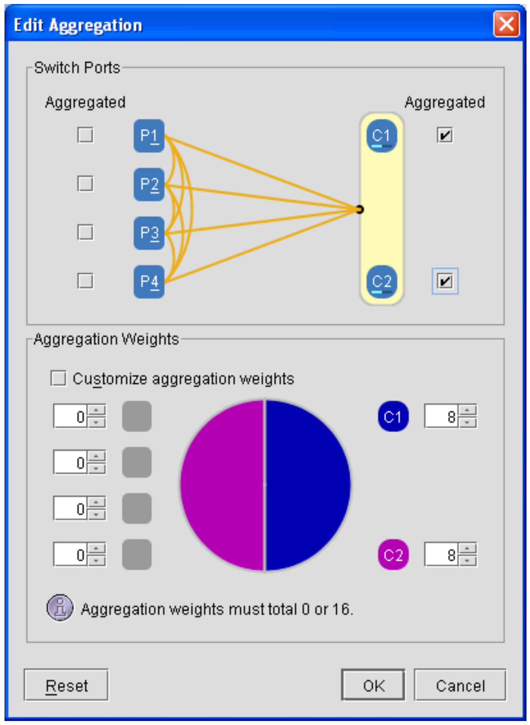
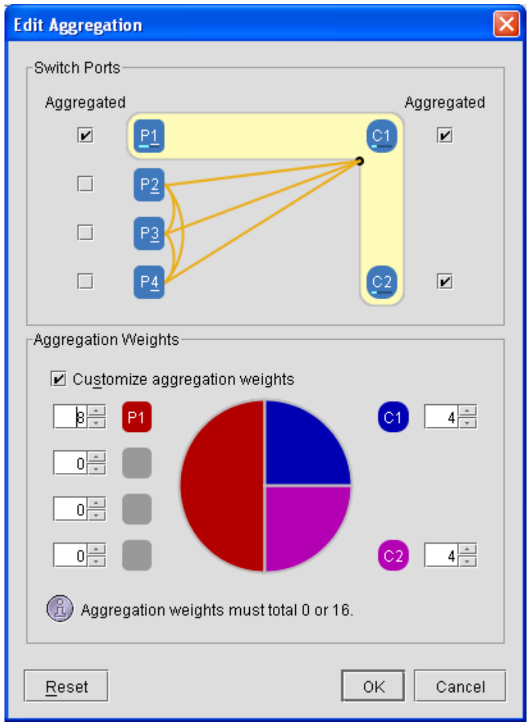


Figure 3-38 illustrates C1, C2 and P1 aggregation, and the use of customized aggregation weighting for an application where C1 and C2 are each mapped to a 150 Mbps link, and P1 to a 300 Mbps link on a co-located INU. 8 keys are assigned to the 300 Mbps, and 4 to each 150 Mbps link.

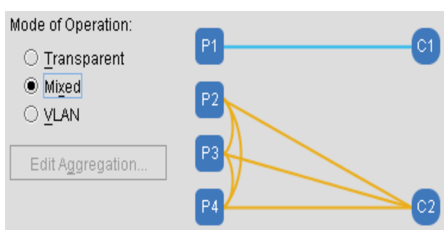
Figure 3-38. Transparent Mode with C1, C2 and P1 Aggregation



Mixed Mode

Mixed Mode provides a two-LAN solution where LAN P1-C1 provides dedicated transport for port 1 traffic. A second transparent/broadcast mode LAN connection is provided with P1, P2, P3 and C2 interconnected.

Figure 3-39. Mixed Mode Port and Channel Assignment

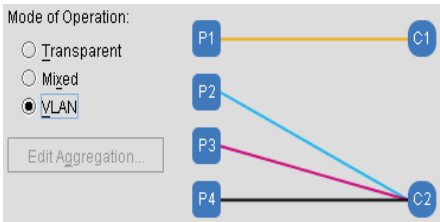


Normally the two channels would be assigned on the same path, but they may be used to support east and west paths in a ring network using an *external* RSTP switch, where C1 is assigned to one direction and C2 to the other.

VLAN Mode

VLAN Mode supports four separate LANs. LAN 1 is the same as for Mixed Mode, where dedicated transport is provided for port 1 traffic. For ports 2, 3 and 4, three separate (virtual) LANs (VLANs 2, 3 and 4) are multiplexed to C2, with internal tagging of the packets ensuring correct end-to-end matching of LANs over the link.

Figure 3-40. VLAN Mode Port and Channel Assignment



Normally the two channels would be assigned on the same path, but they may be used to support east and west paths in a ring network using an *external* RSTP switch, where C1 is assigned to one direction and C2 to the other.

DAC GE Transport Channels

Channel Type

Channel type is selected for 2 Mbps, 1.5 Mbps or 150 Mbps.

- With a 2 Mbps or 1.5 Mbps backplane selected, DAC GE is compatible with DAC ES (DAC GE at one end of the link and DAC ES at the other.
- With 2 Mbps or 1.5 Mbps backplane selected, DAC GE traffic can be mapped to a RAC, or to a DAC 155oM for a fiber link.
  - A RAC 30 or RAC 40 supports throughputs to 150 Mbps
  - A RAC 3X supports throughputs to 200 Mbps
  - The DAC 155oM supports throughputs to130 Mbps
- With 150 Mbps backplane selected, DAC GE traffic can only be mapped to a RAC 30 or RAC 40 for 150 Mbps, or to a RAC 3X for 300 Mbps.

Channel Capacity[4]

Channel capacity is selected on a per-channel basis (C1, C2):

- Channel capacity provides selection of one or two transport (link) channels.
- The maximum assignable capacities[5] for one channel or over both channels are:
  - 200 Mbps in 2 Mbps (2.048 Mbps) steps
  - 196 Mbps in 1.5 (1.544 Mbps) steps
  - 300 Mbps in 150 Mbps (155.52 Mbps) steps

DAC GE Basic Port Settings

Supports the following port parameters:

[4] *Nominal capacities are generally used to represent Ethernet capacities, for example the maximum assignable capacity of 204.8 Mbps (100x 2.048 Mbps) is shown as 200 Mbps.*

[5] *Note that 200 Mbps also represents the backplane capacity maximum for an INU/INUe configured for an Nx2 Mbps or Nx1.5 Mbps backplane. Similarly, 300 Mbps represents the backplane maximum for an Nx150 Mbps backplane setting.*

Enabled

A port must be enabled to allow traffic flow.

Name

A port name or other relevant port data can be entered.

Speed-Duplex

Provides selection per-port of auto or manual settings for speed, and half or full duplex operation.

Interface Type

Provides selection per port of auto or manual settings for the physical interface. The manual settings are Mdi or MdiX (straight or cross-over respectively).

Priority

Provides a four-level, low, medium-low, medium-high or high priority setting for each port. This prioritization only has relevance to ports using a shared channel. Priorities are fair-weighted to ensure that low priority traffic gets some bandwidth when availability is restricted.

Port Up

Indicates that a valid Ethernet connection with valid framing has been detected.

Resolved

Indicates auto-resolution of speed and duplex for an Auto or 1000 Mbps selection.

DAC GE Priority Mapping

Provides selection of queue-controller operation for the following options. This selection applies to *all* ports.

- Port default. Enables the setting of a four-level port priority on each of the four ingress ports. See DAC GE Basic Port Settings above.
- 802.1p provides prioritization based on the three-bit priority field of the 802.1p VLAN tag. Each of the possible eight tag priority values are mapped into a four-level (2-bit) priority level. Mapping is user configurable.
- DiffServ provides prioritization based on the six bits of the IP packet DiffServ or Type of Service byte. Each of the possible 64 levels are mapped into a four-level (2-bit) priority level. Mapping is user configurable.
- No priority. Incoming packets are passed transparently.

DAC GE Flow Control

Flow Control is implemented through use of IEEE 802.3x PAUSE frames, which tell the terminal node to stop or restart transmission to ensure that the amount of data in the receive buffer does not exceed a ‘high water mark’.

- The receiver signals to the transmitter to stop transmitting until sufficient data has been read from the buffer, triggered by a ‘low water mark’, at which point the receiver signals to the transmitter to resume transmission.
- To be effective, flow control must be established from the originating source through to the end point, and vice versa, which means the equipment connected to the DAC GE ports and beyond should also be enabled for flow control.

DAC GE Disable Address Learning

Address Learning is default implemented to support efficient management of Ethernet traffic in multi-host situations. The option to disable Address Learning is for use in a ring network where protection for the Ethernet traffic is provided by an *external* RSTP switch. To avoid conflict between the self-learning functions within the DAC GE and external RSTP switches during path failure situations, the DAC GE capability *must* be switched off.

DAC GE Maximum Frame Size

Maximum Frame Size sets the largest size frame for the interface, which determines the largest datagram than can be transmitted without it being broken down into smaller units (fragmented). The DAC GE supports jumbo-frames to 9600 bytes; configurable range is 64 to 9600 bytes.

Link Status Propagation

Link Status Propagation is enabled to enhance rapid detection by externally-connected equipment of the status of a DAC GE channel. It does so by capturing the channel status (up/down) on the DAC GE ports to force a port shutdown in the event of a channel failure, such as a radio link failure. A port shutdown is immediately detected by the connected equipment.

For example, when operating with an external RSTP switch, a failure on a DAC GE transport channel is reflected directly to the external user device through a DAC GE port shut-down to support improved link failure detection times for these devices, compared to the times needed for conventional hello time-out or polling time-out using control frames.

It also applies to DAC GE L2 link aggregation, when *co-located* INUs are installed to provide the physical links. Link aggregation functionality depends directly on the aggregated port status to confirm the operational status of the aggregated link.

For more information on link status propagation, refer to Procedure for DAC GE Configuration, Volume IV, Chapter 7.

Link Aggregation

Link aggregation brings together two or more links to support a single interface with a traffic capacity that is the sum of the individual link capacities.

Link aggregation also supports redundancy. If one link fails, then capacity available on the remaining link or links is shared. While the reduced bandwidth may result in some traffic loss for low-priority traffic, it should ensure security for all higher priority traffic.

For 9500 MXC two modes of link aggregation can be configured with the DAC GE, layer 2 (L2) or layer 1 (L1):

- L2 link aggregation uses source and/or destination MAC address data in the Ethernet frame MAC/LLC header to determine which traffic stream is to be forwarded over which link.

- The assignment (load balancing) of traffic between links generally ensures that traffic is distributed equitably so that no one link is overwhelmed. The weighting mechanism used operates well where there are many MAC sessions in play. However it is not effective where one source/destination MAC address is in play, such as between two routers, and has limited effectiveness where a few (less than 10) concurrent sessions are in play, especially so where one or two traffic streams dominate throughput on one link.
- The weighting mechanism operates with link aggregation keys (LAKs), where 16 such keys are split between the aggregated channels, and/or ports. In turn, traffic (MAC sessions) are randomly assigned to a LAK.
- Normally (default), the 16 LAKs are split evenly, or near-even for an odd-number split, between the aggregated channels and/or ports. For example where two channels are configured for link aggregation 8 LAKs are assigned to each; for two channels and one port, 6 LAKs are assigned to the port and 5 to each of the channels.
- CT provides a tool to customize this splitting of LAKs between channels and ports, which has particular application where links of different capacities are used. For example to provide even (near even) load balancing between a 300 Mbps link and a 150 Mbps link, 10 LAKs can be assigned to the 300 Mbps link, and 6 to the 150 Mbps link. The number of LAKs assigned must always total 16.
- In this way two, three, or four links may be link-aggregated to provide an aggregated maximum up to1000 Mbps.
- L2 link aggregation is enabled within the DAC GE Operational Mode settings.

- L1 link aggregation uses the circuit cross-connects on the INU/INUe backplane bus to split DAC GE transport channel traffic between two separate links.
  - Ethernet traffic is split equally between the link timeslots on a byte basis (parallel bus) meaning data within an Ethernet frame is transported across both links.
  - Links do not need to be configured for equal capacity.
  - Compared to L2 aggregation it provides optimum payload balance regardless of the throughput demands of individual user connections. Whether there is one, a few or many concurrent sessions, traffic is always split between the links based on the configured capacity of the links.
  - In the event one link is lost its traffic is assigned to the remaining link.
  - One or both DAC GE transport channels can be configured for L1 link aggregation.

L2 and L1 link aggregation can be deployed in tandem. For example where two DAC GEs are used to support four co-path links, L1 aggregation can be used for transport channel aggregation, and L2 for aggregating the traffic between the DAC GEs.

For applications where just two physical links are to be aggregated L1 aggregation is recommended as it supports equitable loading (load balancing) regardless of the number of data sessions in play. It also supports higher burst speeds compared to L2 aggregation.

For more information on aggregation refer to Link Aggregation on page 7-66, Volume IV, Chapter 7.

RWPR

RWPR is enhanced (fast-switched) RSTP. The ring network *topology* is established and maintained using RSTP, but with RWPR the reconvergence times are reduced to carrier-class standards.

- While the topology change mechanism under RWPR is identical to that specified for RSTP within IEEE 802.1D-2004, the process used to initiate a topology change is accelerated using the RWPR rapid failure detection (RFD) algorithm to bypass the normal RSTP time-out period associated with Hello BPDUs (bridge protocol data units).
- The end result is that when a 9500 MXC link (point-to-point link) in an RWPR network fails (SW, equipment, path, or diagnostic failure event), it triggers the RWPR RFD algorithm, which immediately forces an RSTP switch-port state from discarding to forwarding, and from that point forward, RSTP action manages the topology change.

RFD (the RFD algorithm) is a patent-pending product. It accelerates the normal processes used to achieve RSTP switching on an Ethernet ring/mesh to bring typical service restoration or re-convergence times of 2 to 5 seconds down to as low as 50 ms.

- The RFD mechanism inserts an end-to-end link monitoring signature into the transport channel VC (virtual container) at 500 us intervals. This signature allows each end to rapidly detect a link status change at the local end and to provide feedback to the far-end. Capacity/bandwidth dependent thresholds are established to prevent oscillations or false alarms on noisy channels. The signature elements are related to a radio's BER, AIS, ES and SES, but not directly.
- The failure detection algorithm provides an end-to-end solution. It is agnostic to the number of hops required by the transport channel to get the payload across the radio link(s).
- The failure detection algorithm resolves both unidirectional and bi-directional failures.
- The failure detection algorithm operates autonomously in its detection of a failure. It does not depend on other alarms or signals available in the system to determine a failure. The algorithm is also independent of the presence of payload traffic.
- The failure detection algorithm also automatically recovers from a failure. The protocol used for failure detection remains in operation (attempting to re-establish communication with the far-end) after a failure takes place. This allows the algorithm to recover automatically when the link is restored.

RSTP. On a DAC GE, two or more channels/ports are enabled as RWPR (RSTP) bridge ports, the bridge is assigned a priority, and each port is assigned a cost and a priority to assist RSTP election of a root switch, and root and alternate ports. When a ring path failure has been detected (RFD), the RSTP topology change mechanism forces the following action:

- On the immediately affected switches (DAC GEs), link port states that were 'discarding' are moved to 'forwarding', and this triggers a BPDU with a topology change notification (TCN) message. It also MAC flushes these ports.
- When a BPDU with TCN flag is received from its neighbor switch, it MAC flushes all link (non-edge) ports except the one that it received the TCN on. It then on-sends the BPDU with the TCN flag to its designated ports and root port (except for the one it received the TCN on).
- In this way the topology change mechanism is propagated rapidly through the network.

For more information on RWPR settings refer to DAC GE Configuration, Volume IV, Chapter 7.

VLAN Tagging

DAC GE supports 802.1q tagging with menus for selection of VLAN tagging modes, and priority settings for tagged-traffic. Diagrams assist understanding of the tagging action for each mode.

The tagging options are Do Nothing, Q-in-Q, or 802.1q. Selections are made on a per-port basis.

- With Q-in-Q, frames with existing tags are tagged (double tagged).
- With 802.1q untagged frames are tagged.
- The tagging options of Q-in-Q and 802.1q are only available for Transparent mode and on ports P2 to P4 for Mixed mode. Do Nothing is fixed for VLAN mode and for P1 of Mixed mode

A VLAN ID can be entered (range 0 to 4095) or left as default.

A VLAN membership filter is also provided. Only VLAN IDs within the membership range are allowed to transit the relevant port/channel.

With this VLAN tagging capability, DAC GE can tag, 802.1p prioritize, and aggregate LAN traffic from two, three or four ports onto a common trunk/channel. At the far end of the DAC GE trunk, which may be over multiple hops, the options are to remove the VLAN tags applied by DAC GE, or allow them to be retained intact for VLAN traffic management at downstream devices.

Ethernet Diagnostics

CT diagnostics screens capture Ethernet performance and history. The data for DAC GE includes:

- Port/channel status.
- Configured capacities.
- Graphed current Rx and Tx throughputs and discards per port and channel.
- Graphed historical Rx and Tx throughputs, frame type and discards per port and channel.
- Historical statistics per port and channel.
- Comprehensive RMON performance statistics per port and channel.
- Event history.

For more information refer to Volume IV, Chapter 15 for:

- System/Controls DAC ES and DAC GE Menu
- Ethernet Performance
- History Screen: Ethernet

DAC GE Front Panel Layout

Figure 3-33 shows the DAC GE front panel layout. Table 3-22 describes the interfaces.

Figure 3-41. DAC GE Front Panel Layout

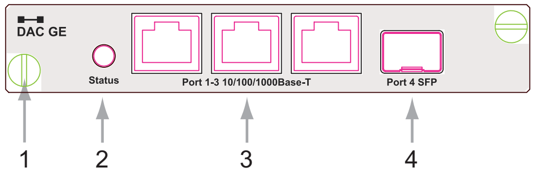


Table 3-24. DAC GE Front Panel Descriptions

No	Item/Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and plug-in pull (2).	
2	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical alarm[2]
3	RJ-45 Port Connector Assembly	Three RJ-45 connectors labelled Ports 1 to 3 provide 10/100/1000Base-T access to customer networks. Internally, the interface implements an ethernet bridging/switching function. Each RJ-45 port connector includes Activity and Connection LEDs:	
	Ethernet orange LED	Orange flashing LED indicates Ethernet receive activity. Off indicates no receive activity.	
	Ethernet green LED	Green LED indicates connection of an Ethernet link. Off indicates no Ethernet link connection.	
4	SFP Port	Small Form-factor Pluggable optical transceiver port. LC connector.	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.
2. Indicates a traffic-affecting hardware failure.

AUX

The AUX plug-in provides user-configurable auxiliary data channels, and alarm input and output (I/O) options.

- Up to three AUX plug-ins may be installed in an INU; six in an INUe.
- For an *INUe*, the AUX must only be installed in slots 1 to 6 when NMS access is required. If NMS via AUX is not required, the AUX may also be installed in slots 7 to 9.
- Refer to:
  - Auxiliary Interfaces on page 3-55
  - Alarm I/O Interfaces on page 3-56
  - AUX Front Panel on page 3-58

Figure 3-42. AUX Plug-in

Auxiliary Interfaces

Three auxiliary interfaces are provided. Each may be configured in 9500 MXC CT for synchronous 64 kbps data or serial data to 19.2 kbps.

- Synchronous conforms to TIA/EIA-422 / V.11 at 64kbps, with selectable clock. The source of the transmit clock can be set to internal (provided by the auxiliary card) or external (provided by the user). For an external clock, channel synchronization is supported by a selectable clock phase (rising or dropping edge of the clock pulse).
- Asynchronous conforms to TIA/EIA-562 (electrically compatible with RS-232 / V.24 but via a DB-15 connector rather than a DB-9)
- Asynchronous baud rates are 1200, 2400, 4800, 9600, or 19200bps with the following format options:

  1 start, 7 data, 1 parity, 2 stop

  1 start, 8 data, 1 parity, 1 stop

  1 start, 8 data, no parity, 2 stop

  1 start, 9 data, no parity, 1 stop

  1 start, 7 data, 1 parity, 1 stop

  1 start, 7 data, no parity, 2 stop

  1 start, 8 data, no parity, 1 stop

Refer to:

- Auxiliary Applications
- Auxiliary Data and NMS Functions
- Installation and Operation

Auxiliary Applications

Intended applications are:

- Transport of 3rd party NMS (or other data) over a 9500 MXC network.
- Transport of 9500 MXC NMS over a 3rd party network to a remote 9500 MXC node or network.

Auxiliary Data and NMS Functions

Two data function options are provided on a per-port basis, Data and NMS:

Data Option

Customer auxiliary data is transported within one of up to six discrete 64 Kbps link overhead ports (channels) on each link (RAC or DAC 155oM).

Data type can be configured for asynchronous V.24/RS-232, or synchronous V.11/ RS-422.

The channels share the same overhead as the NMS and INU-INU internal communication.

At intermediate sites, each channel must be re-directed to the next RAC, or DAC 155oM. (An AUX is not required at intermediate sites).

At the destination site, each channel is directed to the required port on the AUX plug-in.

NMS OPtion

9500 MXC NMS is provided for transport over a 3rd party network to a remote 9500 MXC node/network, where it must be ported back in via an AUX.

The data type is default configured for synchronous V.11/RS-422, 64 kbps.

Installation and Operation

For a RAC 30V3, RAC 3X or RAC 40, the maximum radio link overhead capacity is 512 kbps, of which a *minimum* 128 kbps is required for NMS transport. This leaves a maximum 384 kbps (6x 64 kbps) available for auxiliary data transport.

Each end of the link auto-negotiates on the link overhead to assign the maximum available capacity to NMS. When no auxiliary traffic is present, the full overhead is assigned to NMS; when one channel is used 448 kbps is assigned to NMS; for two channels 384 kbps is assigned to NMS, and so on to a minimum 128 kbps.

- For a DAC 155oM, the maximum overhead capacity is 512 kbps, but is only available when the MSOH (Multiplexer Section Overhead) NMS option is selected. If NMS data is assigned to the RSOH (Regenerator Section Overhead), the total NMS overhead is 192 kbps, meaning just one auxiliary data channel can be configured.

Alarm I/O Interfaces

The AUX plug-in provides up to 6 TTL alarm inputs and up to 4 Form C relay outputs. The configuration options are:

- 2 TTL alarm inputs and 4 Form C relay outputs
- 4 TTL alarm inputs and 2 Form C relay outputs
- 6 TTL inputs only (default configuration)

Refer to:

- Alarm Inputs
- Alarm Outputs
- Alarm Application

Alarm Inputs

The active state of each TTL alarm input is configurable to be active if the voltage on the input is high, or active if the voltage is low. The alarm software detects a change in the state of each input circuit, and raises or clears an input accordingly. The nominal alarm polling rate is 1 second. Fleeting changes are ignored.

- Input state changes are captured in the event log as an alarm.
- TTL input thresholds are specified at 2V min high, and 0.8V min low. High voltage (spike) protection to 48V is included.

Alarm Outputs

The output relays may be configured to be energized or de-energized on receipt of an alarm event.

Both normally closed and normally open contacts are available on the I/O connector.

State changes are captured in the event log as an informational event.

Relay contact specifications:

- Maximum Voltage 250 Volts
- Maximum Current 2 Amps
- Maximum Power 60 Watts

Note: These are maximum values, which require de-rating if the relay is to be used for frequent-switch applications.

The contact voltage must be restricted to less than 60 Volts for compliance with SELV regulations.

Maximum current specification applies up to 30 Volts

Alarm Application

Events are mapped to outputs:

- Individual AUX alarm inputs or internal alarm events may be mapped to any output within the network.
- Multiple input or internal events may be mapped to a common output.
- Mapping is achieved using IP addressing for the destination node, plus a slot location and output number for the AUX plug-in.

AUX Front Panel

Figure 3-43. AUX Front Panel Layout

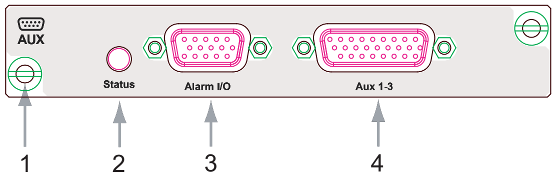


Table 3-25. AUX Front Panel Descriptions

No	Item / Label	Description	
1	Plug-in fastener	Finger-grip screw-type fastener and plug-in pull (2).	
2	Status LED	Status LED provides indications of:	
		Off	INU power off
		Green	Normal operation
		Orange flashing	Configuration not supported, or software / hardware incompatible[1]
		Red	Critical alarm[2]
3	Alarm I/O connector	DSUB 15 connector. Refer to Appendix E for pinout and alarm I/O cable data.	
4	Auxiliary connector	DSUB 26 connector. Refer to Appendix E for pinout and AUX cable data.	

1. Includes situations where the slot configuration does not support the plug-in, or the plug-in requires a later/different version of system software.
2. Indicates a data-affecting hardware failure.

NPC

The NPC provides a protection option for the NCC with backup for TDM bus management (bus clock), and power supply. One NPC can be installed per INU/INUe.

The NPC protects tributary and auxiliary traffic. Alarm I/O is not protected

- Protection switching is not hitless for a TDM bus clock failure. Restoration is within 100 ms, during which time all traffic on the node will be affected.
- Protection is hitless for a power supply failure. If the NCC converter or one of its supply rails fails, the NPC will take over without interruption. And vice versa.

When the TDM bus clock has switched to NPC control, it will not automatically revert to NCC control on restoration of the NCC. Return to NCC control requires either withdrawal/failure of the NPC, or use of diagnostic commands in the System Controls screen.

There is no operational need to revert to NCC for bus clocking. If the clock is with the NPC, and the NPC clock subsequently fails, bus clocking will switch to the NCC.

Figure 3-44. NPC Plug-in

The NPC is field replaceable and hot-swappable (providing the NCC is on line). It plugs into slot 4 of an INU, or slot 10 of an INUe.

An INU/INUe must always *start* with a valid NCC installed; the NPC will provide protection only after a node has been powered up.

Refer to Figure 3-45 and Table 3-26 for front panel interfaces.

Figure 3-45. NPC Front Panel Layout

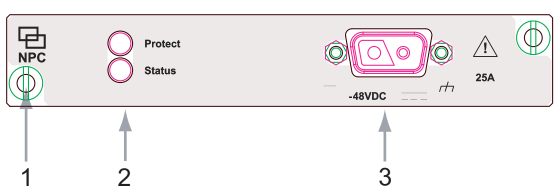


Table 3-26. NPC Front Panel Descriptions

No	Item/Label	Description
1	Plug-in fastener	Finger-grip screw-type fastener and card pull (2).
2	Protect LED	Protect LED provides indications of:
		Unlit Off-line
		Green On-line (providing the bus clock)
	Status LED	Status LED provides indications of:
		Unlit INU/INUe power off
		Green Ready to protect
		Red Critical alarm
3	-48 Vdc connector	2-pin power connector with screw fasteners

Protected Operation

This section provides data on the Node protection options and their operation.

Refer to:

- Protection Overview on page 3-61
- Hot Standby and Diversity on page 3-62
- Dual Protection on page 3-63
- Ring Protection on page 3-64
  - Super PDH Rings on page 3-65
  - Super PDH Ring Operation on page 3-66
  - 1+1 Protected Ring Links on page 3-70
  - Co-channel XPIC Operation on a Ring on page 3-71
- Ethernet Traffic on a Ring on page 3-72
- DAC/Tributary Protection on page 3-76
- Protection Switching Criteria on page 3-77
- NCC Protection with NPC Option on page 3-84

For additional information on protection *operation*, refer to Appendix F. .

Protection Overview

9500 MXC Node includes options for protection of hardware, radio path, tributary, and NCC functions.

Protected operation between an INU and IDUs is not supported. Where protected IDUs are to be used, they must be at both ends of the link.

Hardware and Radio Path Protection

RACs and ODUs are used in pairs to support hot-standby, space diversity, frequency diversity, or ring protection.

Generally speaking *path* protection is about providing for protection against changes in radio-path variables, such as anomalies caused by signal reflection over water or by ducting. Such protection demands hitless (errorless) receive switching between the alternate (protected) radio paths.

Hardware/equipment protection is about providing backup (alternate) hardware that can be switched into service in the event of a hardware failure. Such protection is generally offered with or without hitless receive operation.

- Space or frequency diversity are used for path protection. They also provide hardware protection.
- Hot-standby is used for hardware protection.
- Ring protection is primarily used for hardware protection though through its inherent *route* diversity it does provide protection against localized (single link) *path* failure events. Switching of ring-protected circuits is not hitless.

9500 MXC also supports dual-protection whereby a master protection option protects two subordinate protected links, or one protected link with one non-protected link. 9500 MXC dual protection options are:

- Frequency diversity over hot-standby
- Frequency diversity over space diversity

For more information on dual protection, refer to Dual Protection on page 3-63.

RAC / ODU Protection Partnering

RAC 30 and RAC 3X:

- Supports hot standby and diversity. Rx switching is hitless; Tx switching is not hitless.
- Supports ring protection. Ring switching is not hitless.

RAC 40:

- Supports hot standby and diversity (protected co-channel links). Rx switching is hitless. Tx switching is not hitless.
- Supports ring protection of CCDP XPIC ring links. Each link operates on the same frequency channel, but as separate ring-protected links (Two concentric rings, one on the vertical polarization, the other on the horizontal). Ring switching is not hitless.

Table 3-27. Primary Protection Options

Devices	Protection Type
2x(RAC 30V3 / RAC 3X + ODU 300)	Hot-standby Diversity Ring
4x(RAC 40 + ODU 300) (Protected XPIC co-channel)	Hot-standby Diversity Ring (protected XPIC ring links)

Tributary Protection

E3/DS3 and STM1/OC3 DACs, may be paired to provide hot-standby tributary protection.

The protectable DACs are:

- 2xDAC 3xE3/DS3M
- 2xDAC 155o or
- 2xDAC 2x155o
- 2xDAC 2x155e
- 2xDAC 155oM

Trib protection switching is not hitless.

Except for the DAC 155oM, Tx and Rx tribs are switched independently.

When a switch occurs, all tribs either Tx or RX, or Tx and Rx depending on the failure mode, are switched together.

NCC Protection

The NPC plug-in provides protection for the NCC bus management and power supply functions:

- Bus management switching is not hitless.
- Power supply protection is hitless.

For more information on the NPC and its protection function, refer to NPC on page 3-58.

Hot Standby and Diversity

The INU supports three non-protected links, or one protected plus one non-protected link. The INUe supports up to three protected links.

Two RACs and two ODUs are used for protected operation. For single-antenna protected operation, the two ODUs are direct-mounted on a coupler, which in turn is direct or remote mounted to its antenna.

Space and frequency diversity can be combined to provide hybrid diversity.

Receive path switching is hitless between two online-receiving RAC 30s, RAC 3Xs, and RAC 40s.

Transmit switching for hot-standby and space diversity is not hitless. Refer to Hot-standby and Diversity Switching Criteria on page 3-77.

For single antenna protected operation, equal or unequal loss couplers are available:

- Equal-split has a nominal 3.5/3.5 dB loss per side.
- Unequal-split has a nominal 1.6 /6.4 dB insertion loss.

For more information on coupler losses, refer to Coupler Losses on page 7-17, Volume IV, Chapter 7.

Dual Protection

Dual protection enables master protection of two subordinate protected links, or one protected link with one non-protected link.

The dual protection options are:

- Frequency diversity over hot-standby
- Frequency diversity over space diversity

Table 3-28 summarizes the dual link protection options; two protected subordinate links are in turn protected by a higher, frequency diversity master. All RACs (RAC 30 or RAC 3X) must be located in the same INUe. Except for the Space Diversity pairings where two vertically separated antennas are required, a single dual-polarized antenna can be used.

Table 3-28. Dual Protection Options

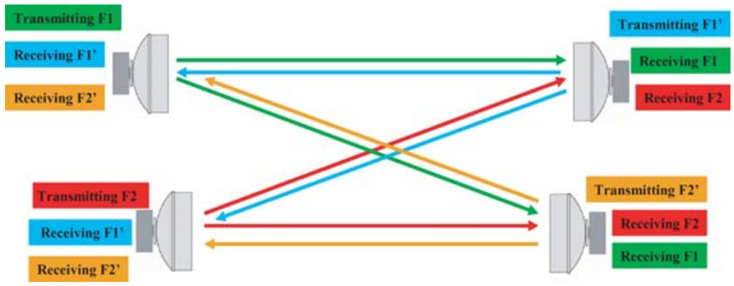
Master Protection	Subordinate Protected Link Pairings	
	Link A	Link B
Frequency Diversity	Hot Standby	Hot Standby
	Hot Standby	Non-protected
	Space Diversity	Space Diversity
	Space Diversity	Non-protected

Figure 3-46 illustrates the action of a frequency diversity master with subordinated space diversity links.

- The two space diversity links are on different frequencies, F1/F1'and F2/F2'[6].
- Both space diversity links are online transmitting.
- At any one time only one of the space diversity links is sending received data to the INUe backplane bus.
- Master protection controls which of the two space diversity links is sending data to the INUe backplane bus; default the secondary link under master (frequency diversity) configuration.

6 *F1/F1' and F2/F2' denotes Tx high and Tx low and its corresponding Rx.*

Figure 3-46. Dual Diversity (Frequency over Space) Tx and Rx Partnering



- Each of the subordinated links are first configured for the protection option required and both must be configured for the same capacity. Subsequently the dual (master) switch protection is applied.
- Normally all RACs would be of the same type (RAC 30 or RAC 3X) but while each of the subordinated protected links must have the same RACs one protected pair may use RAC 30s, the other RAC 3Xs.
- Each subordinated link may operate on different channel bandwidths, and/or different frequency bands.
- Each of the subordinated links operates as a normal link of that configuration and under dual protection only one link of the two is sending received data to the INUe backplane bus at one time.
- With frequency diversity master protection both subordinated links are online transmitting. Subordinated links (hot-standby / space diversity / non-protected) must be configured on different frequency channels.
- With a frequency diversity master switch it is possible to operate with Rx from one protected link, and Tx to the other.
- Dual protection master switching is not hitless. Each of the two subordinated protected links incorporate hitless (errorless) Rx path switching in the normal way, but the master switch between the two subordinated links is not hitless. Refer to Service Restoration Times for Dual Protection.
- For more information refer to Additional Rules for Dual Protection in 9500 MXC CT Volume IV, Chapter 8.

Ring Protection

9500 MXC directly supports ring protection of NxE1 or NxDS1 traffic.

9500 MXC does not support E3/DS3 or STM1/OC3 rings. Where ring protection of such rates is required, an external add/drop mux is required.

9500 MXC directly supports RSTP protection of Ethernet traffic in ring and mesh networks using the DAC GE GigE plug-in.

Refer to:

- Super PDH Rings on page 3-65
- Super PDH Ring Operation on page 3-66
- 1+1 Protected Ring Links on page 3-70
- Co-channel XPIC Operation on a Ring on page 3-71
- Ethernet Traffic on a Ring on page 3-72

For information on maximum ring capacities, refer to Appendix E.

Super PDH Rings

9500 MXC Node supports protected PDH ring configurations for capacities to 75xE1 or 100xDS1, with traffic switching at the INU/INUe level. The rings are implemented by east/west facing RAC and ODU combinations from a single node (INU/INUe). A closed loop is formed when each node is connected to two adjacent nodes, the east and west nodes.

North Gateway or Any-to-Any Ring Topologies are supported.

Within the protected ring there are two traffic rings, one nominated as clockwise, the other anti-clockwise. Under normal no-fault conditions, all traffic is passed on the clockwise *primary* ring.

East, west, clockwise and anti-clockwise descriptors are conventions used to describe and configure 9500 MXC ring operation. The physical implementation of a ring may be quite different.

In the event of a fault the *secondary*, anti-clockwise ring, provides the protection capacity needed. Traffic is looped onto the secondary ring at one side of the break point, and off at the other side, to bypass the break. This process is called *wrapping*.

One or more radio paths can be replaced by a fiber span using the DAC 155oM.

Hot-standby or diversity protection for ring links is scheduled, which has particular application on long and difficult paths (paths subject to fading), using diversity options.

Ring protection protects the payload and alarm I/O addressing between nodes; ring protection does not protect auxiliary data.

North Gateway or Any-to-Any Ring Topologies

Super-PDH ring architecture supports configurations for *North Gateway* or *Any-To-Any* topologies. With North Gateway, one of the nodes operates as the gateway, through which all traffic on the ring is sourced and sent. For any-to-any operation, traffic can be routed from any node in the ring to any other node. In both modes, the E1 or DS1 circuits involved are unique on the ring (cannot be re-used within the ring).

Most ring topologies use a single gateway where all circuits are sourced and sunk. For such rings 64xE1 or 84xDS1 is the nominal ring maximum because of backplane capacity limitations at the gateway, but where a ring incorporates a number of gateways, up to 75xE1 or 100xDS1 can be ring-protected. For information on ring capacity maximums, refer to Appendix E.

Super PDH Ring Operation

This section addresses:

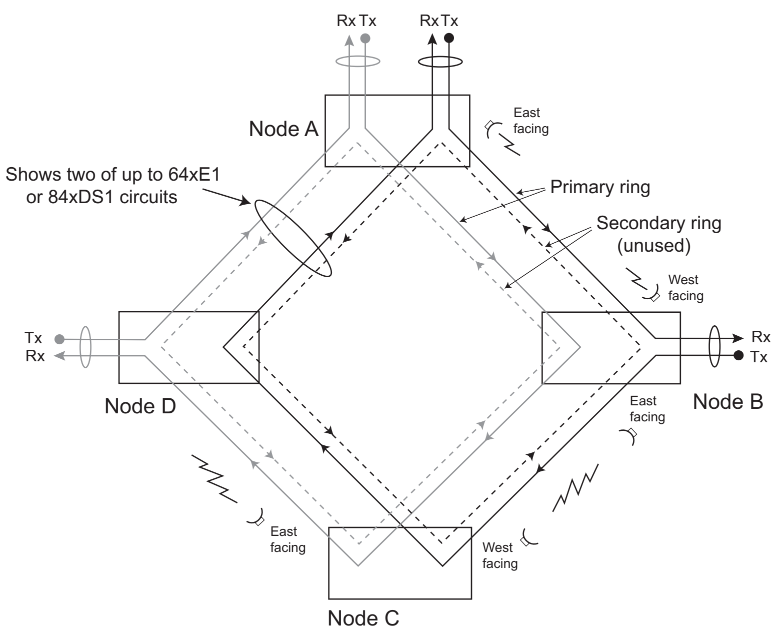
For Ethernet traffic applications, refer to Ethernet Traffic on a Ring on page 3-72

Ring Protection Operation

Figure 3-47 represents normal, no-fault operation for a super-PDH ring. It shows two circuits in a 64xE1 ring routed clockwise around the *primary* ring. Data sent to the ring on an E1 interface exits after travelling *around* the ring.

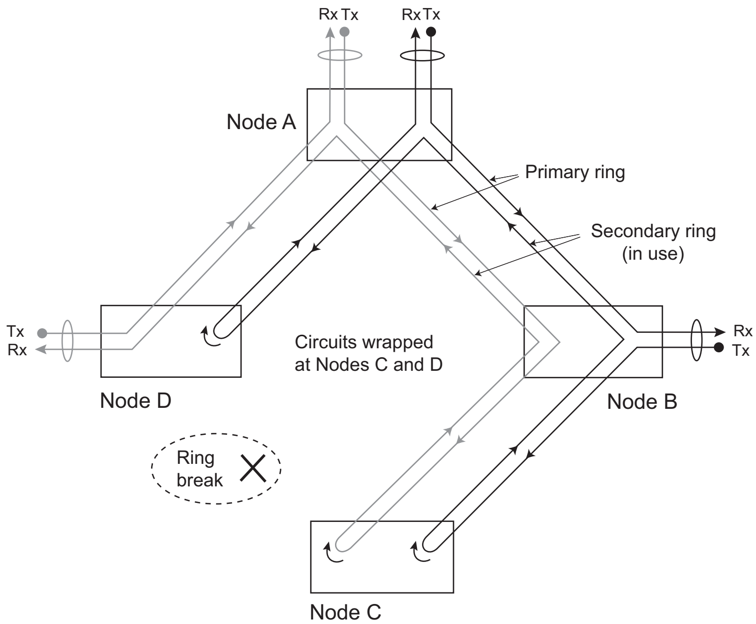
The secondary ring circuits are not being used, and carry pseudo-random data.

Figure 3-47. Normal No-fault Operation



When a break occurs, the ring protection mechanism applies loopbacks at each end of the failed E1 circuits, 'wrapping' primary ring traffic onto the secondary ring, *and* wrapping secondary back onto primary on the other side of the break. Refer to Figure 3-48. In this example all circuits are restored.

Figure 3-48. Ring-break Operation



Providing the ring only experiences a single fault, all traffic is deliverable once the ring has completed the wrapping operation.

When wrapped, the ring is left unprotected against a further failure. For this reason, when the condition(s) that caused the wrap are removed, the ring reverts to normal operation (restorative switching).

The revertive switch command for return to normal service is initiated after the relevant alarms on the failed link have been cleared for a period set by the Error-Free Timer (default 5 minutes), or by the optional Delay Ring Unwrap Timer, which sets a time of day for an unwrap. For more information refer to Unwrap Timers on page 3-83.

Ring wrapping and restoration is nor hitless. Refer to Ring Protection Switching Criteria on page 3-81 for details.

Ring Delay Times

There is no practical limit on the number of hops in a ring *providing* the delay times do not become an issue. The delay is a function of ring capacity *and* the number of hops on the ring; the higher the capacity, the lower the delay for the same number of hops. Refer to Table 3-29. To avoid most instances of unacceptable delays for equipment connected to a 9500 MXC ring, the number of hops should not exceed sixteen.

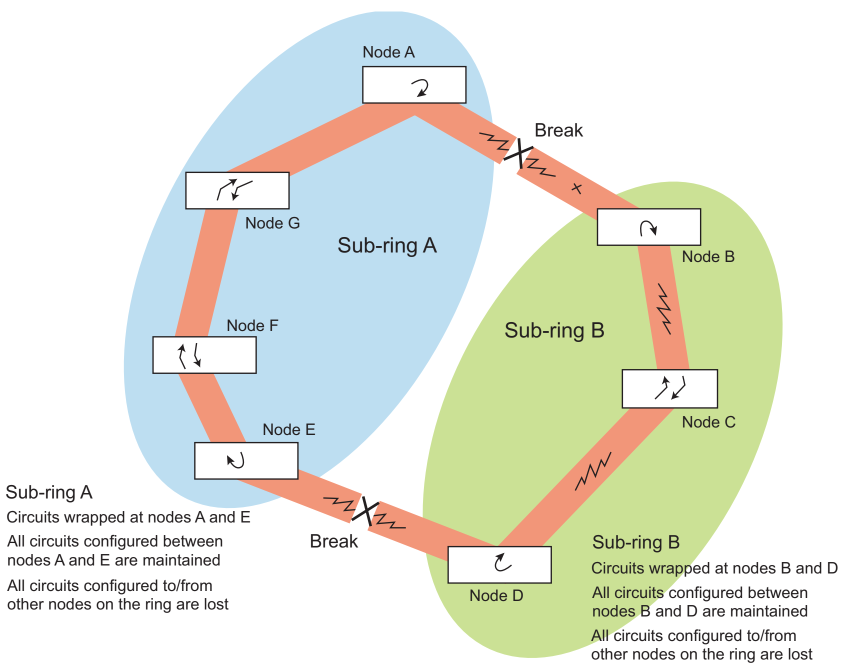
Table 3-29. Typical Ring Delay Times

Ring Capacity	20xE1	40xE1	75xE1
Delay Per Hop	0.45 ms	0.3 ms	0.25 ms
Delay for 16 Hops	7.2 ms	4.8 ms	4 ms

Double Break Operation

In the event there are two or more link failures on the ring, (adjacent, or non-adjacent links), the traffic will wrap up to each side of the failed points to provide limited service restoration. The node or nodes between the break points will be isolated, but where there is an 'sub-ring' of isolated nodes (two or more hops), traffic will wrap up to their node break points in the same way, to provide normal service on all circuits *that have been configured between them*. Refer to Figure 3-49.

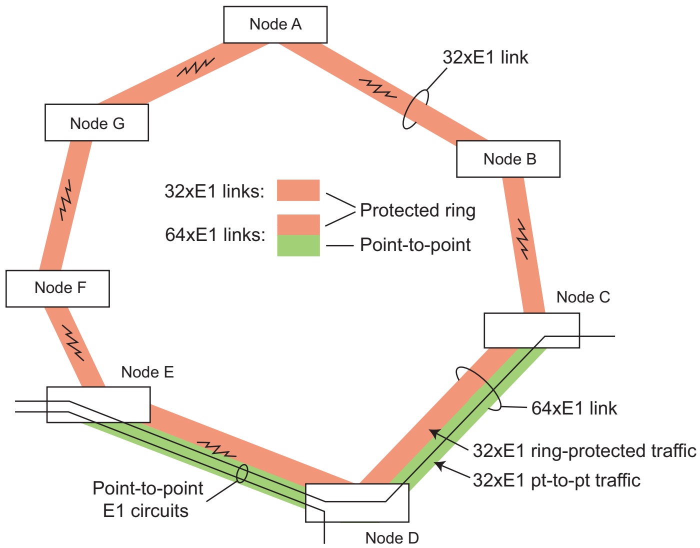
Figure 3-49. Double-break Operation



Point-to-Point Traffic Overlay on a Ring

Point-to point overlay operation is illustrated in Figure 3-50. The additional capacity needed for overlay is required only on the overlaid links. Overlaid traffic is *not* ring protected.

Figure 3-50. Example of a Ring Network with Point-to-Point Traffic Overlay

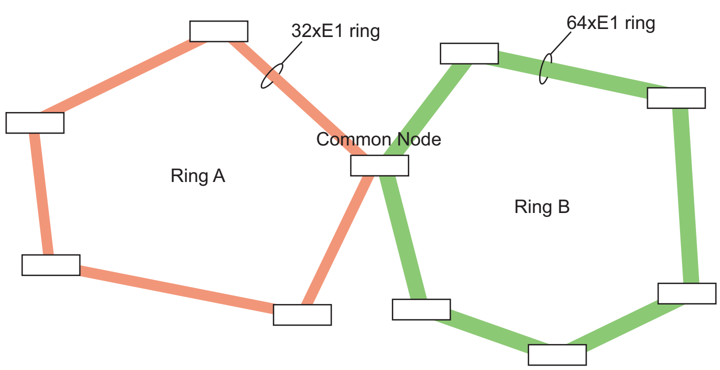


In this example the links between nodes C, D and E are carrying 32xE1 point-to-point *non-protected* traffic as well as 32xE1 *ring-protected* traffic.

Ring-Node Intersection

Using the INUe, two or three rings can intersect at one node.

Figure 3-51. Example of Intersecting Rings



As the maximum backplane bus capacity for a 9500 MXC node is 100xE1 or 128xDS1, this sets the upper limit of the combined capacity of the rings *through* the node. In the Figure 3-51 example one ring operates at 32xE1, the other at 64xE1, for a combined bus capacity of 96xE1, leaving just 4xE1 spare capacity on the intersection Node. Refer to Appendix E.

Fiber Ring Closing

One or more radio links in a ring can be replaced with a span of fiber optic cable using the DAC 155oM. It maps 63xE1 or 100xDS1 from the TDM bus directly to a single STM1/OC3 frame, to enable fiber closures without need for external SDH/SONET muxes.

DAC 155oM uses SFP (small form-factor pluggable) short-range or long range optic transceiver sub-assemblies to support fiber spans to 15 km or 40 km respectively.

1+1 Protected Ring Links

An 9500 MXC Super-PDH ring protected network can be enhanced with one or more 1+1 protected links.

- 1+1 protection of a ring-protected link is normally implemented to provide path protection as distinct from equipment protection. Therefore space diversity (SD) is the required/recommended 1+1 protection mode[7].
- One, some or all links on the ring may be 1+1 protected.
  - An 9500 MXC ring Node may have one or both (east and/or west) ring links configured for 1+1 protection.
- 1+1 protection may be applied to co-channel ring links.
  - Using RAC 40s two concentric, autonomous rings of equal capacity/bandwidth can be configured to operate on the same frequency using the V and H polarizations.
  - Where co-channel links are to be 1+1 protected, both links (V and H) must protected.
  - For more information on RAC 40 ring operation, with and without 1+1 protection, refer to Co-channel Operation on page 3-84.
- A ring-wrap will occur when:
  - The path supported by a 1+1 link exhibits a path fail condition. The path failure switching criteria are the standard ring path failure criteria, with the exception of the 10^{-6} BER option[8]. Refer to Radio Wrap Conditions on page 3-82.
  - The 1+1 link triggers an online Rx and/or Tx switch event. Refer to Hot-standby and Diversity Switching Criteria on page 3-77.
  - The 1+1 link triggers a demodulator not locked alarm on both RACs.
- The decision to unwrap is made when the ring error-free timer times out and, if set, the time of day timer. Refer to Unwrap Timers on page 3-83.
- Ring wrap and unwrap times for 1+1 ring links are identical to 1+0 ring links. Refer to Wrap and Unwrap Times on page 3-82.
- Event Browser entries are created for switch events on the ring and subordinate space diversity link(s).

Figure 3-52 illustrates the protection management hierarchy where both east and west links on a Node are space diversity.

Figure 3-53 illustrates the heirachy where one ring link is space diversity, and the other 1+0.

[7] *Hot-standby can be configured, but unlike space diversity offers no protection against path fade events. However, should ring 1+1 operation with hot-standby links be required, its CT configuration is identical to space diversity.*

[8] *For 1+1 ring links the 10^{-6} BER ring wrap/unwrap option is not supported.*

Figure 3-52. Switch Management Heirachy: SD + SD Subordinated Links

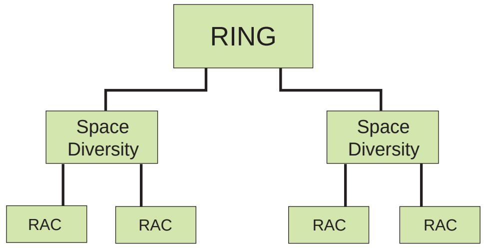
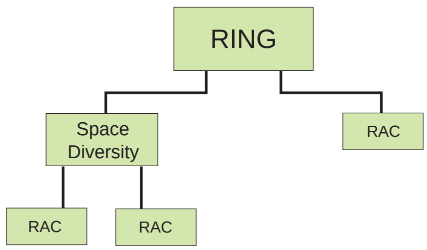


Figure 3-53. Switch Management Heirachy: SD + 1+0 Link



A ring wrap occurs when the path provided by the space diversity link fails, or a Tx or Rx online switch event occurs on the space diversity link, or both space diversity receivers trigger a demodulator not locked alarm

- A silent transmitter switch[9] is initiated when both far-end receivers are in path-fail alarm, and the link has been wrapped for not less than 5 seconds.
  - If the link failure is due to a path fade, the silent transmitter command from the far-end(s) will not be received at the local end(s), meaning no Tx switch will occur.
  - If the link failure is due to a Tx failure, the silent transmitter command from the far end will initiate a switch to the standby Tx at the local end (the secondary RAC is the default standby Tx).
- Auxiliary data circuits and any payload circuits configured for point-to-point operation are not protected in the event of a ring wrap (as for a ring operation using 1+0 links).
- NMS is supported on the 1+1 ring links (as for ring operation using 1+0 links).
- Standard ring diagnostics are supported at the ring level, and operate independently of the 1+1 diagnostics.
- Standard 1+1 link diagnostics are supported on the 1+1 ring links.

Co-channel XPIC Operation on a Ring

Using RAC 40s for Co-channel Dual Polarized (CCDP) operation, two independent Super-PDH protected rings can be established over the same ring topology and on the same frequency by using the vertical and horizontal polarizations.

- Standard RAC 40 configuration procedures are used on each of the ring links.

[9] *A silent transmitter switch is designed to prevent an undetected transmit failure from causing a link to go down indefinitely.*

- The capacities supported are the standard PDH RAC 40 rates of 64x, 75xE1 or 70x, 84x, 100xDS1. However for single-gateway rings (all ring traffic sourced and sunk through one ring site), the Node backplane maximums mean the maximum usable capacities are 64xE1 or 70x, 84x DS1.
- Two co-located INUs are required at each ring node. Each supports an east and west RAC 40.

For more information on RAC 40 CCDP operation refer to Co-channel Operation on page 3-84.

Ethernet Traffic on a Ring

9500 MXC platforms offer multiple solutions for protection of Ethernet traffic on a ring:

- Protection can be provide in a radio environment where Nx2 Mbps or Nx1.5 Mbps circuits used to transport the Ethernet data are protected by the 9500 MXC Super-PDH ring-wrapping mechanism. Refer to Radio Environment on page 3-72.
- Protection can be provided in an Ethernet environment using the Spanning Tree Protocol (STP) or Rapid Spanning Tree Protocol (RSTP) on a L2 switch installed at Node sites. Refer to Ethernet Environment on page 3-73.

A circular connection or loop occurs when there is more than one Ethernet path to reach a destination. A spanning tree capability is required to resolve such loops.

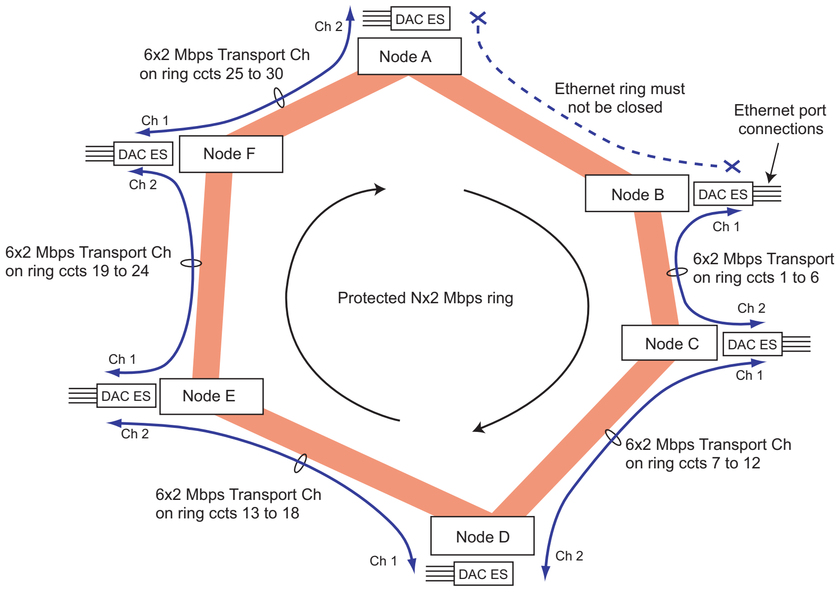
The transport solutions are provided by:

- 9500 MXC Node with the DAC ES for Fast Ethernet. Ring protection options include radio-environment, and Ethernet-environment. With Ethernet-environment an *external* RSTP switch is normally installed at each site.
- 9500 MXC Node with DAC GE for Gig-Ethernet. Ring protection is supported in an Ethernet-environment only, with the DAC GE providing an enhanced RSTP function; RWPR^{TM} (Resilient Wireless Packet Ring). An external RSTP switch is not required.
- 9500 MXC IDU ES for Fast Ethernet. Ring protection is supported in an Ethernet environment only, and an external RSTP switch is required at each site. Refer to IDU ES Link on page 2-8.

Radio Environment

Radio environment ring protection of an Ethernet channel is provided by creating a linear (daisy-chained) Ethernet network on the ring *without closing the final Ethernet channel connections*. The individual 2 Mbps or 1.5 Mbps circuits used to support a DAC ES Ethernet channel on the ring operate in the normal any-to-any circuit mode, to provide ring wrapping in the event of a ring break. In this way, the protection advantages of a ring are provided without compromising the Ethernet environment; no Ethernet loops are created so no external spanning tree management is needed. Refer to the example in Figure 3-54 on page 3-73.

Figure 3-54. Example of Radio-Environment Protection for Ethernet Traffic



When used in this way the DAC ES must be set for *transparent* mode, and the transport channels would normally be configured for identical Nx2 Mbps (or Nx1.5 Mbps) capacity. The example shows each hop on the ring configured for a 6x2 Mbps DAC ES transport channel.

Note that DAC ES Ch 1 on Node A and Ch 2 on Node B are not used, and the five 6x2 Mbps circuit groupings used are unique to each Ethernet node-node channel, requiring a total of 30x2 Mbps on the ring.

Ethernet Environment

Ethernet alternate-path ring protection is enabled by the rapid spanning-tree algorithm held within RSTP switches[10] at each ring site.

The contention that would otherwise occur with the arrival of looped Ethernet frames is managed by RSTP, which creates a 'tree' that spans all switches in the ring, forcing redundant paths into a standby, or blocked state. If subsequently one network segment becomes unreachable because of a device or link failure, the RSTP algorithm reconfigures the tree to activate the required standby path.

RSTP is defined within IEEE 802.1D-2004 and is an evolution of the Spanning tree Protocol (STP).

- For DAC ES and IDU ES an external RSTP switch is required.
- DAC GE includes an RSTP switch function in the form of RWPR™, which provides fast-switched, enhanced RSTP operation.

10 *Layer 2 switch with a rapid spanning-tree protocol option. A switch need not be located at each site, but is recommended to avoid the potential for a site to become isolated in the event of a path/link failure.*

- Unlike normal RSTP action, which involves a progressive exchange of messages between all nodes beginning with those immediately adjacent to the failure point, the RWPR uses a unique fast-link-detection (FLD) mechanism to rapidly and reliably detect a failure on one of the transport channels, and to then communicate immediately with participating RWPR ring nodes when a ring re-configuration is required. Depending on the network topology re-convergence can be within 50 ms.

Ring-wrapping is not used, rather Ethernet traffic is carried on *point-to-point* circuits on the ring. See Point-to-Point Traffic Overlay on a Ring on page 3-69.

RSTP service restoration or 're-convergence' times are typically 1 to 5 seconds. By comparison, the earlier Spanning Tree Protocol (STP) exhibited a convergence time of about 50 seconds.

RWPR supports re-convergence times of less than a second, typically 50 msecs for a five-node ring and less than 100 msecs for a ten node ring.

Ethernet Ring Solutions

9500 MXC Nodes support Fast and Gigabit Ethernet rings:

- 9500 MXC Node with the DAC ES supports Ethernet rings to 100 Mbps.
  - A single DAC ES is configured to provide two transport channels, one to the east RAC, the other to the west, from an external RSTP switch.
  - E1/DS1 traffic may also be configured in the ring, which may be point-to-point (not protected) or ring-wrap protected.
- A single 9500 MXC Node with a DAC GE supports Gig-Ethernet rings to 150 Mbps. One DAC GE is configured to provide two transport channels, one to the east RAC, the other to the west. No external RSTP switch is required.
- Two INUs may be co-located at each site to support a 300 Mbps ring. The 300 Mbps throughput may be configured on single 300 Mbps links, or as two co-path, link-aggregated 150 Mbps links.
- Four INUs may be co-located to support a 600 Mbps ring using two co-path, link-aggregated 300 Mbps links, or four co-path, link-aggregated 150 Mbps links.

Figure 3-55 shows a 9500 MXC ring configured for RSTP protection of Ethernet traffic using an external RSTP switch, and ring-wrap protection of NxE1 traffic.

- Point-to-point circuits are configured for Ethernet traffic, and via the DAC ES are ported to an external RSTP switch, which manages the ring protection. Note that the 2 Mbps circuits designated to carry the Ethernet traffic (1 - 16) are *reused* on each radio link to provide superior ring-traffic efficiency, compared to ring-wrap protection of Ethernet traffic.
- Ring-wrap protected circuits are configured for the NxE1 traffic.

If a radio link fails:

- RSTP re-directs Ethernet traffic on the ring.
- 9500 MXC ring protection re-directs E1 traffic on the ring to bypass the break.

When used with an *external* RSTP switch:

- The DAC ES or DAC GE should be configured for Mixed Mode (not Transparent mode), to provide dedicated ports for each of the two (east and west) transport channels (C1 and C2).
- There can be an equal or unequal number of DAC ES or DAC GE plug-ins on the ring.
- Disable Address Learning must be selected in the Plug-ins screen.

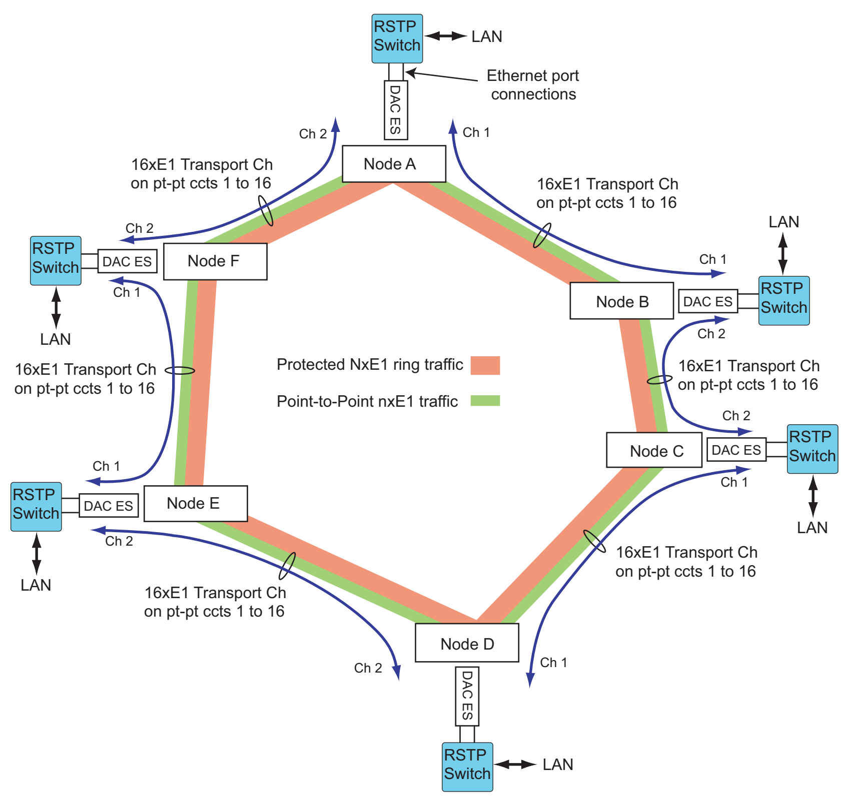
When used with the built-in RSTP switch provided on the DAC GE:

- With its RWPR capability the DAC GE provides enhanced (fast-switched) RSTP protection management of Ethernet traffic on the ring.
- Transparent mode must be selected (where *one* DAC supports both the east and west links).

For information on DAC ES configuration, refer to: DAC ES and IDU ES Configuration, Volume IV, Chapter 3.

For information on DAC GE configuration, refer to: DAC GE Configuration, Volume IV, Chapter 7.

Figure 3-55. Example of RSTP and Ring-Wrap Protection on a Ring



DAC/Tributary Protection

E3/DS3, and STM1/OC3 DACs may be used in pairs to provide hot-standby redundancy.

The protectable DACs are:

- DAC 3xE3/DS3M
- DAC 1x155o
- DAC 2x155o
- DAC 155oM
- DAC 2x155e

Two protection configurations are supported, tributary protection, and always-on:

Tributary Protection

- Y cables connect the paired DACs to customer equipment.
- In the Rx direction (from the customer) both DACs receive data, but only the online Rx DAC sends this data to the TDM bus.
- In the Tx direction, the online Tx DAC sends data to customer equipment, the other mutes its Tx line interface.

Tributary Always On

- Separate cables connect each DAC to customer equipment.
- In the Rx direction (from the customer) both DACs receive data, but only the online Rx DAC sends this data to the TDM bus.
- In the transmit direction both DACs send data to customer equipment, and the customer equipment switches between these two **always on** tributaries.
- TA protection must be used where two 9500 MXC INU/INUes are to be interfaced using protected DACs.

The DACs are configured as primary and secondary. The primary is the default DAC for online Rx and Tx.

Except for the DAC 155oM, protection switching operates independently for Rx and Tx, meaning it is possible for one of the DACs to be the online Tx, and the other online Rx.

When a switching event occurs, all Tx and/or Rx tributaries are switched to the protection partner. Refer to DAC Protection Switching Criteria on page 3-83.

Protection Switching Criteria

In this section, switching criteria and service restoration times are provided. Refer to:

- Switching Guard Times
- Hot-standby and Diversity Switching Criteria
- Dual Protection Switching Criteria on page 3-80
- Ring Protection Switching Criteria on page 3-81
- DAC Protection Switching Criteria on page 3-83

Switching Guard Times

To prevent protection switch oscillation a *switch oscillation guard time* mechanism applies to all forms of *online*[11] protection switching. The mechanism is described below.

- A period of guard time begins immediately after each protection switch occurs.
- No protection switches are permitted during the guard time. Protection switching may resume once the guard time has elapsed.
- To damp possible oscillations in the system the guard time is regularly adjusted, using the following rules:
  - The guard time doubles after each switch (up to the maximum)
  - The guard time halves after each period of guard time during which no switching occurs (down to the minimum).
  - When the guard time decays to its minimum, subsequent switch requests are actioned immediately.
- There are two independent guard timers for each protection context, one associated with TX switching and one associated with RX switching.
- The switch guard time has a minimum period of 5 seconds and a maximum period of 320 seconds (5 x 26 events).
- The guard time mechanism is disabled in protection diagnostic modes.

Hot-standby and Diversity Switching Criteria

The Tx and Rx paths are independently switched. Protection criteria are similar for all RACs. Refer to:

- Transmitter Switching on page 3-77
- Receiver Switching on page 3-79
- Service Restoration Times for Hot Standby and Diversity on page 3-80

Transmitter Switching

Transmit switching for hot-standby and space diversity is not hitless; service is restored within 200 ms. Transmit switching for frequency diversity is hitless *providing* the online Tx RAC is not removed.

The *online* Tx RAC manages the Tx protection switch function, and is transferred between RACs to always be with the online Tx RAC.

---

[11] *It does not apply to diversity-bus (hitless) Rx path switching.*

For hot-standby and space/frequency diversity the default protection configuration has the primary RAC online Tx and the secondary RAC online Rx.

- Only the online Tx is operational for hot-standby and space diversity.
- Both online Tx and standby Tx are operational for frequency diversity. The online Tx is managing Tx traffic synchronization.
- Switching from the online to standby transmitter will not be initiated if the standby transmitter has failed, or the standby Tx RAC has been removed or replaced by an incorrect plug-in. Similarly, a switch will not be initiated if the ODU associated with the RAC has failed or is disconnected.
- When a switch has occurred, protection management remains with what was the offline transmitter. The primary-designated RAC (default online Tx) is *not* automatically returned to online transmit on repair or replacement

Transmit Switching Operation, Hot-standby and Space/Frequency Diversity:

- The primary RAC is the default online Tx RAC.
- When a Tx switch from primary to secondary occurs, the online Tx status is transferred from the primary to secondary RAC, and remains with the secondary RAC; the primary-designated RAC is not automatically returned to online on repair/ replacement. The same process occurs in reverse - for a switch from secondary RAC Tx online to primary RAC Tx online.
  - For hot-standby and space diversity the online Tx status is changed for a card withdrawal, RAC/ODU failure, or software load failure.
  - For frequency diversity the online status is only changed for a card withdrawal or software load failure.
- The switch of *online* Tx status is not hitless, service is restored within 200 ms.

Transmit Switching Criteria, Hot-standby and Space Diversity:

Transmitter switching to the alternate transmitter is initiated for the following *local alarm* conditions:

- RAC plug-in is missing or incorrect
- RAC software load failure
- Transmitter path failure, Hot-standby and Space Diversity:
  - Tx synthesizer not locked
  - Tx transceiver failure
  - Tx power failure
  - Tx ODU IF synthesizer not locked
  - Tx RAC IF synthesizer not locked
  - Modulator not locked
  - ODU cable unplugged

Transmitter switching is also *remote-end* initiated in the event of an undetected ‘silent transmitter’ failure.

- This occurs when *both* online receive RACs are in receive alarm, whereupon a switching command is returned to the local-end transmitter[12].

- This remote-initiated switch is designed to prevent a *silent* transmit failure (failure cannot be detected by the local hardware/software) from causing the link to go down indefinitely.

A silent Tx switch is initiated when both the demodulators have lost lock or both receivers have lost frame synchronization (demodulator not locked alarm).

Transmit Switching Criteria, Frequency Diversity:

Both transmitters are operational. A switch only affects the online status of the RACs, which for frequency diversity is the RAC controlling transmit synchronization.

Online RAC Tx switching is initiated for the following conditions:

- RAC plug-in is missing or incorrect
- RAC software load failure

Manual return to primary RAC transmit requires a 9500 MXC CT command in the System/Controls screen. This should be forced for hot-standby installations using an unequal coupler where the primary RAC is assigned to the low-loss side.

Receiver Switching

Receiver path switching (voting) between the two receiving RACs is hitless for hot-standby and diversity configurations. The least errored data stream is selected on a frame-by-frame basis within the online, bus-driving, RAC.

The *online* Rx RAC manages the Rx protection switch function, and is transferred between RACs to always be with the online Rx RAC.

The RAC assigned as the secondary RAC in a protected primary/secondary pairing is the default online RAC. Refer to Protected and Diversity Operation on page F-8, Appendix F. .

In the event of RAC/ODU receive *equipment* failure:

- If the designated *offline* RAC/ODU (default primary) receiver fails or is removed, the receive data stream will not be errored as the RAC designated as *online* is controlling the switching and driving the TDM bus.
- If the designated *online* RAC/ODU (default secondary) receiver fails, the receive data stream will not be errored if the failure occurs *prior* to the RAC Rx diversity bus (between ODU antenna input and the RAC Rx diversity bus).
- If the designated *online* RAC/ODU (default secondary) receiver fails *after* the diversity bus (between RAC Rx diversity bus and the TDM bus) or is removed, the offline (primary) RAC/ODU is switched to become the online bus-driving RAC. This switching is not hitless, and the primary RAC remains as the online bus-driving RAC until changed within 9500 MXC CT, or a subsequent bus-drive switch event.

[12] *Where both RACs are in receive path alarm because of a path problem, no signal is received in either direction. In such situations the 'silent Tx' switch command will be prompted by receive path alarms at both ends of the link, but will not be received at the transmit ends of the link.*

- Switching from the *online* to *offline* Rx RAC will not be initiated if the offline Rx RAC has failed, or the offline Rx RAC has been removed or replaced by an incorrect plug-in. Similarly, a switch will not be initiated if the ODU associated with the offline RAC has failed or is disconnected.

One gate-array is employed between the Rx diversity bus and the TDM bus. It provides a function that is directly equivalent to a receive protection switch.

Correct operation is monitored, and in the event of an alarm (software corruption) a RAC switch command is initiated. A software auto-reload to the alarmed gate array (from the embedded software set held in the NCC CompactFlash) is also initiated to attempt to clear the alarm.

RAC Rx Online Switching Criteria

An online RAC switch is triggered by one or more of the following conditions:

- RAC plug-in is missing
- RAC plug-in is incorrect
- RAC FPGA software load failure

Service Restoration Times for Hot Standby and Diversity

Service restoration times (detection, switching and recovery) for a switch event are:

Transmit Switch

- 200 ms maximum for a local alarm
- 20 seconds maximum for a remote-end command (silent transmitter event)

The 20 second period is set to prevent unwanted switching caused by momentary path fade or other switching events.

Receive Switch

- Switching is hitless for all alarm events except for a failure at the bus-drive protection switch within the online designated RAC.
- 200 ms maximum for a bus-drive switch.

Dual Protection Switching Criteria

Currently dual protection is only offered with a frequency diversity master, which means that only Rx (to the backplane bus) is switched; both subordinate protected links are online transmitting (transmit protection criteria do not apply).

For restoration times refer to: Service Restoration Times for Dual Protection on page 3-81.

Receive Switching Criteria, Frequency Diversity Master

RAC bus-drive switching is initiated between the two subordinate links under the following conditions:

- RAC plug-in is missing or incorrect
- RAC component failure:
  - RAC software load failure
  - EEPROM failure
- Rx path failure:
  - Rx synthesizer not locked
  - RF IF synthesizer not locked
  - Demodulator not locked
  - ODU Tx cable IF synthesizer not locked

Service Restoration Times for Dual Protection

For the subordinate links their service restoration times as individual protected links are unaltered from those stated above for hot-standby and space diversity.

The service restoration times for a master switch are as follows, and apply for a switch between:

- One protected link to a protected link
- One protected link to a non-protected link
- A non-protected link to a protected link

Receive Switch

- 200 ms maximum. Applies to the master protection switch event.

Note that with a frequency diversity master there is no Tx switch event; both transmitters are online transmitting

Ring Protection Switching Criteria

This section describes the ring-wrapping switching criteria for radio (RAC/ODU) and fiber (DAC 155oM) closures. Refer to:

- Radio Wrap Conditions on page 3-82
- Fiber (DAC 155oM) Wrap Conditions on page 3-82
- Wrap and Unwrap Times on page 3-82
- Unwrap Timers on page 3-83

Ring protection protects the payload and alarm I/O addressing between nodes; ring protection does not protect auxiliary data.

Radio Wrap Conditions

Conditions for ring wrapping:

- Tx path failure:
  - Tx synthesizer not locked
  - Tx transceiver failure
  - Tx power failure
  - Tx ODU IF synthesizer not locked
  - Tx RAC IF synthesizer not locked
  - Modulator not locked
- Rx path failure:
  - Rx synthesizer not locked
  - Rx IF synthesizer not locked
  - Demodulator not locked
  - ODU Tx cable IF synthesizer not locked
  - 10^{-6} BER (user-selectable wrap and/or unwrap options)
- RAC plug-in is missing
- RAC software load failure

Fiber (DAC 155oM) Wrap Conditions

Conditions for ring wrapping:

- Loss of SDH/SONET frame
- DAC 155oM plug-in is missing
- DAC 155oM software load failure

Wrap and Unwrap Times

The wrapping process is performed without any participation of the alarmed RAC or DAC 155oM, or potentially failed RAC/DAC in the instance of a silent transmitter failure.

Ring wrapping and unwrapping is not hitless:

- 100 ms maximum service restoration time (detection, switching and recovery) for a ring wrap based on a 16-hop ring, which is the maximum recommended ring size. It will typically be between 40 and 100 ms, depending on the number of hops and ring capacity; the higher the capacity, the lower the ring delay.
- The revertive switch *command* for return to normal service is initiated after the relevant alarms on the failed link have been cleared for a period set by the Error-Free Timer (default 5 minutes), or by the optional Delay Ring Unwrap Timer, which sets a time of day for an unwrap. Full restoration of normal traffic (unwrapped) on the ring occurs within 100 ms of receipt of the revertive switch command.

Unwrap Timers

An **Error-free Timer** in the Protection configuration screen sets the period of error-free operation needed prior to initiation of an unwrap. When a wrap has occurred this timer counts down towards an unwrap as soon as all wrap conditions are cleared. The count begins anew should a wrap condition re-occur during the countdown. The time options are 10 seconds, or 1, 5, or 10 minutes. 5 minutes is default (recommended).

A **Delay Ring Unwrap** timer in the Protection configuration screen allows setting of a time of day when an unwrap will occur providing all wrap conditions have been cleared for a period not less than that set in the Error-free Timer. This timer has a 1-hour window; if the conditions which caused the wrap are not cleared by the Error-free Timer during this window, then Delay Ring Unwrap resets for the same time the following day.

- The System/Controls screen provides a countdown timer to indicate the time to go before the ring will unwrap. Applies to both the Error-free Timer and Delay Ring Unwrap Timer. (Counts down to zero).

DAC Protection Switching Criteria

The Tx and Rx tribs are independently switched. Switching is not hitless.

- 200 ms maximum restoration time for a Tx or Rx trib switch.
- Trib protection is available for E3/DS3 and STM1/OC3 DACs, including DAC 3xE3/DS3M and DAC 155oM. Switch criteria are common for all DACs.

Refer to:

- Tx Trib Switching
- Rx Trib Switching

Tx Trib Switching

Transmitter switching to the alternate DAC transmitter is initiated for the following local alarm conditions:

- SW/HW failure:
  - Plug-in missing or incorrect
  - FPGA software load failure
  - LIU failure
  - Clock generator failure

Rx Trib Switching

Receiver switching to the alternate DAC receiver is initiated for the following local alarm conditions:

- SW/HW failure:
  - Plug-in missing or incorrect
  - FPGA software load failure
  - LIU failure
  - Clock generator failure

- Tributary LOS

NCC Protection with NPC Option

The NPC plug-in provides protection for NCC TDM bus management (bus clock), and power supply functions. One NPC can be installed per INU/INUe.

Bus protection protects all tributary and auxiliary traffic; Alarm I/O is not protected.

- Switching is not hitless for a TDM bus clock failure; restoration is within 200 ms, during which time all traffic on the node will be affected.
- Protection is hitless for a power supply failure. If the NCC converter or one of its supply rails fails, the NPC will take over without interruption. And vice versa.

When the TDM bus clock has switched to NPC control, it will not automatically revert to NCC control on restoration of the NCC. Return to NCC control requires either withdrawal/failure of the NPC, or use of diagnostic commands in the System/Controls screen.

Co-channel Operation

This section provides data on Co-channel Dual Polarization (CCDP) operation with Cross-Polarization Interference Cancellation (XPIC). This allows two radio links of identical capacity and modulation to operate over the same path, on the same frequency channel, by operating one link on horizontal polarization, and the other on vertical. In this way, one frequency channel can be used to support two same-path links (double the capacity), compared with one link for a standard (non-CCDP) radio.

- Co-channel operation requires paired RAC 40 plug-ins with companion ODU 300s.

Refer to:

- XPIC on page 3-84
- RAC 40 Operating Guidelines on page 3-86

XPIC

For CCDP operation XPIC is required to provide the additional cross polarization discrimination needed to avoid unacceptable co-channel interference.

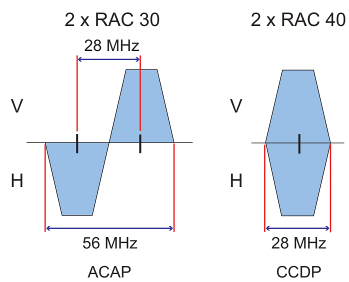
- Standard high performance shielded antennas typically exhibit 30 dB cross polarization discrimination (XPD) whereas 40 dB is typical for purpose-designed, high polarization discrimination antennas.
- Correct end-end polarization alignment is essential to achieve a *path* XPD to closely match the antenna XPD. Refer to Additional Procedures for CCDP XPIC links on page 5-7 of Chapter 5, Volume III.
- XPIC provides up to an additional 20+ dB of XPD, which is achieved by cancelling interference caused in the *wanted* signal by taking a sample of the *unwanted* signal received on the opposite polarization. For an explanation of XPIC operation, refer to RAC 40 in Appendix F.

  - In a non-XPIC STM1/75E1/64E1 system, ETSI specifies that a co-channel interfering signal 37 dB below the wanted signal (37 dB C/I) shall not degrade Rx threshold by more than 1 dB. In an XPIC system ETSI specifies a 17dB C/I for a 1 db threshold degradation.
  - While high performance dual polarized antennas when correctly aligned may provide up to 30 dB of isolation between received H and V signals, such isolation may reduce dramatically during fading conditions, which is when the XPIC function provides maximum benefit.
- Each RAC 40 operates with an ODU300ep or ODU 300hp.

Figure 3-56 shows the relative difference between conventional adjacent channel alternate polarization (ACAP) operation, and CCDP, for same-path operation. The RAC 30V3s (ACAP) must be on different frequency channels, or if on adjacent channels (as shown), one should be configured for vertical polarization, and the other for horizontal. The RAC 40s (CCDP) are on the same frequency channel, with one configured for vertical polarization, and the other for horizontal.

Each ODU 300 is connected to either the V and H polarization feedhead on a dual-polarized antenna, using a remote mount and a flexible waveguide connection.

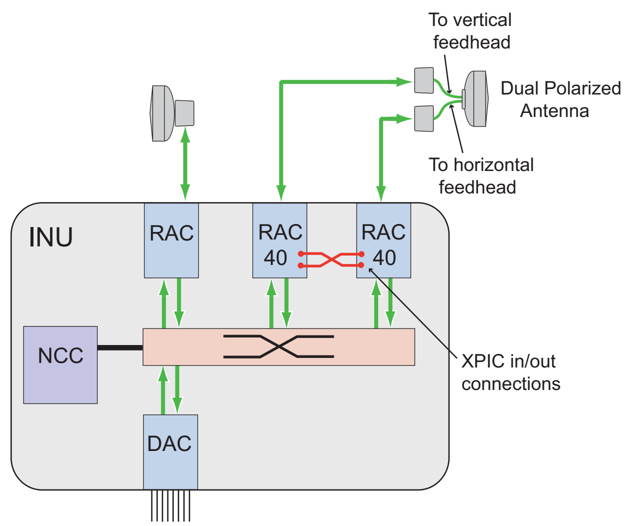
Figure 3-56. ACAP and CCDP Operation



RAC 40s can be hot-standby or diversity protected.

Figure 3-57 shows a RAC 40 pairing in an INU. The cable pair between the RAC 40s provides the sample of the unwanted signal (opposite polarity signal) received on one RAC, to the other RAC.

Figure 3-57. Example Co-Channel STM1 RAC 40 Deployment



9500 MXC fitted with RAC 40s meets ETSI EN 301 127 requirements for co-channel operation. This document specifies the performance of a system in the presence of cross polarization interference (XPI) coming from an opposite polarization.

Refer to RAC 40 Operating Guidelines for application data and example configurations.

RAC 40 Operating Guidelines

Two RAC 40 cards are used to support:

- Co-channel STM1/OC3
- Co-channel 64 or 75xE1
- Co-channel 70, 84 or 100xDS1

Co-channel operation only has application where a single-path capacity greater than that provided by a single RAC 30V3 is required; path capacities greater than 75xE1, 100xDS1, or STM1/OC3.

Refer to:

- Backplane Bus Capacity on page 3-86
- Settings, Protection and ATPC on page 3-87
- Example Configurations on page 3-88

For information on RAC 40 refer to RAC 40 on page 3-23.

Backplane Bus Capacity

An INU/INUe has a maximum backplane bus capacity of 100xE1, 128xDS1, or 2xSTM1/OC3, which for the available RAC 40 capacities means that co-channel operation is only supported for STM1/OC3. See Figure 3-58 on page 3-88.

- One INU/INUe supports co-channel STM1/OC3 when configured as a terminal Node.
- One INUe supports co-channel STM1/OC3 when configured as a repeater Node (no drop-insert to an external mux).

Two co-located INU/INUes support co-channel operation for 64/75xE1, 70/84/100xDS1, or STM1/OC3.

- The co-channel RAC 40 pairs are installed *across* the INU/INUes as shown in Figure 3-59.

For more information on node capacity rules refer to Appendix E.

Settings, Protection and ATPC

- Each RAC 40 in a co-channel XPIC pairing must be configured for the *same* frequency, capacity and modulation.
- A special Tx mute function applies if one of the receive RACs fails, the RAC is withdrawn, or the XPIC cables are removed or incorrectly connected. Refer to Remote Tx Mute.
- Co-channel links may also be **hot-standby or diversity protected** using two RAC 40s per vertical and horizontal feed. The protection partners must be installed in the same INUe and slot-located according to INU/INUe RAC protection rules.
  - Where co-channel links are to be 1+1 protected, both must be 1+1 protected[13].
  - The RAC 40 assigned to each polarization is 1+1 protected by adding a RAC 40 protection partner in the CT Protection screen.
  - For hot-standby or frequency diversity protection using a single dual polarized antenna at each end, remote-mounted *equal-loss* couplers[14] must be used to mount the ODUs.
  - Similarly, for space diversity operation all four antennas must be of the same size (have the same gain).
  - The protected V and H links operate as two independent links - the standard protection switch criteria for protected links apply. Refer to Hot-standby and Diversity Switching Criteria on page 3-77.
  - Similarly, the Remote Tx mute functions apply where both RACs of a protected pair fail, are withdrawn, or have their XPIC cables removed or incorrectly connected. Refer to Remote Tx Mute.
- RAC 40s can be operated in single channel/non-XPIC mode to provide an upgrade path to co-channel operation without hardware changes.
- ATPC must be OFF on both co-channel links. (Receive signal level measurements are affected by the interference caused on one link by the other, which results in abnormal ATPC action).

Remote Tx Mute

This section sets out the special operating conditions that apply to RAC 40 CCDP links under Rx failure conditions to ensure continued operation of the remaining link.

- XPIC interference cancellation cannot function if one of the RACs is withdrawn, its XPIC cables are removed or are incorrectly installed, or there is a RAC hardware failure.
- Under these conditions the Tx signal (remote transmitter) on the failed link is muted to prevent unwanted interference to the remaining RAC Rx.
- Table 3-30 lists conditions under which the remote Tx is muted.

[13] *If just one of the co-channel links is 1+1 protected, a failure of XPIC cross-connect between the 1+0 RAC 40 and its 1+1 XPIC partner may cause both V and H receive streams to error as the discrimination provided under XPIC would be lost. An unlikely double-failure event would be needed to cause the same error if both co-channel links are 1+1 protected.*

[14] *Optimum XPIC interference cancellation performance requires equal, or near equal V and H receive signal levels.*

Table 3-30. Tx Mute Request Conditions

Remote Tx Mute Request Alarms	
NCC:	RAC 40 plug-in missing.
RAC hardware failure:	RAC 40 synthesizer RX LO failure, or synthesizer RX IF failure.
Path failure:	RAC 40 ODU cable unplugged, RX synthesizer not locked, or RX IF synthesizer not locked.
Path warning:	XPIC cable unplugged or XPIC failure.

Where both XPIC cable are removed at the local end, the request to mute will be sent to both remote transmitters. This mute contention situation is resolved by applying a bias to the vertical RAC; the remote horizontal RAC Tx is muted, the remote vertical RAC Tx is not muted.

Example Configurations

The configurations illustrated are:

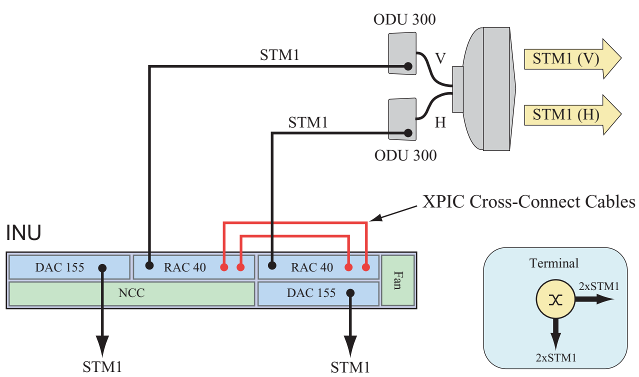
- Single INU on page 3-88
- Paired INUs on page 3-89
- Protected Co-channel Links on page 3-89
- Ring Node Configurations on page 3-91

Single INU

Figure 3-58 shows a *single* INU for 2x STM1/OC3 operation.

- One INU/INUe supports a co-channel XPIC capacity of 2xSTM1/OC3, or 2x150 Mbps Ethernet using a DAC GE.
- The example shows a terminal configuration, where each STM1/OC3 trib is terminated on a DAC 155o plug-in. (The two DAC 155o plug-ins shown could be replaced by a single DAC 2x155o or DAC 2x155e).
- One INUe also supports 2xSTM1/OC3 or 300 Mbps Ethernet co-channel XPIC when configured as a repeater - no drop-insert (4 ODUs required). Each STM1/OC3 / 150 Mbps stream is cross-connected on the backplane bus from one ODU to its partner in the opposite direction.

Figure 3-58. Co-Channel STM1 Terminal

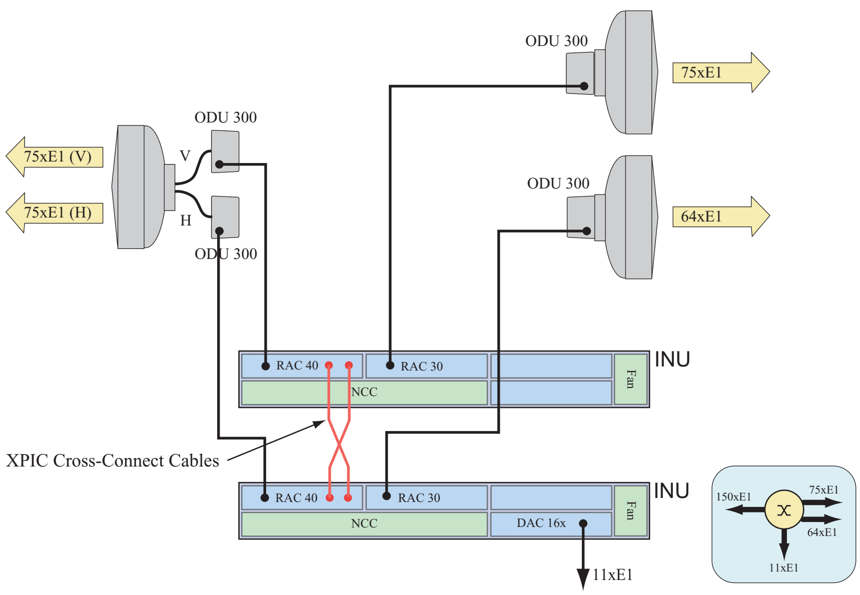


Paired INUs

Paired INU/INUes can be used to share backplane bus loading, as illustrated in Figure 3-59, for a 150xE1 backhaul.

- By pairing Nodes the combined backplane bus capacity of 200xE1, 256xDS1, 4xSTM1/OC3, or 600 Mbps Ethernet is available to support:
  - Co-channel 2x 75xE1 or 2x 100xDS1 in terminal Node configurations (INUes are required to provide the number of slots needed for DAC 16x plug-ins).
  - Co-channel 2x 75xE1 or 2x 100xDS1 aggregation, as in Figure 3-59.
  - Co-channel 2x 75xE1 or 2x 100xDS1 9500 MXC Super-PDH ring operation. However for a typical single-gateway ring (all traffic sourced and sunk at one site on the ring), 2x 64xE1 or 2x 84xDS1 are the ring maximums. Refer to Appendix E.
  - Co-channel 2xSTM1/OC3 ring operation. Requires an external ADM.
  - Co-channel 2x 150 Mbps Ethernet rings. Links are operated point-to-point. RSTP ring switching is provided internally using the DAC GE (RWPR) or using an external switch with the DAC ES. Refer to Ring Node Configurations on page 3-91.

Figure 3-59. Co-channel 2+0 75xE1 Backhaul



Protected Co-channel Links

Co-channel links (links on the V and H polarizations) can be 1+1 protected using hot-standby, space diversity, or frequency diversity.

Refer to Settings, Protection and ATPC on page 3-87.

Example confutations are provided for:

- 2+2 Hot-standby 75xE1 Co-channel Links.
- 4+4 Hot-standby Operation.

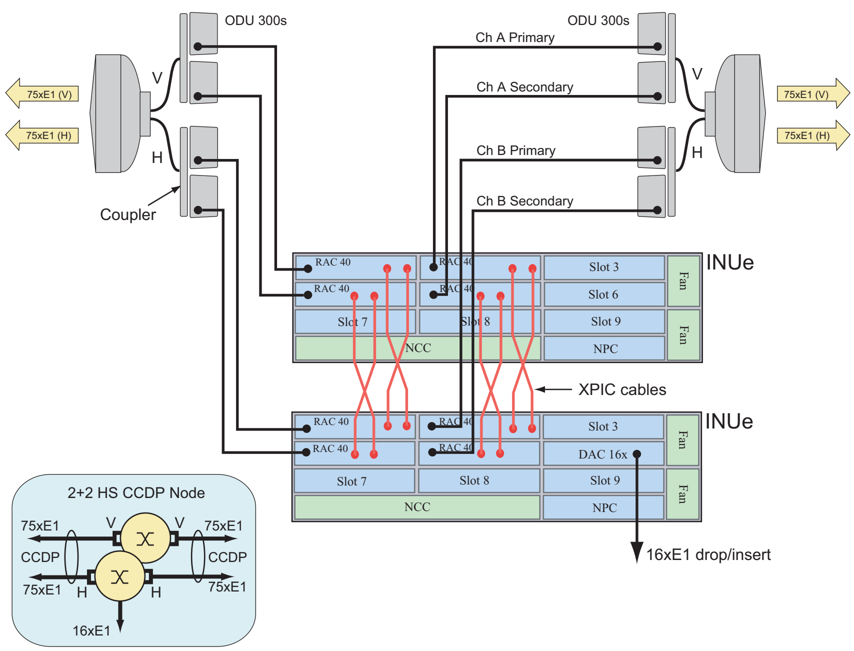
For examples of 2+2 and 4+4 space diversity configurations see Ring Node Configurations on page 3-91.

2+2 Hot-standby Co-channel Links

Figure 3-60 illustrates a Node configured for hot-standby protection of the two 75xE1 co-channel links.

- Hot-standby is normally deployed where equipment protection is the primary requirement, as distinct from path (and equipment) protection through space or frequency diversity.
- Both co-channel links (V and H) must be 1+1 protected.
- An NPC plug-in is included in each INUe to provide NCC redundancy.
- The couplers must be equal-loss.
- The nominal loss through each coupler is 3.5 dB, meaning an additional 7 dB loss must be included in the system gain calculations for each link.
- All RAC 40 capacity options are supported for 2+2 protection: 64x, 75xE1, 70x, 84x, 100xDS1, or STM1/OC3.
- The example illustrates a repeater/aggregation Node with a 16xE1 drop. While the up-haul capacity on the lower INUe may therefore only need to support 59xE1, because its co-channel partner is still transporting 75xE1 traffic, it must also be over-air configured for 75xE1.

Figure 3-60. 2+2 Hot-standby 75xE1 Co-channel Links



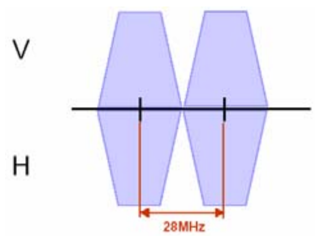
4+4 Hot-standby Operation

Figure 3-62 illustrates 4+4 'quattro' operation where CCDP (co-channel dual polarization) and ACCP (alternate channel co-polarization) are used to support hot-standby protected operation on four co-path links.

- Supports a maximum of 4x 75xE1, 4x 100xDS1, or 4x STM1/OC3 on two 28/30 MHz radio channels.
- CCDP with ACCP supports the four co-path links on two 28/30 MHz radio channels.
  - Uses the V and H polarizations on two adjacent channels. Figure 3-61 illustrates the channel/link alignment.

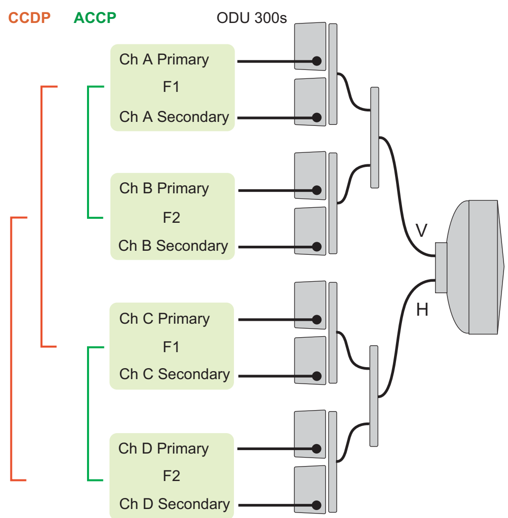
- Figure 3-62 illustrates the ACCP pairings on F1 and F2 (channel 1 and channel 2), and CCDP pairings on the cross-polarized co-channel pairings.

Figure 3-61. Channel/Link Alignment for 4+4 CCDP and ACCP



- Cascaded couplers are used to connect the protected ODU pairings to the common antenna. Couplers must be equal loss.
- The nominal loss through each coupler is 3.5 dB, meaning an additional 14 dB loss must be included in the system gain calculations for each link.

Figure 3-62. 4+4 Hot-standby Operation



Ring Node Configurations

RAC 40 CCDP operation may be included within 9500 MXC ring networks to support two concentric rings on the same frequency channel.

The rings may be configured for any of the capacities supported by the RAC 40, but bear in mind:

- For STM1/OC3 rings, ring protection requires an external SDH mux. 9500 MXC ring links are configured as point-to-point.
- For PDH rings 9500 MXC Super-PDH ring protection applies.
  - For single gateway rings (all ring traffic sourced and sunk at one ring site) the maximum capacity supported on each ring is 64xE1 or 84xDS1. For more information refer to Appendix E.
- For Ethernet rings an RSTP switch is required. An RSTP function (RWPR) is included with the DAC GE. With the DAC ES, an external RSTP switch is required.
- Each ring operates autonomously.

CT is used to individually configure the two ring links.

- The V and H ring links are separately configured for identical frequency, Tx power and capacity/bandwidth.
- XPIC cables are installed between the east RAC 40s, and between the west RAC 40s.

Co-channel ring links can also be 1+1 protected:

- Co-channel ring links can be 1+1 protected using space diversity or hot-standby.
  - 1+1 protection of a ring-protected link is normally implemented to provide path protection as distinct from equipment protection. Hence space diversity (SD) is the required/recommended 1+1 protection mode.
  - One or all co-channel ring links can be 1+1 protected.
  - Where co-channel ring links are to be 1+1 protected, both must be 1+1 protected.
  - The 1+1 protection is subordinated to the ring protection mechanism (ring wrap and unwrap). For guidance on 1+1 protection of ring links refer to 1+1 Protected Ring Links on page 3-70.
- When using a coupler to combine two ODUs onto a single polarization, the operating channels must be chosen from within the same diplexer option. If the two ODUs are not from the same tuning/diplexer option interference may occur, resulting in degraded link performance.

Example configurations are provided for:

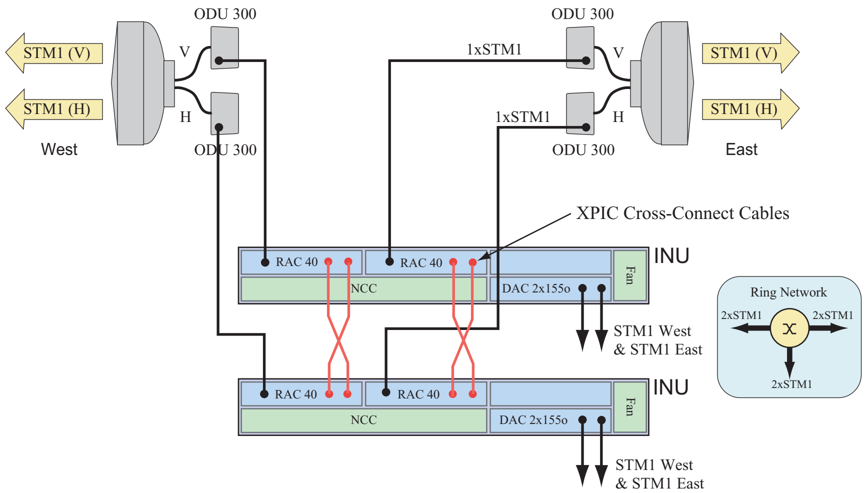
- Co-Channel STM1 Ring Node with Drop-Insert.
- 300 Mbps Co-channel Ring Node: 2x150 Mbps
- Co-Channel 64xE1 Ring Node with 16xE1 Drop-Insert.
- Space Diversity Protected 64xE1 Co-channel Ring Links.
- 4+4 Space Diversity Operation Using CCDP and ACCP

2xSTM1 Co-Channel Ring Node

Figure 3-63 illustrates co-channel STM1 ring operation.

- Each INU supports two 1xSTM1 links; STM1 east and STM1 west.
- Each INU ports its STM1 east and west tribs to an external SDH mux, which provides the ring protection mechanism.
- 9500 MXC links are configured for point-to-point operation.

Figure 3-63. Co-Channel STM1 Ring Node with Drop-Insert

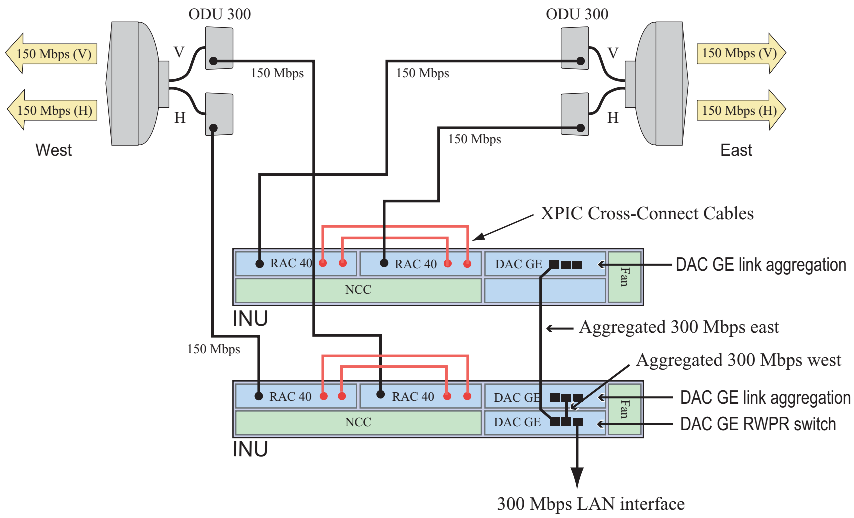


300 Mbps Co-channel Ethernet Ring Node

Figure 3-64 illustrates a 300 Mbps DAC GE Ethernet ring solution using co-channel 150 Mbps links east and west. Separate DAC GEs are required for the RWPR and link aggregation functions.

- Using RAC 40s the east and west links are configured on the same 28 MHz (ETSI) or 30 MHz (ANSI) radio channel.
- One DAC GE provides the RWPR ring function, which operates on 300 Mbps link-aggregated virtual links. Separate DAC GEs provide the link aggregation function.
  - DAC GE 'A' in INU 1 aggregates the east 150 Mbps links to provide a single 300 Mbps connection on ports 1 to 4, using transparent mode with C1 and C2 aggregation.
  - DAC GE 'B' in INU 2 aggregates the west 150 Mbps links to provide a single 300 Mbps connection on ports 1 to 4, using transparent mode with C1 and C2 aggregation.
  - DAC GE 'C' in INU 2 provides the RWPR ring switch function and hosts the local LAN. Note that the east, west and local LAN interfaces are all port-connected; the DAC GE 'C' transport channels are not configured (no backplane bus access is required).
  - The east and west aggregated links are treated as one virtual link by RWPR. If one link in the aggregated pair fails, ring switching does not occur - both links must fail to initiate switching.

Figure 3-64. 300 Mbps Co-channel Ring Node: 2x150 Mbps



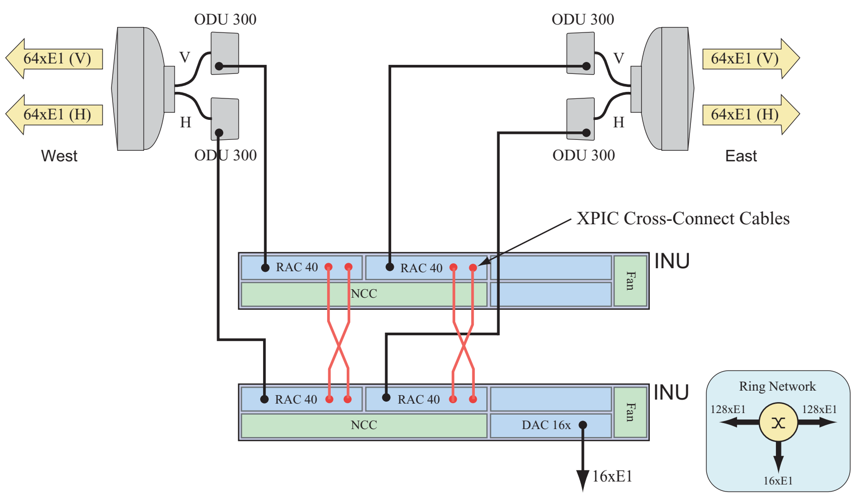
Co-Channel 64xE1 Ring Node

Figure 3-65 illustrates co-channel ring operation.

- 9500 MXC Super-PDH ring operation provides the ring protection mechanism.

For single gateway rings 64xE1 or 84xDS1 are the ring capacity maximums.

Figure 3-65. Co-Channel 64xE1 Ring Node with 16xE1 Drop-Insert

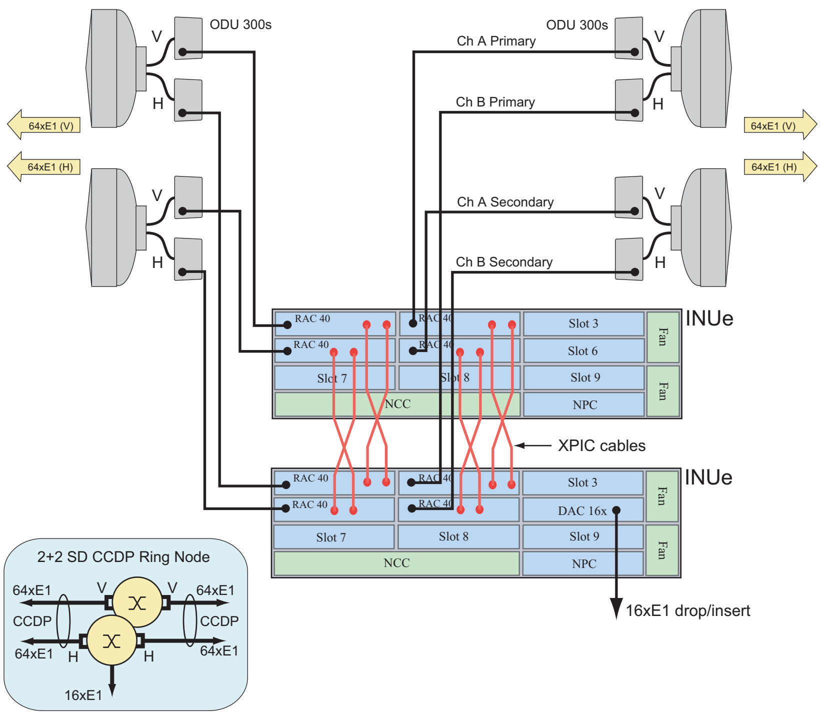


Space Diversity Protected Co-channel Ring Links

Figure 3-66 illustrates space diversity protection of co-channel ring links.

- Where path protection of a ring link is required space diversity (SD) is recommended.
- One or all ring links can be SD protected.
- Where co-channel ring links are to be SD protected, both must be SD protected.
- SD protection is subordinated to the ring protection mechanism (ring wrap and unwrap). For guidance on SD protection of ring links refer to 1+1 Protected Ring Links on page 3-86.
- The link maximums on single gateway rings are 64xE1 or 84xDS1.
- An NPC plug-in is included in each INUe to provide NCC redundancy.

Figure 3-66. Space Diversity Protected 64xE1 Co-channel Ring Links

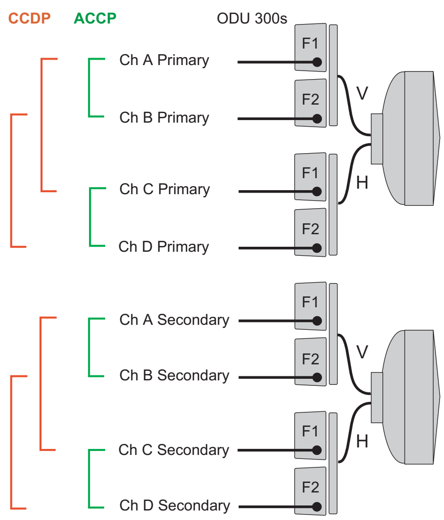


4+4 Space Diversity Operation Using CCDP and ACCP

Figure 3-67 illustrates ‘quattro’ 4+4 operation.

- When used within 9500 MXC Super PDH rings this configuration supports up to four co-path space diversity protected (SD) ring links.
- The combination of CCDP (co-channel dual polarization) and ACCP (alternate channel co-polarization) supports the four links on two 28/30 MHz channels.
  - Each of the two radio channels supports two co-channel links. Figure 3-61 illustrates the channel/link alignment.
- Link maximums on single gateway rings are 64xE1 or 84xDS1.
- The couplers must be equal-loss.
- The nominal loss through each coupler is 3.5 dB, meaning an additional 7 dB loss must be included in the system gain calculations for each link.

Figure 3-67. 4+4 Space Diversity Operation Using CCDP and ACCP



Configuration and Diagnostics

This section provides an overview of CT screens for INU/INUe/ODU configuration and diagnostics. Refer to:

- 9500 MXC CT Log-in on page 3-97
- Configuration on page 3-98
- Diagnostics on page 3-98

For more information on configuration and management, refer to Chapter 5.

9500 MXC CT Log-in

The INU and INUe include Ethernet and V.24 front-panel 9500 MXC CT PC (NMS) ports.

For Ethernet (10/100Base-T NMS port) there are two connection options:

- Direct addressing using the CT PC TCP/IP properties window to set a LAN compatible address on your PC, which requires knowledge of the IP address of the connected INU/INUe. Where not provided, it is discovered using CT address auto-discovery.
- DHCP server connection, where a server function in the INU/INUe provides an IP address to the CT PC client. This option does not require knowledge of the IP address for the connected radio.

For a V.24 connection, knowledge of the IP address for the connected INU/INUe is not required.

For information on CT PC connection, Refer to Volume IV, Chapter 2.

To enable CT access on a new (unconfigured) INU/INUe a V.24 connection is required at the outset. Once connected, an IP address can be configured, from which point Ethernet access can be used. All INU/INUe installation kits includes a V.24 cable.

An Ethernet connection is recommended as it provides a much faster connection and running speed, compared to a V.24 connection. Ethernet must be used for remote-end and network-wide access.

Configuration

CT configuration screens for 9500 MXC INUs are common to those used for IDUs (where service functionality is the same).

More information:

- For a summary list of configuration features, refer to 9500 MXC CT Feature Summary on page 5-1
- For information on a recommended configuration process for a new INU/INUe, refer to Procedure Overview for a New Installation on page 3-7 of Volume III.
- For detail configuration data, refer to the relevant screens in Volume IV.

Diagnostics

The CT Diagnostics screens support:

- Event browser.
- History. Graph and report options capture 7 days worth of 15 minute data bins, or one month of daily bins. Screens are provided for RACs and Ethernet DACs. The RAC screen captures G.826, G.821, RSL and event data. The Ethernet screen captures throughputs, frame types, discards, errors and events.
- Alarms, with context-sensitive Helpset support for alarm description, probable cause and recommended remedial actions (For context sensitive help '9500 MXC9500 MXC9500 MXC' must be loaded on your PC).
- RMON performance statistics for all ports and channels on the DAC ES and DAC GE plug-ins.
- G.826 link performance data and G.821 BER - with built-in BER test function on PDH and SDH tribs.
- Controls, with safety timers, for setting loopbacks, AIS, protection locks, Tx mute.
- Data dashboards for the DAC ES and DAC GE plug-ins. Includes information on Tx and Rx throughputs, discards and errors on all ports and channels.
- Information on serial number, part number, and time in service.
- Software reset and history-clear functions.

More information:

- For a summary list of diagnostic features, refer to 9500 MXC CT Feature Summary on page 5-1.
- To view the 9500 MXC CT diagnostic screens and their operation, refer to Diagnostics on page 15-1 of Volume IV.
- For a list of troubleshooting processes supported by the CT Diagnostic screens, refer to Using CT Diagnostics Screens on page 2-30 of Volume V.

Chapter 4. Outdoor Units

This chapterintroduces:

ODU Construction and Mounting

Housings are similar for ODU 300ep and ODU 300hp. Construction comprises:

- Cast aluminium base (alloy 380)
- Pressed aluminium cover (sheet grade alloy 1050).
- Base and cover passivated and then polyester powder coated
- Compression seal for base-cover weatherproofing
- Carry-handle

Figure 4-1. 9500 MXC ODU 300ep Housing

The ODUs include a waveguide antenna port, Type-N female connector for the ODU cable, a BNC female connector (with captive protection cap) for RSSI access, and a grounding stud.

The ODUs, are designed for direct antenna attachment via a 9500 MXC-specific mounting collar supplied with the antennas.

ODU polarization is determined by the position of a polarization rotator fitted within the antenna mounting collar (the ODU installed such that there is correct waveguide port alignment between the ODU and its antenna).

A remote ODU mounting kit is also available as an option. These may be used to connect an ODU to a standard antenna, or to a dual-polarized antenna for co-channel link operation.

The ODU assembly meets the ASTME standard for a 2000 hour salt-spray test, and relevant IEC, UL, and Bellcore standards for wind-driven rain.

ODU Data

There are two ODU options:

- ODU 300hp
- ODU 300ep

Both share the same RAC profiles, which means they operate to the RAC 30V3, RAC 40, RAC 3X and the IDUs.

- Within their band limitations the ODU 300hp and ODU 300ep are over-air compatible.
- ODUs are fixed for Tx High or Tx Low operation.
- ODUs are frequency-band specific, but within each band are capacity independent up to their design maximums. Main ODU performance characteristics are summarized in Table 4-1.

Table 4-1. ODU Characteristics

Item[1]	ODU 300ep	ODU 300hp
Frequency Bands	6 to 23 GHz	6 to 38 GHz
Capacity	5 to75xE1 4 to 100xDS1 1 to 6xDS3 2xSTM1/OC3	5 to 75xE1 4 to 100xDS 1 to 6xDS3 2xSTM1/OC3
Modulation Options	QPSK, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM	QPSK, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Bandwidths Supported	3.5 to 56 MHz	7 to 56 MHz
Tx Power	Extended power (except 11 GHz), with a maximum 30 dB power control range	High power, with a maximum 20 dB power control range
Tuning Range	Typically (depending on T/R spacing) 56 MHz at 6 / 7 GHz to 230 MHz at 15 GHz. 340 to 380 MHz on higher bands.	

Item[1]	ODU 300ep	ODU 300hp
IF Interface	RAC 30, RAC 3X, RAC 40, IDUs	RAC 30, RAC 3X, RAC 40, IDUs

1.ODU 300ep availability is now restricted to 13 and 15 GHz.

- Where two ODUs are to be connected to a single antenna for hot-standby or frequency diversity configurations, a direct-mounting coupler is used. They are available for equal or unequal loss operation. Equal loss is nominally 3.5/3.5 dB. Unequal is nominally 1.5/6.5 dB.

ODU 300hp and ODU 300ep Compatibility

These units are air-compatible, but the following points should be considered:

- When sparing an ODU 300hp with an ODU 300ep (or vice-versa), both ODUs must be on the same frequency band and the selected sub-band option must support the carrier spot frequencies. In some cases the sub-band options differ.
- ODU 300hp weighs 6.4 kg, whereas the ODU 300ep weighs 8.3kg.
- ODU 300hp power consumption is nominally 40W, whereas the ODU 300ep consumption is 50W. Where appropriate, consider the impact on site power supply loading when sparing an ODU 300hp with an ODU 300ep.
- The Tx power control range for the ODU 300hp and the ODU 300ep differ. The manual Tx control range must be considered for heavily (manually) attenuated links when substituting an ODU 300ep with an ODU 300hp.
- The Tx output power and Rx sensitivity figures for ODU 300hp and ODU 300ep vary depending on the ODU frequency band. Refer to the 9500 MXC datasheets for specific details. Differences should be considered to ensure target design fade margins are maintained when substituting ODU 300ep for ODU 300hp, and vice-versa.
- In a *protected RAC40* pairing, support is provided from SW release 4.3, for mixed ODU 300hp and ODU 300ep operation. Mixed hp/ep operation in protected RAC 40 configurations prior to this release is not recommended.

Further Information

Refer to Volume III, Chapter 2. for information on:

- Installation
- Lightning surge suppression
- Waveguide flange data

Refer to the 9500 MXC datasheets (ETSI or ANSI) for complete specifications.

Chapter 5. Configuration and Diagnostics

This chapter introduces features and capabilities of the craft terminal, 9500 MXC CT.

9500 MXC is a software-driven product; there are no manual controls.

9500 MXC CT

CT is a web-enabled application supported in the 9500 MXC system software. Once installed on a PC, it automatically downloads support from the radio as needed to ensure CT always matches the version of system software supplied, or subsequently downloaded in any radio upgrade. For information on auto-matching, refer to Volume 4, Chapter 2.

CT has the look and feel of a Windows environment with screen-based views and prompts for all configuration and diagnostic attributes.

There are two PC to INU/INUe or IDU connection options: 10/100Base-T Ethernet, or V.24/RS-232:

- Ethernet provides faster communication and supports access to all other NMS-connected Nodes/Terminals on the network. There are three Ethernet connection options:
  - Auto discovery of the IP address and terminal name of the connected terminal, with auto matching of the CT PC addressing.
  - Direct-entry of a LAN compatible IP address within the TCP/IP properties window on your CT PC. This is used where the auto discovery mechanism cannot establish compatible routing with the connected terminal.
  - DHCP connection, where the 9500 MXC Node/Terminal is the server and your CT PC the client.
- V.24/RS-232 is required in the absence of a DHCP connection option where the address of a Node/Terminal is unknown. It is typically used to load an IP address into a new, unconfigured Node/Terminal, from which point Ethernet is used.

For an overview of configuration and diagnostic features, refer to 9500 MXC CT Feature Summary on page 5-1.

For information on CT PC connection, refer to Volume IV, Chapter 2.

9500 MXC CT Feature Summary

Table 5-1 summarizes configuration features, Table 5-2 diagnostic features.

For detail information on CT installation and operation, refer to Volume IV.

Table 5-1. 9500 MXC CT Configuration Features

Configuration Feature	Function Summary
Plug-in slot location (INU/INUe)	The system summary screen (Diagnostics) is used to verify installation of new plug-ins, or the removal or re-location of existing plug-ins.
Plug-in/module setup	Screens prompt for all configuration actions relevant to the selected plug-in/module.
Protection settings	For 9500 MXC Node the protection screen supports RAC/ODU partnering for hot-standby, space diversity, frequency diversity, or ring. It also supports RAC 30 and DAC 155oM partnering for a radio-to-fiber ring transition. For permitted Terminals, the protection screen supports IDU/IDU partnering for hot-standby, diversity or ring operation.
Circuit cross-connect configuration	For the Node, circuit screens prompt for traffic and auxiliary cross-connections between all relevant plug-ins. Additionally, the TDM backplane bus is configured for NxE1, DS1, E3, DS3, or STM1/OC3 operation. For the Terminal, the Circuits screen is only applicable to the IDU ES.
Network management IP addressing and routing	Networking screens support single or individual port-based addressing, and static or dynamic routing. Also selection of an Ethernet DHCP server option for CT PC DHCP log in.
Alarm Actions	Prompts the mapping of alarm input/output actions within a 9500 MXC network.
Date and time	Date and time screens prompt for date and time settings based on locality or PC settings.
License upgrade	The licensing screen provides a view of the licensed capacity for a Node or Terminal, and prompts for the up-loading of a new license.
Software management	The software management screen supports loading of system software.

Table 5-2. 9500 MXC CT Diagnostic Features

Diagnostic Feature	Function Summary
System summary	The system summary screen provides a system layout and real-time status overview for a Node or Terminal. The layout options support slot assignment selection/confirmation for INU/INUe plug-in options. Circuit connection data provides a visual indication of all traffic cross-connections for an INU/INUe. Includes quick-access menus to relevant configuration and diagnostics screens, as well as single-click access to relevant alarms screens.

Diagnostic Feature	Function Summary
Status bar	A top-level alarm severity icon is displayed within the status bar of all screens. It is supported by problem icons and mouse-over tool-tips, with single-click access to the System Summary screen for more data.
Event browser	The events browser screen provides a real-time view of all alarms, both active and cleared. Icons indicate severity, and if active or cleared. All events are time and date stamped, and options are provided to view just current alarms, or all occurrences of a selected alarm type. The events listing can also be exported as a csv (Excel) file.
History	History screens provide selection of 15-minute or 24-hour options. 15-minute provides viewing of seven days worth of 15 minute data bins; 24-hour provides one months worth of 1 day data bins. Screens are provided for RACs and for Ethernet DACs. RACs: The graph option provides a histogram of G.826 statistics, G.821 bit errors, event detected, configuration changes, and RSL. The report option enables selection of five history summaries: G.826, G.821, RSL, Event or Configuration. Ethernet DACs: Screens present Ethernet Rx and Tx statistics per port and channel, events and configuration changes.
Alarms	The alarms screen provides a tree-view of all alarm actions for a selected plug-in since log-on, or a history reset.
Performance	For a link (RAC) the performance screen provides G.826 data, RSL, current BER, remote fade margin, transmit power, ODU temperature, and ODU supply voltage. For the DAC ES and DAC GE it presents RMON performance data.
System controls	Systems controls presents plug-in and module relevant diagnostic menus for setting loopbacks, AIS, protection locks, Tx mute, and BER testing. For DAC ES and DAC GE it presents Ethernet data dashboards, which include Tx and Rx throughput, discards and errors per port and channel.
Circuit Loopbacks	Circuit loopbacks supports activation of a both-way loopback on the TDM bus.
Parts	The parts screen provides information on serial number, part number, and time in service for a selected plug-in.
Advanced Management	Provides software reset and history-clear functions: • The software reset is equivalent to a power-down reboot (power off - pause - power on), and saves a copy of the Helpdesk Data File to a default folder on your CT PC. • The clear option clears all (unwanted) historical data from the Event Browser and History screens.

Chapter 6. 9500 MXC Performance and Diagnostic Features

This chapter highlights some of the extensive 9500 MXC performance and diagnostic features. Refer to:

- 9500 MXC Node on page 6-1
- 9500 MXC Terminal on page 6-5
- Operation on page 6-6
- Diagnostics on page 6-7

9500 MXC Node

9500 MXC Node provides unmatched capabilities and ease of configuration at sites where two or more links are required, and/or where a link, or links are to be protected for hot-standby, diversity or ring operation. Refer to:

- Platform
- Multiplexer Modes
- Capacity and Modulation
- Super PDH
- Internal Cross-connects
- Protection
- Dual Protection
- Ethernet
- Co-channel XPIC
- Auxiliary Data and Alarm I/O

Platform

The Node delivers a *nodal* solution; one 9500 MXC platform directly supports up to six links. Radio paths and customer interfaces are customized by plug-in cards, with interconnection of traffic and services on a high-speed backplane bus.

For TDM transport the Node is SW configurable for link capacities from 4 to 100xE1, or 4 to 127xDS1. Other traffic options are E3, DS3, STM1/OC3

For Fast and Gigabit Ethernet the Node is SW configurable for link capacities from 6 to 300 Mbps.

Path options include hot-standby, space diversity, frequency diversity, and ring. Dual protection options are also available, as is co-channel XPIC operation.

Frequency bands extend from 6 to 38 GHz.

See INUs and ODUs.

INUs

The 1RU INU supports a maximum of three ODUs for three non-protected links, or one protected/diversity link with one non-protected link

The 2RU INUe supports a maximum of six ODUs for six non-protected links, or up to three protected/diversity links

Each ODU is supported by a RAC plug-in via a single coax cable.

ODUs

There are two ODUs:

- ODU 300hp for 6 to 38 GHz with high Tx power, capacities from 5xE1 or 4xDS1 to 2xSTM1/OC3, and modulation options from QPSK to 256QAM.
- ODU 300ep for 6 to 23 GHz with extended Tx power, capacities from 5xE1 or 4xDS1 2xSTM1/OC3, and modulation options from QPSK to 256QAM.

Multiplexer Modes

Where a combination of rates is needed on the same Node, such as STM1/OC3 and E1/DS1, or E3/DS3 and E1/DS1, multiplexer DACs map the STM1/OC3 or E3/DS3 interfaces to a common E1 or DS1 backplane rate. This allows side-by-side transportation of STM1/OC3, or E3/DS3 with E1/DS1 traffic over 9500 MXC links.

Capacity and Modulation

Capacity and modulation can be selected up to the maximum supported by each installed RAC/ODU.

TDM Transport:

- For RAC 30V3, ETSI capacity options extend from 5xE1 to 75xE1, and STM1. North American options extend from 4xDS1 to 100xDS1, 1xDS3 to 4xDS3, and OC3.
- For the RAC 3X, ETSI capacity options extend from 64x to 100xE1, or 1/2x STM1. ANSI options extend from 32x to 100xDS1, 4xDS3, or 1/2xOC3.
- Capacity is licensed per RAC/link, beginning with a base Node license of six 40xE1 links, or six 16xDS1 links.

Ethernet Transport

- For RAC 30 Ethernet capacity options extend from 6 Mbps to 150 Mbps.
- For RAC 3X the options extend from 50 to 300 Mbps.
- For the CCDP RAC 40, the options extend from 100 to 150 Mbps.

Depending on permitted capacity/bandwidth combinations, modulation is selectable for QPSK, 16QAM, 32QAM, 64QAM, 128QAM, or 256QAM.

Liquid Bandwidth

Capacity can be assigned between Ethernet and TDM data over the same link.

- Using an E1 / 2 Mbps backplane bus, traffic is assigned in 1xE1 or 1x2 Mbps steps between PDH and Ethernet data.
- With a DS1 / 1.5 Mbps backplane bus, traffic is assigned in 1xDS1 or 1x1.5 Mbps steps between PDH and Ethernet data.
- With an STM1/OC3 / 150 Mbps backplane bus, 1xSTM1/OC3 *and* 1x150 Mbps Ethernet can be transported over the same link.

Super PDH

The extension of over-air capacities to 75xE1 or 100xDS1 (Super PDH) means that for most backhaul requirements there is no need to migrate to SDH. Staying with PDH results in significant savings on cost of equipment, complexity, and time.

Internal Cross-connects

By supporting up to six links with internal cross-connects, the Node provides a much more compact and flexible solution when compared to stand-alone links. Avoiding patch panels and cabling also provides a neater and more reliable installation, and software configurability means traffic circuits can be remotely configured and executed.

Protection

TDM Protection Options

Hot-standby and diversity options are complemented by ring protection for PDH traffic, where the protection is managed within the 9500 MXC for Super-PDH ring capacities up to 75xE1 or 100xDS1; no external equipment is required.

Ring protection timers are provided to set an unwrap time, which can be set to act after a period of error-free operation, or to a time of day.

The DAC 155oM multiplexer plug-in supports fiber ring closures on capacities to 63xE1 or 84xDS1.

DAC (tributary) protection is supported for E3/DS3 and STM1/OC3 DACs, including the DAC 155oM.

Ethernet Protection Options

The DAC GE directly supports carrier-class RWPR (Resilient Wireless Packet Ring), an enhanced RSTP capability for Ethernet ring/mesh network topologies. When a ring connection fails, RWPR supports ring re-convergence times of less than 100 ms, compared to the 1 to 5 seconds typically needed for RSTP.

Dual Protection

Protected links can also be protected; a master protection option protects two subordinate protected links, or one protected link with one non-protected link. Dual protection options are:

- Frequency diversity over two hot-standby links, or over one hot-standby link and one non-protected link.
- Frequency diversity over two space diversity links, or over one space diversity link and one non-protected link.

Ethernet

The 9500 MXC Node provides comprehensive solutions for transporting Ethernet traffic using the DAC ES plug-in for Fast Ethernet, and DAC GE for Gigabit Ethernet:

DAC ES

- Fast Ethernet is supported on one or two transport channels, with each channel configurable to 100 Mbps.
- Options include selection of transparent, VLAN or mixed-mode operation, and QoS policing and prioritization.
- Traffic can be configured to ride side-by-side with E1 or DS1 traffic.

DAC GE

- DAC GE supports one or two transport channels with capacities selected in multiples of 2 Mbps, 1.5 Mbps, or 150 Mbps.
  - For Nx2 Mbps or Nx1.5 Mbps selections, a maximum of 200 Mbps is supported on one channel, or 200 Mbps total using both channels.
  - For Nx150 Mbps, channel capacity selections support 150 Mbps on each channel, or 300 Mbps on one channel.
- Options include selection of transparent, VLAN or mixed-mode operation, QoS traffic policing and prioritization, RWPR™, link aggregation, and VLAN tagging.
  - RWPR delivers enhanced RSTP (Rapid Spanning Tree Protocol), but whereas RSTP re-convergence times are typically between 1 to 5 seconds, RWPR times are as low as 50 milliseconds.
  - The same RWPR fast-switch capability is also used to optimize layer 2 link aggregation, when traffic from a failed link is switched to share the bandwidth available on the remaining link or links.
- Ethernet traffic can be configured to ride side-by-side with E1 or DS1 traffic.
- Using L2 (layer 2) link aggregation multiple Nodes may be co-located to support virtual link configurations with throughputs to 1000 Mbps.
- L1 (layer 1) link aggregation is also available, which has particular relevance for 300 Mbps router-to-router connections on parallel-path 150 Mbps links.

Co-channel XPIC

Co-channel operation (CCDP) allows two links to operate on different polarizations over the same radio path and on the same frequency, to provide double the capacity of a normal link, and only occupy one radio channel. XPIC enhances polarization discrimination between the vertical and horizontal radio paths.

RAC 40 supports capacities to 75xE1, 100xDS1, 1xSTM1/OC3, or 150 Mbps Ethernet per link. Together, the paired RAC 40s support up to 150xE1, 300xDS1, 2xSTM1/OC3 or 300 Mbps Ethernet on the same 28 MHz or 30 MHz radio channel.

Auxiliary Data and Alarm I/O

The Node supports six 64 kbps synchronous, or 19.2 kbps (1.2 to 19.2 kbps) asynchronous auxiliary data channels per link, plus an alarm I/O capability. The alarm I/O supports up to six TTL alarm inputs and 4 Form C relay outputs per AUX plug-in.

9500 MXC Terminal

9500 MXC Terminal is a single-link terminal, comprising an IDU (Indoor Unit) and ODU. They may be operated as single links, or back-to-back network connected.

The PDH and SDH Terminals can be paired for protected link operation, and all IDUs can be over-air interfaced to 9500 MXC Node.

Terminal variants support PDH, SDH or Ethernet applications on bands 5 to 38 GHz:

- **IDU 20x** supports two operational modes:
  - In standard mode it supports over-air rates from 5x to 20xE1 or 4x to 16xDS1, QPSK to 128 QAM, for non-protected, hot-standby, or space diversity operation.
  - In expanded mode paired terminals are operated as hot-standby or space diversity links, but the tributary field supports up to 40xE1 or 32xDS1. Path, ODU and RAC module protection is retained; tributary module protection is not.
- **IDU 155o** supports 1xSTM1/OC3 via optical LC interfaces, 16 to 128QAM. Non-protected, hot-standby or space diversity operation.
- **IDU ES** supports Ethernet to 200 Mbps with up to 8xE1/DS1 waysides, QPSK to 128QAM. Non-protected operation.
  - Supports four customer 10/100baseT ports, two over-air transport channels and comprehensive VLAN and QoS options.
  - Channel bandwidths are selectable through a range of modulation options, from QPSK to 128 QAM, to support operator selection of radio system performance.

ODUs

ODUs used with the Terminals are the same as those used with the Node. Refer to ODUs on page 6-2.

Inter-operation

Terminals may be linked to like Terminals, and to a 9500 MXC Node to support Terminal spurring from a Node.

- A 9500 MXC Node when equipped with the appropriate RAC, DAC and ODU combinations interfaces to an IDU 20x, IDU ES or IDU 155o.

Terminal Auxiliary Data and Alarm I/O

All Terminals support auxiliary data and alarm I/O:

- The data interface supports one 64 kbps synchronous or one 19.2 kbps (1.2 to 19.2 kbps) asynchronous channel.
- The alarm I/O supports two TTL alarm inputs and four Form C relay outputs.

Operation

Advanced operational features include:

- ATPC
- FEC
- Adaptive Equalization
- Tx Power Management

ATPC

Automatic Transmitter Power Control (ATPC) for the 9500 MXC Node and Terminal is configurable over their full dynamic range in 0.1 dB steps. ATPC is enabled/disabled through 9500 MXC CT, with the operator able to select a target fade margin, and low and high transmit power limits.

FEC

All RACs and IDUs employ Reed-Solomon FEC encoding (with interleaving).

RAC 3X, RAC 40, IDU ES and IDU 155o also incorporate Viterbi encoding on selected capacity/modulation options.

Reed-Solomon FEC code is utilized to typically correct up to 8 errored bytes per 250/255 byte block (frame). This improves the receiver 10^{-6} threshold by approximately 3 dB. Actual block size is dependent on the selected capacity for the link.

Immunity to burst noise is enhanced by an interleaving function, which spreads burst errors evenly over the blocks, reducing the number of errors per block, and improving the ability for the FEC to correct induced errors. The amount of interleaving performed is dependent on the transmission capacity, to be over 2 or 4 blocks.

Viterbi is most suited to channels where signal corruption is caused by additive white (gaussian) noise, which is particularly relevant near receive thresholds when signal-to-noise ratios are low.

Adaptive Equalization

Adaptive equalization (AE) is employed to improve reliability of operation under dispersive fade conditions, typically encountered over long and difficult paths.

This is achieved through a multi-tap equalizer consisting of two registers, one with feed-forward taps, the other with feed-back taps. Each of these registers multiply successive delayed samples of the received signal by weighting-coefficients to remove propagation induced inter-symbol interference.

Tx Power Management

9500 MXC platforms provide comprehensive power management options for:

- Power Output
- Power Control Range

- Power Monitoring

Power Output

Output power is band and modulation dependent.

- ODU 300ep is an extended power ODU, with transmit outputs to 30.5 dBm at 6 to 8 GHz, and 21.5 dBm at 23 GHz.
- ODU 300hp is a high power ODU, with transmit outputs to 28.5 dBm at 6 to 8 GHz, 19.5 dBm at 23 GHz, and 17.5 dBm at 38 GHz.

Power Control Range

Transmit power is programmable in 0.1 dB steps.

For the ODU 300hp, the power control range is 20 dB for QPSK, and between 18 dB (16 QAM) and 14 dB (256 QAM) for the QAM options. Accuracy is +/-2dB over range and temperature.

For the ODU 300ep, the power control range is 30 dB for QPSK and between 26 and to 22 dB for the QAM options, with an accuracy of +/-2dB over range and temperature.

Power Monitoring

The ODU 300 series incorporates a detector for Tx power measurement. It is used to provide measurement of forward power as a performance parameter, and to provide a calibration input for transmitter operation over temperature and output range.

Viewed Tx power ranges always match the capabilities of the ODU for a given modulation. When modulation is changed, 9500 MXC CT automatically adjusts/ restricts Tx Power to be within valid range.

Diagnostics

Diagnostic capabilities include:

- System Summary
- Event Browser
- History
- Alarms
- Performance
- System/Controls
- Circuit Loopbacks
- Front Panel LEDs

System Summary

The System Summary screen provides a single-view snapshot of the configuration and health of a Node/Terminal. For the Node it presents plug-in card interconnections, capacities configured and connection status. Single click access is provided to related screens for configuration and diagnostics.

Event Browser

The Events Browser screen provides a time and date-stamped view of the most recent 5000 events, both active and cleared. Options include viewing of current alarms only, or all occurrences of a selected alarm type.

For each alarm or informational event a tab provides access to additional information. For alarms the alarm description, probable causes, and recommended actions are displayed. For information events its description is displayed.

History

The History screens provide either a seven day, or one month graphical and report views of operational history, captured as 15 minute data bins over the most recent seven days, or daily bins over one month. For links the screen supports G.826 data, RSL, events, and configuration changes. For Ethernet modules the screen supports Rx and Tx throughputs, frame type, discards, errors, events and configuration changes.

Alarms

An alarms screen provides a tree-view of all alarm actions for a selected plug-in. For each alarm a tab provides access to the alarm description, probable causes, and recommended actions.

Performance

For a RAC the Performance screen provides G.826 data for the selected link, plus Tx power, RSL, PA temperature, -48Vdc supply voltage at the ODU, and an estimate of current BER and remote fade margin (fade margin at the far-end Rx).

G.826 data includes:

- Elapsed, available and unavailable seconds
- Errored seconds and errored second ratio
- Severely errored seconds, and ratio
- Block error, background block errors, and ratio

For the Ethernet screens (DAC ES, DAC GE), RMON performance statistics are displayed for each port and channel, as well as data dashboards for Ethernet throughput, discards and errors, plus port and channel status summaries.

For a DAC 16x or DAC 4x, background circuit error performance is captured on a selected E1 trib using the CRC (Cyclic Redundancy Check) bits in the G.704 multiframe.

For the NCC, temperature and supply voltage are displayed.

System/Controls

The System/Controls screens present diagnostic menus for:

- Link Menu
- Ring Menu
- Data Menu
- AUX Menu

Link Menu

The Link menu applies to RACs and Radios and includes tools for loopbacks, protection locks and Tx mute:

Loopbacks can be applied on:

- Bus-facing digital or IF loopbacks on RAC plug-ins (Node).
- Customer-facing digital loopback on the Terminal.
- Both-way circuit loopbacks on the TDM bus (Node).

Protection locks enable the locking of a Tx and/or Rx online, and support switching to online secondary from primary, and vice-versa.

Safety timers are provided on all loopback and lock selections.

Graphics provide a status summary for protected configurations.

Ring Menu

The Ring menu applies to RACs to provide a status graphic and locks for East and West Online and Offline operation.

- RAC East; provides locks for East RAC Tx Mute, and for digital and IF loopbacks.
- RAC West; provides locks for West RAC Tx Mute, and for digital and IF loopbacks.

An Online selection locks the selected west and/or east RAC online; ring wrapping is disabled. An Offline selection is used to force ring wrapping.

Locks include a safety timer.

Graphics provide a status summary of the ring protected links.

Data Menu

- For PDH and SDH DACs and Terminals the Data menu provides trib-by-trib selection of loopbacks, transmit AIS, and PRBS generator with G.821 data receiver.
- For the Ethernet DACs and IDU ES, it provides data dashboards, plus port and channel status summaries.
- For protectable DACs the screen enables Tx and Rx locks, and online status change.

Loopbacks. A loopback *or* AIS can be enabled on a trib. Line-facing and radio-facing (bus-facing) loopbacks are supported.

BER Test. A PRBS generator and G.821 receiver support looped, and both-way tests on tribs using a standard BER 2^{15-1} test pattern. User traffic is replaced by the PRBS test pattern and results viewed on the G.821 receiver. Information includes available time, bit errors, errored seconds, severely errored seconds, and errored second ratios. A test can be applied over a single link or multiple links, depending on the routing of the circuit under test. The 2^{15-1} PBRS test pattern can also be used in conjunction with an external BER test set.

Safety Timer. Locks, loopbacks, and PRBS options are supported by safety timers.

Ethernet dashboards provide overview and detailed graphical presentations of port and channel throughputs, discards and errors, plus a summary indication of configured capacities and connection status.

AUX Menu

With the exception of AIS, the AUX menu options are the same as the DAC/Terminal PDH options.

Circuit Loopbacks

The Circuit Loopback screen enables application of a both-way loopback on the TDM bus. Applies to a 9500 MXC Node only.

Circuit loopbacks may be applied to E1, E3, DS1, DS3 or STM1/OC3 selections. Auxiliary data circuits are also supported. Only one Circuit Loopback can be applied at a time, and only traffic on the selected circuit is affected by circuit loopback activation.

In conjunction with the built-in PRBS Generator in DAC plug-ins, the circuits loopback function provides a user-friendly tool for tracing and checking a circuit through a network of 9500 MXC Nodes.

Front Panel LEDs

Front panel LEDs provide a quick indication of status, online, diagnostic and alarm states. Refer to 9500 MXC LEDs on page 2-9 of Volume IV for information on LED indications.

Volume III

9500 MXC Installation

Chapter 1. Introduction

This volume provides installation procedures and guidance for the 9500 MXC radios, from unpacking and checking the equipment to completion of the physical installation and antenna alignment.

This chapter includes:

Product Compliance

9500 MXC has been tested for and meets EMC Directive 89/336/EEC. The equipment was tested using screened cabling; if any other type of cable is used, it may violate compliance.

9500 MXC is a Class A product. In a domestic environment it may cause radio interference in which case the user may be required to take adequate measures. This equipment is intended to be used exclusively in telecommunications centers.

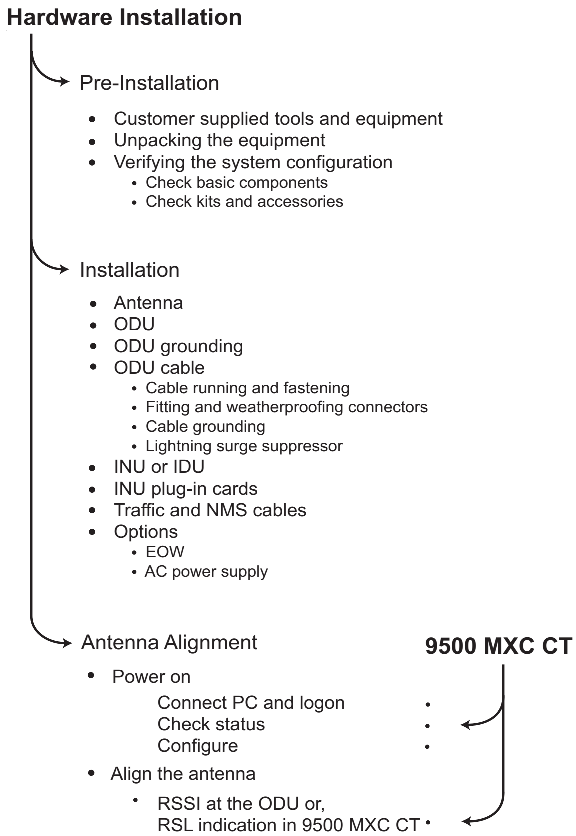
9500 MXC Health and Safety Requirements

The installation ***must*** comply with the relevant health and safety practices when working on or around the 9500 MXC radio equipment. Refer to Volume 1 of this manual.

Installation Overview

Figure 1-1 shows an overview of a typical installation procedure.

Figure 1-1. 9500 MXC Hardware Installation Overview



Installation can be completed up to antenna alignment without the use of 9500 MXC CT, the PC based craft terminal. 9500 MXC CT is required to check and configure a 9500 MXC Node or Terminal.

Before Going On Site

This section includes:

- Tools and Material
- Unpacking the Equipment

Tools and Material

Ensure you have the following tools and material before going to site.

Table 1-1 lists the tools and material that must be sourced or supplied by the installer.

Table 1-1. Required Tools and Material

Equipment	Tool / Material	Description
Antenna	As required by the manufacturer	Alcatel-Lucent offers antennas from various suppliers. Refer to the manufacturer's data supplied with each antenna for required and recommended installation tools and equipment.
9500 MXC Radios	Basic electrician's toolkit	The kit must include a crimp tool for attaching lugs to stranded copper cable, a multimeter, and a set of metric Allen keys for the polarization rotator bolts.
	Open-ended spanners	19 mm (3/4") open-ended spanner for attaching the ODU to the mounting collar.
	Torque wrench	Capable of 66 N-m or 50 ft-lb, with a selection of sockets for antenna mount fastening
	Connector crimp tool	Where crimp-type coax connectors are used, ensure the correct crimp tool is used.
	Cut-off tool	Where solid-outer coax is used for the ODU cable, the correct cut-off tool should be used to avoid damage to the cable outer.
	Hot-air gun	For use on heat-shrink tubing.
	Protective grease and zinc-rich paint	For weather-protecting grounding attachment points on towers and grounding bars.
	BNC cable	To access the RSSI voltage at the ODU for antenna alignment. This could be a BNC to banana plugs cable for connection to a multimeter. Such a cable is available as an optional accessory from Alcatel-Lucent.
	4mm^2 (#12) green PVC insulated strand copper wire and grounding lugs	For grounding the indoor unit to the rack/frame

Equipment	Tool / Material	Description
	16 mm^2 (#6) green PVC insulated strand copper wire and grounding lugs	For grounding the rack to the station ground

Unpacking the Equipment

To unpack the equipment:

1. Open the shipping boxes, carefully remove the equipment and place it on a clean, flat working surface.
2. Ensure all the basic components and accessories for your system have been included in the shipment by comparing the packaging, component part numbers and product descriptions against the packing list, and cross-checking against the installation datapack for the system to be installed.
3. If there has been shipping damage or there are discrepancies between the equipment expected and the equipment received, contact your Alcatel-Lucent service support center or your supplier.

Chapter 2. Outdoor Installations

This chapter describes the following installation procedures:

Installing the Antenna

Antennas must be installed in accordance with the manufacturer's instructions.

- For direct-mounted ODUs the antenna includes a collar with integral polarization rotator. Dependant on frequency band, these antennas are available in diameters up to 1.8 m (6 ft).
- Where standard antennas are to be used, the ODU must be installed on a remote-mount, and a flexible waveguide used to connect to its antenna.

Before going to the site, check that you have the required installation tools as recommended by the antenna manufacturer, and that you have data for positioning the antenna on the tower, its polarization and initial pointing.

- For direct-mounted ODUs, polarization is determined by the setting of the polarization rotator.
- For standard antennas, polarization is determined by the orientation of the antenna.

Installing the ODU

There are two ODU variants; ODU 300hp and ODU 300ep. For details refer to Outdoor Units, Volume II, Chapter 4.

- All ODUs are designed for direct-mounting to a collar supplied with direct-fit antennas.
- All ODUs can also be installed with standard antennas using a flex-waveguide remote-mount kit.

For single-antenna protected operation a coupler is available to support direct mounting of the two ODUs to its antenna, or to support direct mounting onto a remote-mounted coupler.

Refer to:

Direct-Mounted ODUs

Refer to:

Overview

The ODU is attached to its mounting collar using four mounting bolts, with captive 19 mm (3/4”) nuts.

The ODU mounts directly to its antenna mount, as shown in Figure 2-1.

Figure 2-1. ODU and Mounting Collar

Figure 2-2 shows the ODU mounting collar, pole mount and polarization rotator for an Andrew antenna.

Figure 2-2. Andrew Pole Mount and ODU Mounting Collar

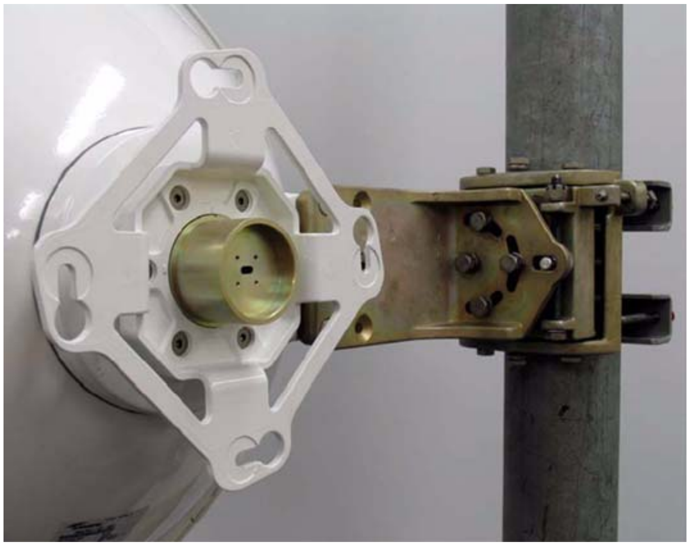


Figure 2-3 shows the ODU mounting collar, pole mount, and polarization rotator for a Radio Waves antenna.

Figure 2-3. Radio Waves Pole Mount and Mounting Collar

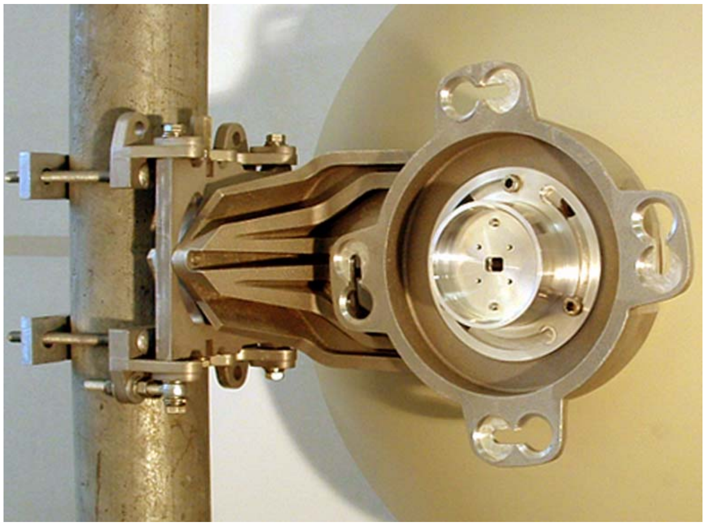
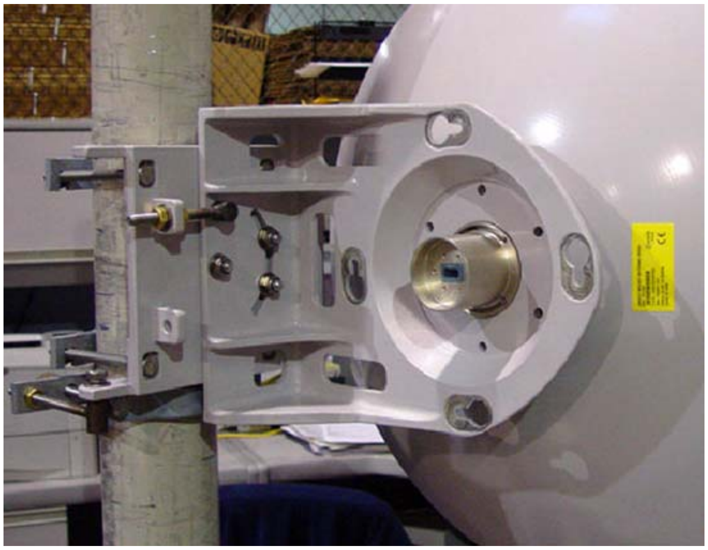


Figure 2-4 shows the ODU mounting collar, pole mount, and polarization rotator for a Precision antenna.

Figure 2-4. Precision Pole Mount and ODU Mounting Collar



Next step: Setting the Polarization on page 2-4.

Setting the Polarization

Antenna installation instructions are included with all antennas. These instructions include procedures for setting polarization.

The polarization of the transmitted signal, horizontal or vertical, is determined by the antenna. The polarization of the ODU is set to match its antenna

- **Direct-Mounted ODUs**: For direct-mounted ODUs, antenna polarization is set using a polarization rotator fitted within the ODU mounting collar.

  The rotator is an integral part of the antenna mount. Vertical polarization is the default setting.

  The V and H settings are indicated on the rotator head.

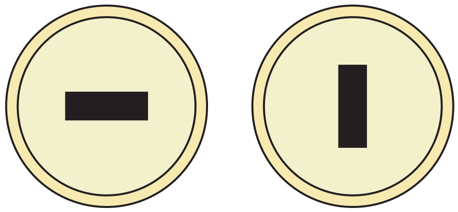
- **Remote-Mounted ODUs** are used where standard antennas are used (antennas are not fitted with the 9500 MXC mounting collar), or where dual-polarized antennas are installed for CCDP XPIC operation.

  Antenna installation for V or H polarization is normally determined by the orientation of the waveguide port / slot.

  To remote mount an ODU, refer to Remote-Mounted ODUs on page 2-8.

Figure 2-5 illustrates antenna waveguide port (slot) orientation for vertical and horizontal polarization settings.

Figure 2-5. Antenna Waveguide Slot Orientation for V and H Polarization



Dual Polarized Antennas

Dual polarized antennas may not be not marked for V and H, and may also present the same orientation for both ports. However, one port should have a straight waveguide feed into its antenna, the other should include a 90 degree twist.

- For *convention*, if ports are not marked for V and H, it is recommended that the port that has the straight waveguide feed is selected as the vertical antenna feed port.
- Ensure the same port is selected for vertical at both ends.
- Where possible, the same 'above and below' relationship of the feed ports should be used at both ends. For example, if at one end the vertical feed port is located above the horizontal port, then the same relationship should be used at the other end.

ODU Rotator Procedure

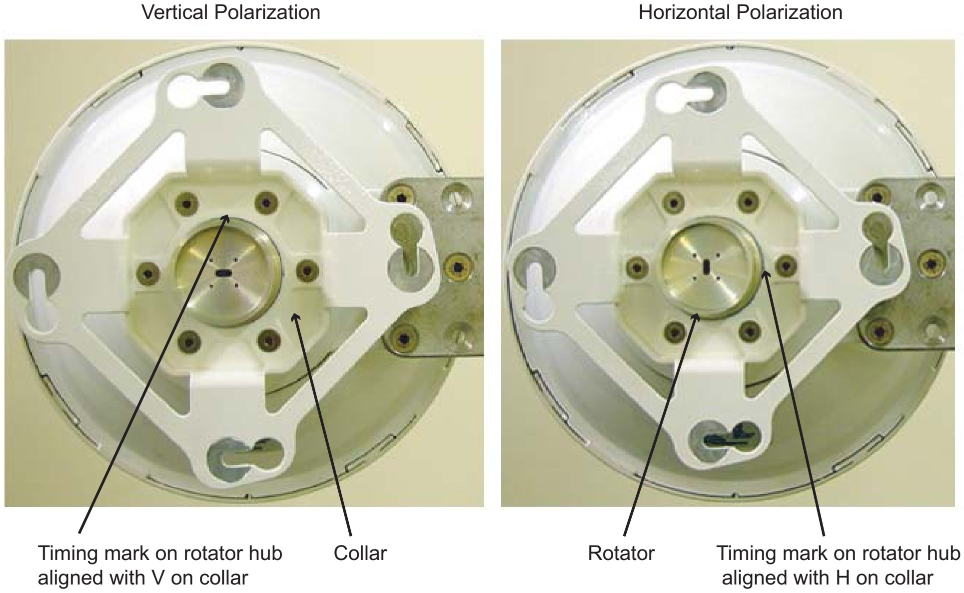
If the ODU rotator is not set for the required polarization, you must adjust its orientation. This topic describes typical adjustment procedures for Andrew and Radio Waves antennas.

Procedure for Andrew Rotator

To change the polarization of the Andrew antenna:

1. Release (do not completely undo) the six metric Allen-head screws approximately 10 mm (3/8 inch). Pull the collar forward and hold the rotator back, which will allow the rotator to disengage from a notch in the collar, and turn freely.
2. Turn the rotator hub 90° until it locates back into a notched "timing recess" *in the collar*.
3. Check that the timing mark on the rotator hub has aligned with either a V or an H on the collar to confirm polarization. Refer to Figure 2-6 on page 2-6.
4. Ensure the rotator hub is correctly seated within its collar, then push the collar back against the antenna mount and re-tighten the six screws.

Figure 2-6. Andrew ODU Collar and Polarization Rotator



Procedure for Radio Waves Rotator

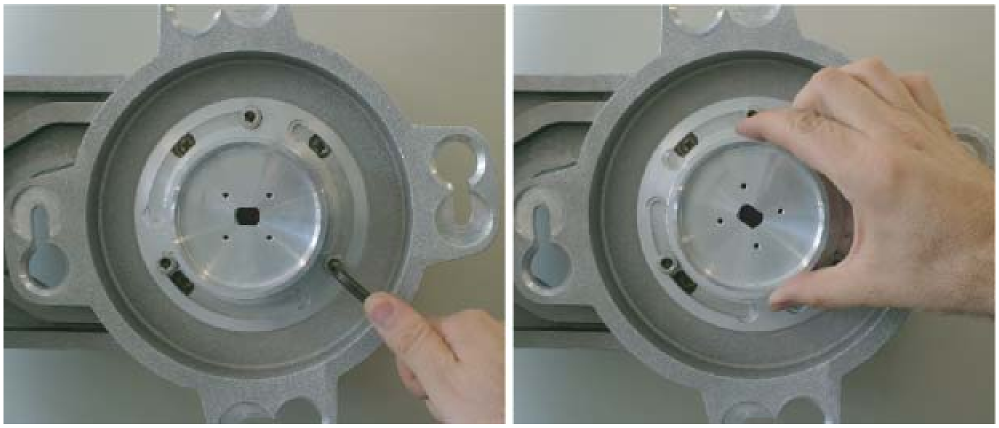
The polarization rotator is fixed by three metric Allen-head bolts.

To change the polarization of the Radio Waves antenna:

1. Loosen the bolts. Refer to Figure 2-7.
2. Rotate to other end of the slots. Refer to Figure 2-7.
3. Check bolt heads are located in the slot recesses.
4. Refasten.

Figure 2-7 shows a close-up of the polarization rotator being released from the vertical position (left) and rotated clockwise towards horizontal (right).

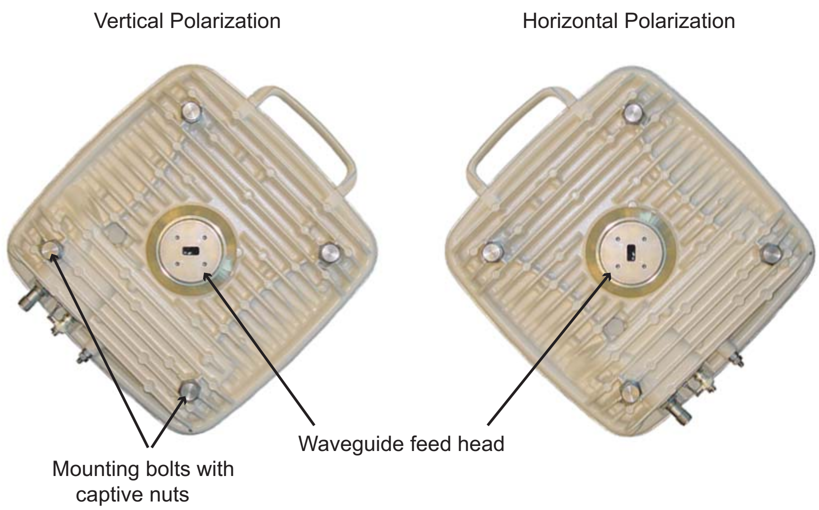
Figure 2-7. Radio Waves Polarization Rotator



ODU Polarization

The ODU must be mounted on the collar to match the chosen polarization. Correct positioning for vertical or horizontal polarization is shown in Figure 2-8.

Figure 2-8. ODU Orientation for Vertical or Horizontal Polarization



An ODU should be installed with its connectors facing down.

Next step: Direct-Mount ODU Attachment Procedure on page 2-7.

Direct-Mount ODU Attachment Procedure

This topic describes the physical attachment of an ODU to an antenna mounting collar.

Related procedures are:

- Installing the ODU Lightning Surge Suppressor; refer to Installing Lightning Surge Suppressors on page 2-20. This is only required for ODUs not fitted with an internal lightning surge suppressor.
- Grounding an ODU; refer to Grounding the ODU on page 2-12
- Installing the ODU cable and connectors; refer to Installing ODU Cables and Connectors on page 2-16

Attaching the ODU

An ODU should be installed with connectors facing down.

To attach the ODU:

1. Check that the ODU mounting collar, polarization rotator, ODU waveguide feed head and O-ring, are undamaged, clean, and dry.
2. Set the polarization rotator for the required polarization. Refer to Setting the Polarization on page 2-4.
3. Apply a thin layer of silicon grease around the ODU feed-head O-ring.

A tube of silicon grease is included in the ODU installation kit.

4. Fully loosen the nuts on the four ODU mounting bolts.
5. Position the ODU so the waveguide slots (ODU and rotator) will be aligned when the ODU is rotated to its end position.
6. Fit the ODU onto its mounting collar by inserting the bolts through receptor holes in the collar, then rotate the ODU clockwise to bring the mounting bolts hard up against the slot ends.
7. Carefully bring the ODU forward to fully engage the ODU feed head with the polarization rotator.
8. Finger-tighten the four nuts, checking to ensure correct engagement of ODU with mounting collar.
9. Ensure the ODU bolt-down points are correctly seated, then tighten the four nuts with an open-ended 19 mm (3/4”) spanner.
10. To remove an ODU, reverse this procedure.

When removing an ODU from its mount, ensure the ODU fastening nuts are fully released.

Remote-Mounted ODUs

Refer to:

- Remote-Mount Overview on page 2-8
- Waveguide Flange Data on page 2-10
- Remote-Mount Installation Procedure on page 2-11

Remote-Mount Overview

An ODU can be installed separate from its antenna, using a remote-mount to support the ODU, and a flexible-waveguide to connect the ODU to its antenna:

A remote mount allows use of standard, single or dual polarization antennas.

The mount can also be used to remotely support a protected ODU pairing *installed on a coupler*. The coupler connects to the remote mount assembly in the same way as an ODU.

When co-channel XPIC, single antenna link operation is required, the two ODUs must each be connected to their respective V and H antenna ports using remote mounts.

The remote mount clamps to a standard 114.3 mm (4.5 ”) pole-mount, and is common to all frequency bands. Figure 2-9 shows an ODU installed on a remote mount.

Figure 2-9. Remote Mount

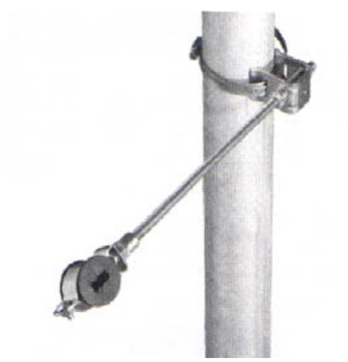
Flexible waveguides are frequency band specific and are available in two lengths:

- 600 mm (2 ft) for frequency bands 18 to 38 GHz
- 1000 mm (3.28 ft) for frequency bands 6 to 15 GHz

Both flange ends are identical, and are grooved for a half-thickness gasket, which is supplied with the waveguide, along with flange mounting bolts.

To prevent wind-flex, a flexible waveguide or coax must be suitably fastened or supported over its length. Where it is not possible to fasten directly to the support structure, hanger assemblies are recommended, comprising a stainless steel clamp, threaded rod and a form-fit rubber grommet. Figure 2-10 shows a typical assembly for a 28 to 38 GHz flexible waveguide.

Figure 2-10. Flexible Waveguide Hanger Assembly



The flexible waveguides have tin-plated brass flanges to minimize dissimilar-metal corrosion between the aluminum feed-head on the ODU and the brass antenna port(s) used on most standard antennas.

Where a flexible-waveguide length greater than the standard length in the 9500 MXC accessories list is needed, contact your Alcatel-Lucent service support center.

Next steps:

- Waveguide Flange Data
- Remote-Mount Installation Procedure on page 2-11

Waveguide Flange Data

Table 2-1 lists the antenna port flange types used with the ODU 300, plus their mating flange options and fastening hardware for remote mount installations. UDR/PDR flanges are rectangular; UBR/PDR flanges are square.

On the ODU, the two flange styles are:

- **UDR**. 6-hole or 8-hole (6/8 bolt holes depending on frequency range/waveguide type), flush-face flange with threaded, blind holes.
- **UBR**. 4-hole flush-face flange with threaded, blind holes.

The corresponding mating flange styles are:

- **PDR**. 6-hole or 8-hole flange with gasket groove and clear holes.
- **PBR**. 4-hole flange with a gasket groove and clear holes.

All fastening hardware is metric.

Table 2-1. Waveguide Flange Data

Freq Band	Radio Flange	Waveguide Mating Flange	Waveguide Type	Spring Washers Reqd	Bolts Reqd	Bolt Type	Thread Spec	Hole Depth mm	Bolt Length Required
6GHz	UDR70	PDR70	WR137	8 x M5	8	M5x0.8	6H	10	Flange thickness + Hole depth - 2mm
7/8GHz	UDR84	PDR84	WR112	8 x M4	8	M4x0.7	6H	8	Flange thickness + Hole depth - 2mm
10/11GHz	UDR100	PDR100	WR90	8 x M4	8	M4x0.7	6H	8	Flange thickness + Hole depth - 2mm
13GHz	UBR120	PBR120	WR75	4 x M4	4	M4x0.7	6H	8	Flange thickness + Hole depth - 2mm
15GHz	UBR140	PBR140	WR62	4 x M4	4	M4x0.7	6H	8	Flange thickness + Hole depth - 2mm
18/23/26GHz	UBR220	PBR220	WR42	4 x M3	4	M3x0.5	6H	6	Flange thickness + Hole depth - 2mm
28/32/38	UBR320	PBR320	WR28	4 x M3	4	M3x0.5	6H	6	Flange thickness + Hole depth - 2mm

Remote-Mount Installation Procedure

This topic describes the installation of a remote mount, the attachment of the ODU to the mount, and the installation of the flexible waveguide.

Related procedures are:

- Installing the ODU Lightning Surge Suppressor; refer to Installing Lightning Surge Suppressors on page 2-20.
- Grounding an ODU; refer to Grounding the ODU on page 2-12
- Installing the ODU cable and connectors; refer to Installing ODU Cables and Connectors on page 2-16

Installing the Remote Mount

The remote mount attaches to a standard 112 mm (4”) pipe mount using two saddle clamps. It can be installed either way up, and with a left or a right offset.

Firmly fasten the clamp nuts.

Attaching the ODU and Flexible Waveguide

Before attaching the ODU to the remote mount, fit the flexible waveguide to the ODU.

1. Remove one gasket from the packet supplied with the flexible waveguide, apply a thin smear of silicon grease to the gasket, and fit the gasket to the recess in the flange.
2. Firmly attach the flange to the ODU feed head using the bolts supplied.
3. Fully loosen the nuts on the four ODU mounting bolts, then thread the waveguide through the center of the mount.
4. Attach the ODU to the mount by inserting the bolts through the receptor holes, and rotating the ODU clockwise to bring the mounting bolts hard up against the slot ends.
5. Tighten the four nuts with an open-ended 19 mm (3/4”) spanner.
6. Prepare the antenna-end of the flexible waveguide as in step 1 above.

7. Check, and adjust if necessary, the run of the waveguide for best protection and support position before fastening the flange to the antenna port.
8. Secure the waveguide to prevent wind-flex using hanger assemblies or similar. If cable ties are used, do not over-tighten.

Grounding the ODU

The ODU must be installed with a lightning surge suppressor. Failure to do so can invalidate the Alcatel-Lucent warranty. Refer to Installing Lightning Surge Suppressors on page 2-20.

This procedure applies where the ODU must be directly grounded, as distinct from being grounded via a *suppressor support bracket*.

It applies where:

- The ODU is fitted with an internal suppressor. Refer to Installing Lightning Surge Suppressors on page 2-20.
- The ODU is installed with an external suppressor but *without* a suppressor support bracket. In this instance one ground wire is installed to ground the ODU, and a separate ground wire is installed for the surge suppressor.
  - For a procedure to ground the suppressor, refer to Installing a Suppressor Without a Support Bracket on page 2-31.
  - For an ODU installed *with* a suppressor support bracket, refer to: Installing a Suppressor With a Support Bracket on page 2-27.

ODU Grounding Procedure

To ground the ODU:

1. Locate the green 2 m ground wire in the ODU installation Kit. One end is fitted with a crimp lug, the other is free.
2. Fasten the lugged end of ground wire to the ODU grounding stud. Before tightening, ensure the cable is correctly aligned towards the tower.
3. Locate a position on a tower member for the ground clamp. This must be as close as practical below the ODU for downward-angled positioning of the ground wire.

Run the ground wire down from the ODU to its ground point using the shortest practical path. Do not loop or spiral the ground wire.

4. Scrape any paint or oxidation from the tower at the clamping point to ensure there will be good low-resistance contact.
5. Cut the ground wire so there will be a just a little slack in the wire when it is connected to the ground clamp. A ground clamp is supplied as part of all ODU Cable Installation and Suppressor kits.

6. Strip the insulation back by 25 mm (1 inch), fit into ground clamp, and firmly secure the clamp to tower.
7. Liberally apply conductive grease/paste around the ground clamp to provide corrosion resistance. Also apply to the ODU ground stud.

Installing a Coupler

Refer to:

- Coupler Overview on page 2-13
- Coupler Installation Procedure on page 2-13
- Unused and Disconnected Coupler Ports on page 2-16

Coupler Overview

Couplers (combiners) are available for equal loss or unequal loss.

- For equal loss the attenuation per side is nominally 3.5 dB (3.5 / 3.5 dB), which applies to both the transmit and receive directions, meaning the additional total one-way attenuation compared to a non-protected link is 7 dB.
- For unequal loss the attenuation is nominally 1.5/6.5 dB. They have application on rain-affected bands, 13 GHz and above.

When using a coupler to combine two ODUs onto a single polarization the operating channels must be chosen from within the same diplexer option. If the two ODUs are not from the same tuning/diplexer option then interference may occur, resulting in degraded link performance.

The rationale for using unequal ratios is that they can be shown to lower annual outage due to rain fades as compared to links deployed with equal loss couplers.

For band-specific coupler loss data refer to Coupler Losses, Volume IV, Chapter 7.

Coupler Installation Procedure

A coupler installation procedure is included with each coupler

The following procedure summarizes installation of a direct-mounted coupler. A coupler may also be remote-mounted, with a single flexible waveguide used to connect the coupler to its antenna.

Attaching a Direct-Mounted Coupler

Before installing a coupler check there will be sufficient mechanical clearance for the coupler and its ODUs. There should be no clearance issues using approved antennas when installed correctly on its mount with the appropriate left or right offset. However care must be taken at locations where a non-standard antenna installation is required.

The ODUs are attached to the coupler as if attaching to an antenna except that there is no polarization rotator associated with each ODU. Rather the *coupler* polarization is set to match the V or H antenna polarization using 0 degree or 90 degree coupler interfaces, which are supplied with the coupler. Couplers are default fitted with the vertical polarization interface.

A coupler must always be installed onto its antenna before ODUs are attached to the coupler.

To install a coupler:

For a vertically polarized antenna proceed to step 2. For a horizontally polarized antenna begin at step 1. (*Antenna* polarization setting is described in Setting the Polarization on page 2-4)

1. To change the coupler interface, remove by unscrewing its four retaining screws. Replace with the required interface, ensuring correct alignment between the interface and coupler body alignment indicators. Relocate the O-ring to the newly fitted interface.
2. Remove all protective tape from the waveguide ports and check that the ODU/coupler mounting collar, polarization rotator, coupler interface and O-ring, are undamaged, clean, and dry.
3. Apply a thin layer of silicon grease around the coupler interface O-ring.

A tube of silicon grease is included in ODU and coupler installation kits.

4. Fully loosen the nuts on the four coupler mounting bolts.
5. Position the coupler so the waveguide slots (coupler and rotator) will be aligned when the ODU is rotated to its end position.
6. Fit the coupler onto its mounting collar by inserting the bolts through receptor holes in the collar, then rotate the coupler clockwise to bring the mounting bolts hard up against the slot ends.
7. Carefully bring the coupler forward to fully engage the coupler feed head with the polarization rotator in the mounting collar.
8. Finger-tighten the four nuts, checking to ensure correct engagement of coupler with mounting collar.
9. Ensure the coupler bolt-down points are correctly seated, then tighten the four nuts with an open-ended 19 mm (3/4”) spanner.
10. To remove a coupler, reverse this procedure.

Figure 2-11 shows an installed coupler. Figure 2-12 and Figure 2-13 show a completed installation with ODUs, surge suppressors and grounding.

Related procedures are:

- Installing the ODUs; refer to Direct-Mount ODU Attachment Procedure on page 2-7. Note that when attaching an ODU to a coupler there is no requirement to first set a polarization; the ODUs are attached such that when rotated into position there is correct alignment of the waveguide slots. ODUs may be attached such that cables exit to the right or left of the ODU.
- Installing the ODU Lightning Surge Suppressor; refer to Installing Lightning Surge Suppressors on page 2-20.
- Grounding an ODU; refer to Grounding the ODU on page 2-12

Installing the ODU cable and connectors; refer to Installing ODU Cables and Connectors on page 2-16

Figure 2-11. Coupler Fitted to Antenna

Figure 2-12. Coupler Installation with ODUs

Figure 2-13. Coupler Installation with ODUs: Rear View

Unused and Disconnected Coupler Ports

Unused ODU ports on a coupler must the blanked off with a microwave load as at some frequencies the reflected power can affect operation at the remaining port, partly canceling the wanted signal.

A flange-mounted termination is used to absorb the RF energy. They are needed in 1+0 and cascaded coupler applications where some ODU ports are left open/not attached to an ODU.

Terminations are available from Alcatel-Lucent.

Installing ODU Cables and Connectors

The ODU cable installation must comply with 9500 MXC requirements. If the cable, suppressors, grounds and weatherproofing are incorrectly installed, the Alcatel-Lucent warranty can be voided.

This section includes information on:

- ODU Cable on page 2-17
- Coaxial Cable Installation Requirements on page 2-17
- Cable Grounding on page 2-18
- Jumper Cables on page 2-20
- Type N Cable Connectors on page 2-20

ODU Cable

Two types of ODU coaxial cable are recommended:

- Alcatel-Lucent ET 390998 - suitable for cable runs to 180 m (590 ft)
- Alcatel-Lucent HPL 50-1/4 XF - suitable for cable runs to 80 m (262 ft)

Both cables are supplied by meter.

Alcatel-Lucent ET 390998 Cable Specifications

ET 390998 is a low-loss RG-8 type.

- Characteristic impedance: 50 ohms +/- 2 ohms
- Center conductor: 7x0.85 bare copper
- Insulation: cellular PE
- Shield: dual, aluminium foil and tinned copper braid
- Jacket: PVC (grey)
- Overall diameter: 10.3 mm (0.41 inch)
- Nominal attenuation at 400 MHz: 11 dB per 100m (328 ft)

Alcatel-Lucent HPL 50-1/4 XF Cable Specifications

Characteristic impedance: 50 ohms +/- 1.5 ohms

Center conductor diameter : 1.75 mm (0.07 inch)

Insulation: PE

Shield: dual, aluminium foil and tinned copper braid

Jacket: LSOH (black)

Overall diameter: 6.85 mm (0.27 inch)

Nominal attenuation at 450 MHz: 14.3 dB per 100m (328 ft)

Coaxial Cable Installation Requirements

Table 2-2. Installation Requirements for Coaxial Cables Summary

Task	Required considerations	Explanation
Installing connectors	Crimped connectors	Always use the crimp tool designed for the crimped connectors/cable being used. A recommended crimp tool for the connectors used with the ET 390998 cable is available from Alcatel-Lucent.
	When removing the jacket *- all coaxial cable*	Take great care when removing the jacket to keep the outer conductor intact. A scored outer conductor will weaken the cable and, for a solid outer cable, can cause the outer conductor to break or crack when subsequently bent.

Task	Required considerations	Explanation
	When removing the jacket -*solid outer conductor cable*	Always use the cut-off and strip tool specifically designed for the cable being used.
	Fastening Type N connectors	Tighten Type N connectors (male to female) by hand only.
	Weatherproofing	All outdoor connections must be made weatherproof. Refer to Weatherproofing on page 2-32.
Planning the route	Protection for the cable	The route chosen must provide physical protection for the cable (protection against accidental damage).
	Keep access to tower and services clear	The cable must be positioned so that there is unimpeded access to the tower and to services on the tower.
	Ease of running and fastening	Use a route which minimizes potential for damage to the cable jacket and avoids excessive cable re-bending.
Installing the cable	Cable jacket	Keep cable clear of sharp edges
	Cable support	Rod support kits or similar must be used across unsupported sections of the cable run so that the cable cannot flex in the wind.
	Bend radius	Ensure the minimum bend radius for the cable is not exceeded.
	Cable ties	Use one UV-resistant cable tie (from the ODU cable kit) every 1m (3 ft) or less, of cable.
	Cable grounding	Ensure the cable is grounded in accordance with the instructions provided in Cable Grounding on page 2-18.
	Ice-fall protection	Ensure adequate physical protection for the cable where ice-fall from towers can occur.

Cable Grounding

Ground kits are included in the ODU Cable Kits.

For tower/mast installations the ODU cable ***must*** be grounded at:

- The point where it comes on to the tower from the ODU
- The point where it leaves the tower to go to the equipment building
- Not more than 25 m (80 ft) intervals on the tower if the height on the tower exceeds 50 m (165 ft)
- A point just prior to building entry. If the building-end lightning surge suppressor is installed prior to the cable entering the building, the ground kit must be installed on the tower side of the suppressor. Refer to Figure 2-18 on page 2-23.

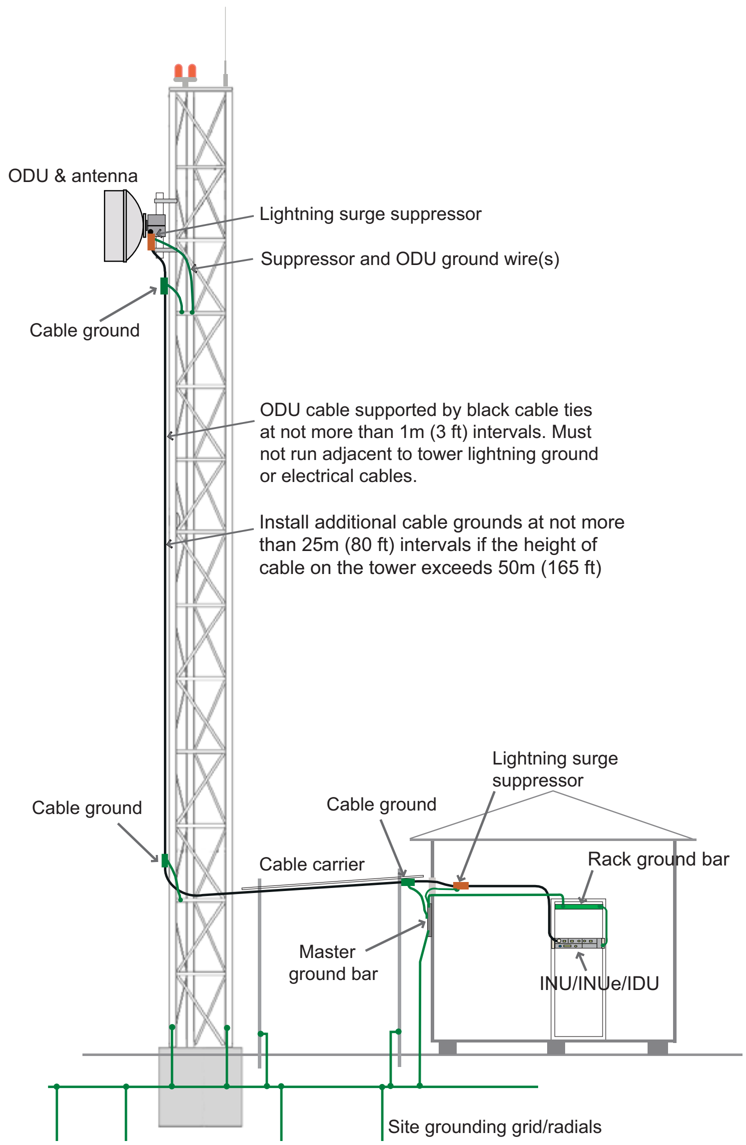
Figure 2-14 on page 2-19 shows typical tower locations for cable grounding and lightning surge suppressors.Note that an external suppressor is shown at the ODU end.

- From April 2008 an internal suppressor will be phased into production of ODU 300hp. An internal suppressor will not be installed in ODU 300ep. Refer to Installing Lightning Surge Suppressors on page 2-20.
- For an ODU fitted with an internal surge suppressor, an ODU ground wire is required.

At non-standard installations, such as building tops or the sides of buildings, follow the same general guidelines but where proper grounding points are not provided these must first be installed.

For ground kit installation instructions refer to the guide provided with each kit.

Figure 2-14. Locations for Cable Grounds and Surge Suppressors



Jumper Cables

A jumper cable is required from the INU/INUe or IDU, to the lightning surge suppressor installed at the building entry.

- For the INU/INUe (9500 MXC Node) a 3m jumper cable is included with each RAC, fitted with an SMA male connector at the RAC end and a Type N female at the suppressor end. If the run length is greater than 3m, an extension cable must be prepared to extend the jumper reach, using the ODU cable with Type N connectors fitted at both ends.
- For the IDU (9500 MXC Terminal) a 3m jumper cable is available as an optional IDU accessory. The cable is fitted with a Type N male connector for the IDU end, and a Type N female connector at the suppressor end. Otherwise, the ODU cable can be used to make up a suitable cable.
- Connectors for an extension cable (1 x Type N male and 1 x Type N female) are included in the Lightning Surge Suppressor installation kits.

Type N Cable Connectors

All Type N connectors used outdoors must be weatherproofed. Refer to ***Weatherproofing on page 2-32***.

Ensure connectors are correctly fitted. Where crimp connectors are used, ensure the correct crimp tool is used.

Installing Lightning Surge Suppressors

Failure to correctly install lightning surge suppressors can invalidate the Alcatel-Lucent warranty. If circumstances do not appear to warrant installation of suppressors at both ends of the ODU cable, this should be checked and confirmed in writing with your Alcatel-Lucent technical support center or an Alcatel-Lucent approved installation company.

Where there is a threat of lightning strikes at a site, a lightning surge suppressor is installed in the ODU cable at the ODU. A surge suppressor can also be installed in the ODU cable at building entry.

- A surge suppressor is a requirement at the ODU end of the cable.

- A surge suppressor should be installed at building entry to provide added protection to the indoor equipment, including that of other vendors. But where required by the site owner or by local regulations, it *must* be installed.

Currently, an *external* surge suppressor is required at the ODU, but from April 2008 an internal matrix-type suppressor will be phased into production to become standard, over time, on all hp series ODUs (ODU 300hp).

Internal suppressors will not be included in the ep series ODUs (ODU 300ep).

For ODUs fitted with an internal suppressor, an additional *external* ODU suppressor may still be required to comply with local installation practices in regions that experience severe lightning strikes.

For external suppressor installations the supplied suppressor is an in-line matrix type. It has a dc-blocked RF path with multiple protection stages in the parallel dc path. These suppressors are designed to withstand repeated strikes and in the event they do fail, to hard-fail so as not to cause un-certain or intermittent operation.

Two versions are available. They have the same physical dimensions and are interchangeable:

- Type BGXZ-60NFNM-AS
- Type MHT250-N48

Refer to:

- Internal ODU Surge Suppressor
- Lightning Surge Suppressor Kit on page 2-22
- Suppressor Installation at Building Entry on page 2-22
- Suppressor Installation at the ODU on page 2-24

Internal ODU Surge Suppressor

ODUs fitted with an internal suppressor must be grounded using the ODU Grounding Procedure on page 2-12. No other special installation procedure is required.

Key benefits of the internal ODU suppressor include:

- Performance comparable to that of the recommended external suppressors. Complies with IEC 61000-4-5, Class 5 and GR-10890-CORE 4.11, Type 1, 3, 5 & 6. The suppressor supports a multi-strike capability.
- More consistent ODU reliability with guaranteed presence of a protection device.
- Reduced installation accessory costs. (There is no cost increase to the ODU300hp).
- Reduced installation time.

ODUs fitted with the internal suppressor are identified with a label. There is no change to ODU part numbers.

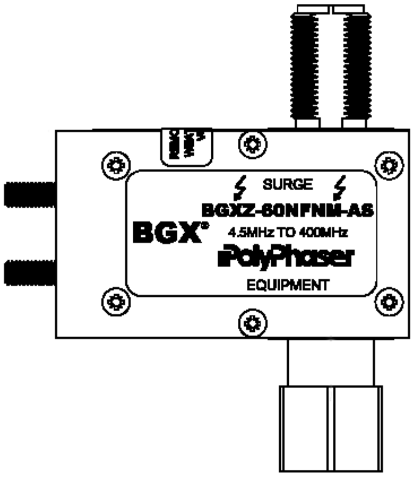
Figure 2-15. Identification Label

If an ODU does not have such a label, an external surge suppressor must be fitted.

Lightning Surge Suppressor Kit

The external suppressor kit includes connectors, ground wire, ground clamp, waterproofing tape, and a support bracket for use at an ODU installation. Kits are available for one or two suppressors.

Figure 2-16. BGXZ Surge Suppressor



Suppressor Installation at Building Entry

This topic describes the installation for the suppressor located at the building-entry end of the ODU cable.

If lightning surge suppressors are not fitted, or are fitted incorrectly, the Alcatel-Lucent warranty may be voided.

The building entry suppressor must be grounded to the master ground bar at, or just below, the cable point of entry.

Refer to:

- Positioning the Building Entry Suppressor
- Installing Building Entry Suppressor Procedure

Positioning the Building Entry Suppressor

Table 2-3 describes the location options for the building-entry suppressor.

Table 2-3. Surge Suppressor Installation at Building Entry

Location of Surge Suppressor	Information
Installed inside the building	The suppressor must be installed as close as practical to cable entry, and the suppressor ground wire connected directly to the master ground bar, or ground bar extension. A normal cable ground kit must be installed at the point of cable entry outside the building. Refer to Figure 2-17 on page 2-23.
Installed outside the building	The suppressor ground must not double as the required building-entry cable ground. A separate cable ground kit must always be installed. Refer to Figure 2-18 on page 2-23. The suppressor must be installed between the building and the building-entry cable ground kit.

Figure 2-17. Suppressor Installed Inside

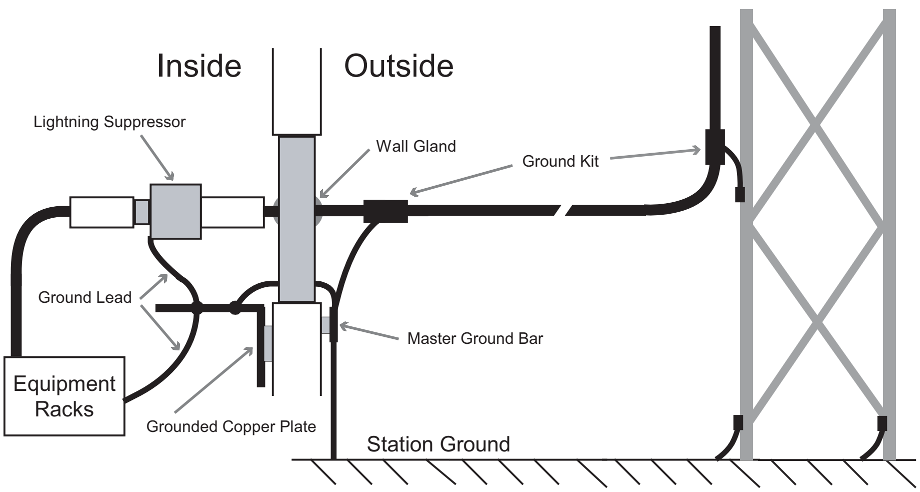
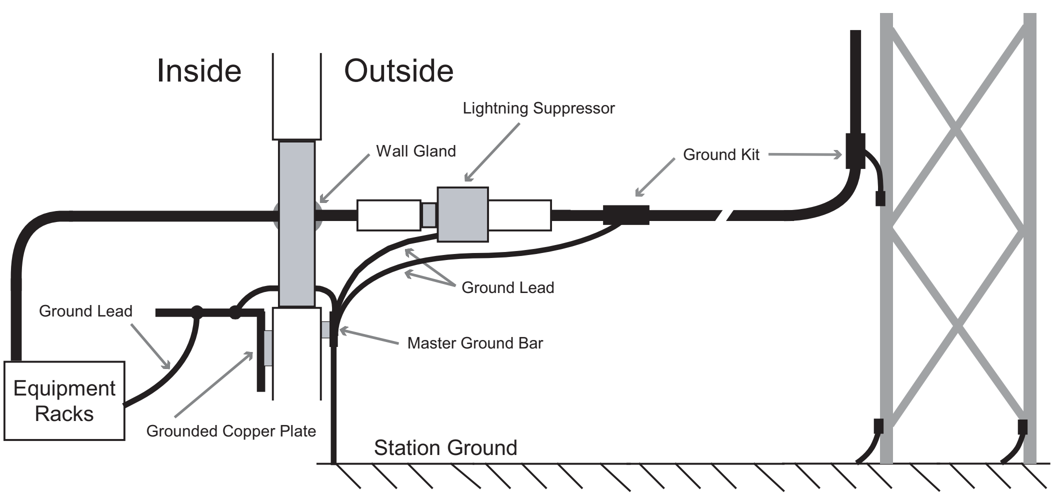


Figure 2-18. Suppressor Installed Outside



Installing Building Entry Suppressor Procedure

To install the lightning surge suppressor at building entry:

1. Determine where the suppressor is to be installed. The normal location is just inside the building.
2. Trim the cable *from* the ODU at the point where the suppressor is to be installed. Terminate the cable with a Type N male connector from the ODU Accessories Kit, and connect to the Type N female connector on the suppressor.
3. Connect the suppressor to the indoor radio unit (RAC or 9500 MXC Terminal) using a jumper cable. Refer to Jumper Cables on page 2-20.
4. Fit one end of the ground wire to the suppressor ground bracket using the nuts and washers supplied.
5. Trim the other end of the ground wire so there is a little slack in the wire when it is connected to the ground bar. Connection can be made using the Harger ground clamp from the suppressor installation kit, or by direct bolting, in which case fit a crimp lug.
6. For an external ground bar, apply copper-based protective grease around the nut/bolt/lug of the ground-bar end of the ground wire.
7. If the suppressor is located outside the building, connectors must be weatherproofed. Refer to Weatherproofing on page 2-32. After weatherproofing, apply copper-based protective grease around the nut/bolt/lug of the suppressor end of the ground wire.

Suppressor Installation at the ODU

This topic introduces procedures for installing an external lightning surge suppressor at the ODU.

For ease of installation the suppressor can be attached to the ODU and weatherproofed (fully or partly) before the ODU (with or without its antenna) is hoisted into place. This is applicable where the suppressor is installed with its support bracket.

Use the suppressor support bracket in all situations *except* where it would result in an unacceptable looping of the ODU cable back towards the tower, or other antenna support structure. However, excessive looping can almost always be avoided by fitting a right-angle connector between the suppressor and ODU cable.

New Universal Suppressor Support Bracket

A new ‘universal’ suppressor support bracket has now replaced the current bracket, which enables both vertical and horizontal positioning of the suppressor to further assist placement of the ODU cable. See Figure 2-20 and Figure 2-21.

- The vertical option locates the suppressor in the same way as the existing support bracket.
- The horizontal option locates the suppressor with its Type N connector on the same axis as the ODU connector.

- Their installation and weatherproofing procedures are directly similar to the following procedure for the current support bracket.

When a suppressor is installed *with* its support bracket, the bracket provides single-point grounding for the assembly. Refer to Installing a Suppressor With a Support Bracket on page 2-27.

Installation is shown in Figure 2-19.

When the suppressor is installed *without* the support bracket, the suppressor and ODU must be *separately* grounded. Refer to Installing a Suppressor Without a Support Bracket on page 2-31.

The ***body*** of the suppressor does not need to be weatherproofed.

Figure 2-19. Installation of the Suppressor on the ODU

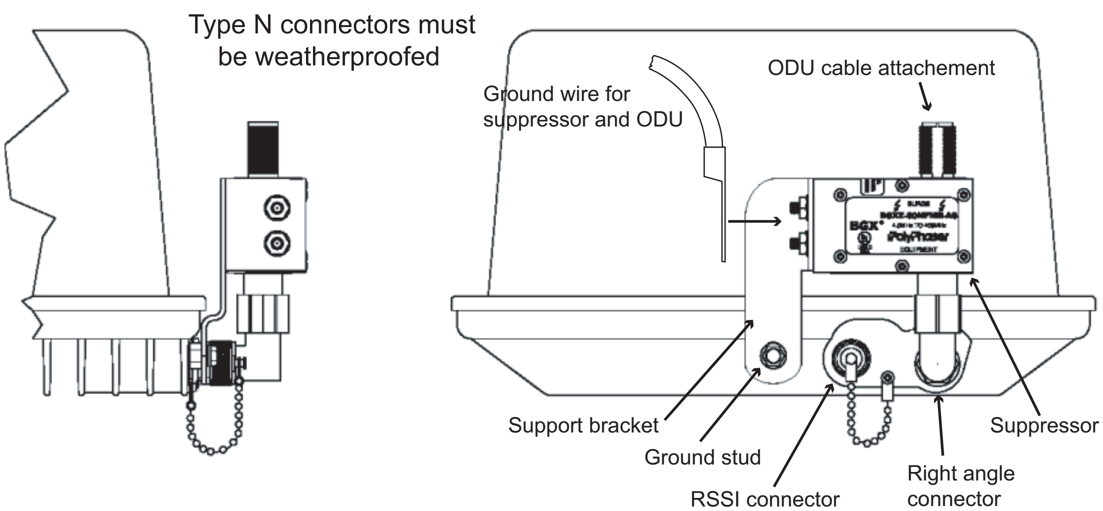


Figure 2-20. Universal Support Bracket: Vertical Suppressor Installation

Figure 2-21. Universal Support Bracket: Horizontal Suppressor Installation

NOTE: When the support bracket is fitted for horizontal suppressor installation access to the RSSI connector is restricted; a BNC right-angle connector must be used to gain access.

Installing a Suppressor With a Support Bracket

This procedure describes the installation process using the original suppressor support bracket, which only supports a ‘vertical’ orientation of the suppressor.

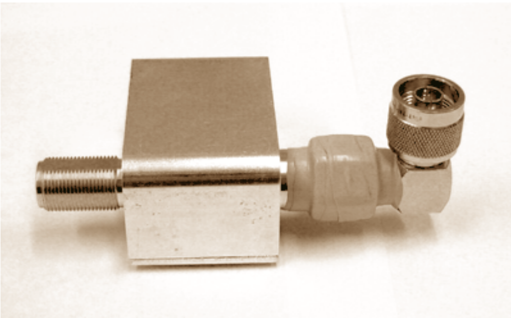
The new universal support bracket supports both a vertical and horizontal orientation. For the horizontal option, omit the right-angle Type N connector in the following procedure.

Procedure:

For ease of installation, complete steps 1 to 13 on the ground.

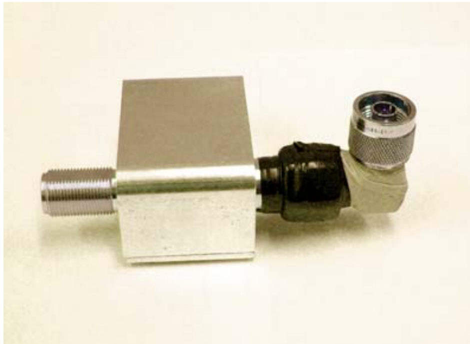
1. Attach the right-angle Type N connector (supplied in the ODU installation kit) to the suppressor.
2. Set in the alignment shown and firmly hand-tighten.

3. Weatherproof the connection between the right-angle connector and suppressor using the self-amalgamating tape supplied in the suppressor installation kit.



Refer to Self Amalgamating Tape on page 2-33.

4. Partially overlay the amalgamating tape with UV-protecting vinyl tape.

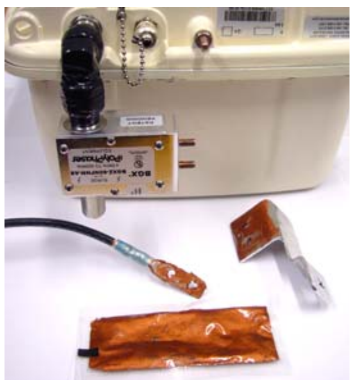


5. Fit the partially weatherproofed suppressor assembly to the ODU and align as shown.

6. Firmly hand-tighten the Type N connector.
7. Complete the weatherproofing of the right angle connector onto the ODU with self-amalgamating tape.

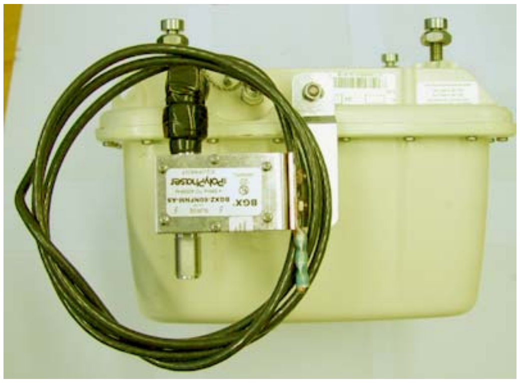
8. Complete with a double-wrap overlay of vinyl tape.

9. Lightly coat the base of the suppressor support bracket, the ground lug, and all three nuts with copper based grease.



10. Fit the support bracket to the suppressor studs and ODU ground stud. Hold in place using the ground stud nut (loosely hand tighten only).
11. Attach the lugged end of the ground wire and secure with the star washers and nuts supplied in the suppressor kit.
12. Check the positioning of the bracket, carefully adjusting the assembly if necessary, and tighten all nuts.

13. Loop and secure the ground wire before hoisting the ODU into position.



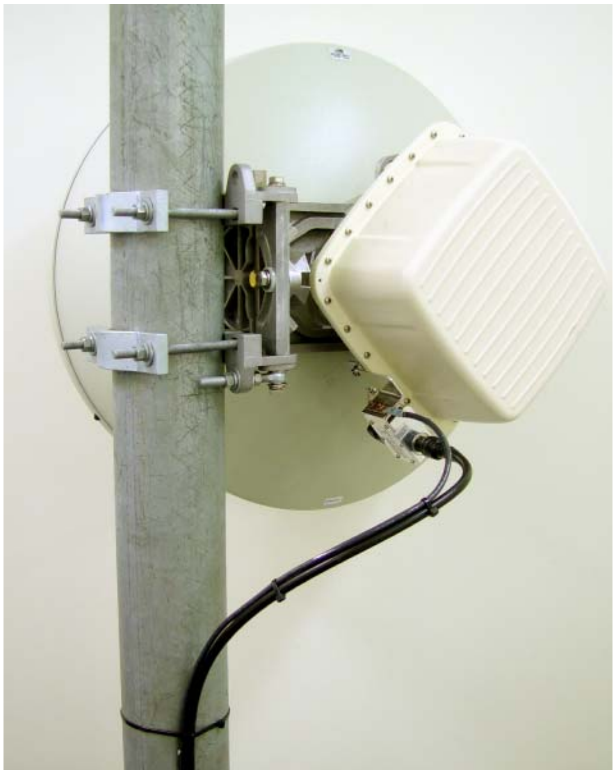
14. Attach the terminated ODU cable to the suppressor and firmly hand tighten. Ensure the cable is first formed (bent to fit) before it is attached to the suppressor. If necessary fit a right angle connector to ease the running of the ODU cable from the suppressor.

Do not attach the ODU cable to the suppressor and then use this as a levering point to bend the ODU cable. Always bend the ODU cable to fit onto the suppressor before attaching it to the suppressor.

15. Weatherproof the connector assembly with self-amalgamating tape ensuring that there is 25 mm of overlap onto the jacket of ODU cable, and maximum possible onto the female barrel. Refer to Self Amalgamating Tape on page 2-33.
16. Overlay the amalgamating tape with a double layer of vinyl tape.
17. Using cable ties, tie the ODU cable to the ground wire every 200 mm (8 inches) up to the point where they meet with the tower.
18. Secure the tied cable/wire assembly to the antenna mount or suitable hard points to stop wind flex.
19. Trim and attach the ground wire to the tower using the supplied Harger ground clamp. First scrape any paint or oxidation from the tower at the clamping point to ensure there will be good low-resistance contact.
20. Apply protective grease around the ground clamp assembly.

Figure 2-22 shows a correct installation.

Figure 2-22. BGXZ Suppressor Installation on an ODU



Installing a Suppressor Without a Support Bracket

Procedure:

1. Attach the suppressor to ODU.
2. Attach the ODU cable to the suppressor and firmly hand tighten the Type N connectors. Ensure the cable is first formed (bent to fit) before it is attached to the suppressor.

Do not attach the ODU cable to the suppressor and then use this as a levering point to bend the ODU cable as this may cause the right angle connector between suppressor and ODU to fracture.

Always bend the ODU cable to fit onto the suppressor before attaching it to the suppressor.

3. Weatherproof the connectors. Refer to Wrapping Guidelines, Amalgamating Tape on page 2-33.
4. Attach the supplied ground wire to the body of the suppressor using the supplied star washers and nuts.
5. Trim and attach the ground wire to the tower using the supplied Harger ground clamp. First scrape any paint or oxidation from the tower at the clamping point to ensure there will be good low-resistance contact.

6. Separately attach the supplied ground wire to ODU ground stud.
7. Trim and attach to the tower. Refer to Grounding the ODU on page 2-12.
8. Apply copper-based protective grease around the ground clamp assemblies, and around the ground studs on the suppressor and ODU.

Weatherproofing

Weatherproofing kits are included with the ODU cable and lightning surge suppressors.

Two types of weatherproofing media are supplied. Refer to:

•Mastic Tape

• Self Amalgamating Tape

Mastic Tape

The ODU cable ground kits include rolls of vinyl and butyl mastic tape. For these, a two-layer wrap process is recommended:

- An initial layer of mastic tape. It is this tape that provides the weatherproofing.
- A top layer of vinyl tape to support good amalgamation and adhesion of the mastic tape and to provide UV protection.

If mastic tape is used to weatherproof connectors a three-layer process is recommended, where a layer of vinyl tape is applied before the mastic to facilitate easy strip-back when connector disconnection is required.

Special attention must be given to ensuring the mastic tape seals cleanly to the primary surfaces, such as the cable jacket.

Wrapping Guidelines, Mastic Tape

To weatherproof connectors start at 1. To weatherproof a cable ground start at 3.

1. Ensure connectors are firmly hand-tightened, dry, and free from all grease and dirt. If necessary, clean with rag lightly moistened with alcohol-based cleaner.
2. Pre-wrap using vinyl tape. Use a 25% overlay when wrapping. To avoid curl-back do not stretch the tape too tightly at the end point.

On an ODU connector, leave at least two-thirds of the smooth length of the barrel clear of pre-wrap vinyl tape, to ensure the mastic tape has sufficient area of direct grip.

3. **W**rap with mastic tape using a 75% overlay. Where possible, use not less than a 25 mm (1”) attachment onto the primary surface (25 mm past the cable sheath cut, or any pre-wrap)**.**

There must be a full seal of mastic tape onto the primary surface for weatherproofing integrity.

4. Lightly firm over by hand to ensure a full seal at all points, using a tear-off section of the mastic tape backing to protect your hands. ***Check that there is no possibility of water entry before proceeding to the next step***
5. Cover the mastic tape with a final layer of vinyl tape. To avoid curl-back, do not stretch the tape too tightly at the end.

To avoid displacement of the mastic tape, do not stretch the final layer of vinyl tape across sharp corners and edges.

Self Amalgamating Tape

Self amalgamating tape binds to the host and bonds between layers to provide a continuous seal. It is especially useful in tight locations, such as around the Type N connectors of the suppressor when installed with its support bracket on an ODU.

Wrapping Guidelines, Amalgamating Tape

1. Ensure the connectors are firmly hand-tightened, dry, and free from all grease and dirt. If necessary, clean with a rag lightly moistened with alcohol-based cleaner.
2. ***Apply the tape with tension (slight stretching), using at least a 75% overlay.***
3. Where possible, apply the tape 25 mm (1”) past the ends of the connector barrels to ensure the weatherproof bond extends beyond the areas requiring protection. The tape ***must*** be applied in such a way that the sealing is robust (no obvious weak points).
4. To avoid curl-back, do not stretch the tape too tightly at the end.
5. To assist UV protection, a post-wrap using vinyl tape can be applied.

Chapter 3. Installing the INU and INUe

The INU and the INU expanded (INUe) are the indoor units for the 9500 MXC Node.

This chapter includes:

For a description of the plug-ins, refer to Volume II, Chapter 3.

For information on user-interface connector and cable data, refer to Appendix C.

For information on the 9500 MXC Terminal, refer to Chapter 4. of this Volume.

INU/INUe Description

The INU/INUe is a rack-mounted unit that pairs with one or more ODUs.

An INU/INUe comprises a chassis (IDC/IDCe) and plug-ins.

The IDC/IDCe has dedicated slots for the NCC and FAN plug-ins, and either four slots (IDC) or ten slots (IDCe) available for optional RAC, DAC, AUX and NPC plug-ins. For slot allocations and assignments, refer to Plug-in Slot Configuration on page 3-8.

Refer to:

- Front Panel Layout on page 3-1
- Power Cable on page 3-3
- Fuses on page 3-3

Front Panel Layout

Figure 3-1 shows an example of an INU front panel, with one DAC x16, two RAC 30s, and a blanking panel over the unused slot. The names and descriptions for this example are listed in Table 3-1. For a full description of all plug-ins and their front panel layouts, refer to Plug-in Cards on page 3-13, Volume II, Chapter 3.

Figure 3-1. Typical INU Front Panel Layout

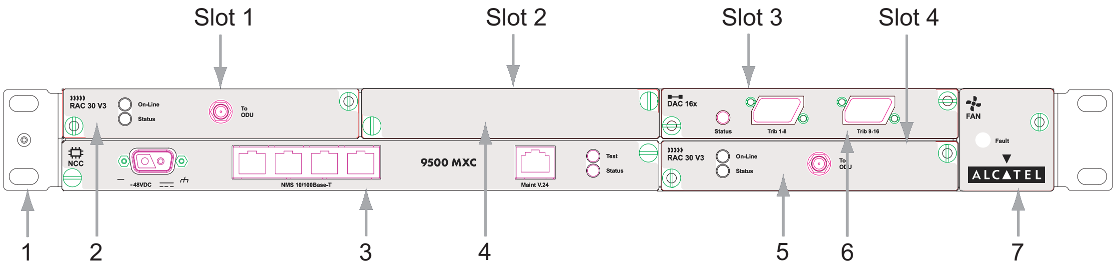


Table 3-1. INU Front Panel Descriptions

No	Item/Label	Description
1	Rack Ear and grounding stud	Rack attachment bracket for the IDC. One ear has a combined ESD and IDC grounding stud. The ears can be fitted either side, which provide flush-with-rack-front mounting.
2	RAC 30	RAC 30 fitted in slot 1
3	NCC	Mandatory Node Control Card (dedicated slot)
4	Blank Panel	Blanking panel fitted to slot 2
5	RAC 30	RAC 30 fitted in slot 4
6	DAC 16x	16xE1/DS1 DAC fitted in slot 3
7	FAN	Mandatory fan plug-in (dedicated slot)

Power Cable

The power cable is supplied in the IDC Installation Kit. It is supplied with the connector fitted at one end and wire at the other. The cable is nominally 5 m (16 ft), and the wires are 4 mm^2 (AWG 12).

The blue (or red) wire must be connected to -48 Vdc (live); the black wire to ground/ +ve.

Figure 3-2. Power Cable and Connector

DC power connector can be shorted inadvertently if applied at an angle. Always insert with correct alignment.

Fuses

The NCC and NPC are fitted with a fast acting 25 A fuse fitted on the PCB behind the power cable connector.

INU/INUe Installation Requirements

Table 3-2. INU Installation Requirements

Function/Requirement	Details
Restricted access	The INU/INUe and its associated dc power supply must be installed in a restricted access area such as a secure equipment room, closet, or cabinet.
Required Rack Space	The INU requires 44.5 mm (1RU) of vertical rack space and 300 mm rack depth. The INUe requires 89mm (2RU) vertical rack space.
Ventilation	The INU/INUe requires unobstructed air passage to *each side* for ventilation purposes. There must be a minimum of 50 mm (2 in.) of side spacing to any rack panels, cable bundles or similar. No space above or below is required for ventilation purposes.
Maximum Ambient Temperature	The INU/INUe is specified for a maximum ambient temperature (Tmra) of +45° Celsius (113° Fahrenheit). The maximum ambient temperature (Tmra) of +45° Celsius applies to the *immediate operating environment* of the INU, which if installed in a rack, is the ambient applying to its location within the rack.
Physical stability	Ensure that adding an INU/INUe to a rack does not adversely impact the physical stability of the rack.
Power supply	The INU has the +ve pin on its dc power supply connector fastened directly to the chassis. It must be used with a -48 Vdc power supply which has a +ve ground; the power supply ground conductor is the +ve supply to the INU. There must be no switching or disconnecting devices in the ground conductor between the dc power supply and the point of connection to an INU/INUe.
Power Supply Location	The INU/INUe must be installed in the same premises as its dc power supply and be located in the same immediate area (such as adjacent racks or cabinets) as any other equipment that is connected to the same dc power supply.
Power Supply Compliance and Loading	The dc power supply must be UL or IEC compliant for a -48 Vdc SELV output (60 Vdc maximum). Check to ensure that connection of a 9500 MXC system to an existing dc supply does not overload the supply, circuit protection devices and wiring. Where a new dc power supply is to be installed for a 9500 MXC Node, the power supply must be rated to supply: • 12.5 A for the INU • 25 A for the INUe

Function / Requirement	Details
Grounding	The INU must be grounded to the station or master ground, which must be the same ground as used for the dc power supply. Normally this is achieved by grounding the INU to the ground bar in its equipment rack or frame. This bar is most often located to one side of the rack or at rack top or bottom. In turn, the ground bar is grounded to the station ground.

Installing an INU

To install an INU:

1. Fit the rack mounting ears to the chassis with the grounding stud to left or right side for the most direct ground wire path to the rack ground bar.
2. Locate the INU/INUe in the equipment rack and secure it using four No.12 Phillips dome-head screws from the IDC installation kit.
3. Ground the INU/INUe from the grounding stud to the rack/frame ground bar using a length of 4 mm^2 (AWG 12) green PVC insulated stranded copper wire with a suitably sized ground lug at each end (supplied by the installer).
4. If the equipment rack/frame requires grounding, use 16 mm^2 (AWG 6) wire from its ground bar to the station ground.

Do not assume that an existing rack or mounting frame is correctly grounded. Always check the integrity of the ground connections, which must include a check through to the master ground for the station, which should be located at the point of cable entry to the equipment building.

5. Install the plug-ins in their assigned slot positions, and check that their front panels are flush-fitted (not protruding) and held secure by their fasteners. Ensure unused slots are covered by blanking panels. Refer to Plug-in Slot Configuration on page 3-8, and Plug-in Installation Requirements on page 3-9.
6. Fit the supplied jumper cable between the RAC and lightning impulse surge suppressor.
7. Secure the cable within the rack/frame using cable ties or similar.

If the jumper cable is too short, make an extension cable. Refer to Jumper Cables on page 2-20.

8. Fit the DAC tributary cables. For data on the tributary cable sets, refer to

Appendix C.

For a DAC 16x, ensure correct orientation of the Mini RJ-21 connector before pushing it home. This can be checked by the scalloped key to one side of the connector. Additionally, a trib cable supplied by Alcatel-Lucent will have the cable exiting to the right side when viewed from the front.

Do NOT over-tighten the Mini RJ-21 retaining screws

Steps 9 to 14 describe the procedure for preparing the power cable, and preparing for power-on. ***Do not connect*** the power until ***all*** steps have been completed.

9. Run the supplied power cable through to the power pick up point, which will normally be at a circuit breaker panel in the rack. A circuit breaker (or fuse) must have a capacity of 12 A for the INU and a 25 A for the INUe.
10. Connect the blue (or red) wire to -48 Vdc (live), and the black wire to ground/+ve. The power input is polarity protected.
11. Measure the voltage on the dc power connector. The voltage should be -48 Vdc, +/ -2 Vdc (limits are -40.5 to - 60 Vdc).

This product meets the global product safety requirements for SELV (safety extra-low voltage) rated equipment and the input voltage must be guaranteed to remain within the SELV limits (48 V nominal, 60 V maximum) in the event of a single internal fault.

Always check the integrity of the dc power supply to an INU/ INUe right to its source. Never assume that the supply provided to the pick-up point in a rack is correct.

9500 MXC dc power, IF, tributary, auxiliary and NMS cables are not to be routed with any AC mains power lines. They are also to be kept away from any AC power lines which cross them.

12. Carry out a complete check of the installation. If all is correct, and the ODU and ODU cable installation has likewise been completed and checked, the 9500 MXC Node is now ready for power-on.

Once powered up the ODU(s) will be transmitting with the pre-configured or ex-factory frequency and power settings unless the start-up transmit mute option has been invoked. (All ODUs shipped ex-factory have the transmit-mute set as the default unless otherwise specified).

If frequency and power settings are not correct, interference can be caused to other links in the same geographical area.

13. Power on by connecting the power cable to the NCC.

The DC power connector can be shorted inadvertently if applied at an angle. Always insert with correct alignment.

Next Step

The 9500 MXC Node is ready for configuration and antenna alignment.

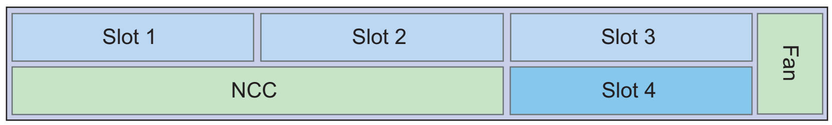
- Refer to Volume IV, Chapter 4, for configuration.
- Refer to Volume III, Chapter 5, for antenna alignment.

Plug-in Slot Configuration

The IDC has four universal slots and two dedicated slots. The IDCe has six universal slots, three restricted slots and 4 dedicated slots. Refer to Figure 3-3 for slot loading details. A populated IDC/IDCe is called an INU/INUe.

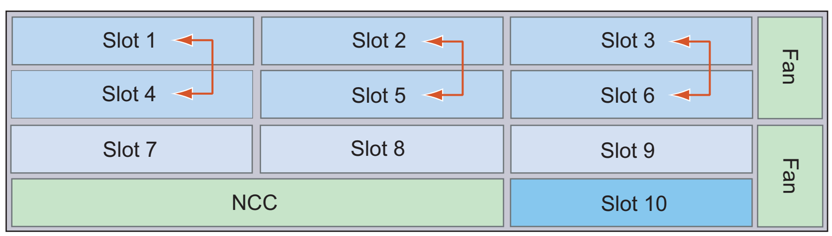
Figure 3-3. Slot Numbering for INU and INUe

INU



Slots 1, 2, 3, 4 are universal: any RAC, DAC or AUX plug-in
Slot 4 is NPC or universal: NPC or any RAC, DAC, AUX
NCC and FAN slots are dedicated
For protected operation the RAC, or RAC/DAC 155oM pairings can be installed in any of the universal slots

INUe



Slots 1, 2, 3, 4, 5, 6 are universal: any RAC, DAC or AUX plug-in
Slots 7, 8, 9 are restricted: any DAC or AUX (except DAC 155oM and AUX*)
Slot 10 is restricted: NPC option only
NCC and FAN slots are dedicated

For protected operation the RAC, or RAC/DAC 155oM pairings must be installed in the positions indicated by the arrows

* Internal (backplane) NMS access is only provided for slots 1 to 6. Do not install DAC 155oM or AUX in slots 7 to 9 if an NMS connection is required in their configuration.

Installing or changing out a plug-in is a straightforward process. The requirements are detailed in Table 3-3 on page 3-9.

During April 2007 an updated IDCe (INUe chassis) was introduced. This IDCe accepts a new 2RU FAN and also the original 1RU FANs.

The updated IDCe is form-fit-function compatible with the previous IDCe, and retains its 002 part number extension.

One 2RU FAN is now supplied as standard with the IDCe.

Plug-in Installation Requirements

Table 3-3 details the plug-in requirements during the installation. Unless specified by the customer, plug-ins will not be installed in an INU/INUe at shipment. Instead, each is individually packed within the shipping box.

For details on plug-ins, refer to Plug-in Cards on page 3-13, Volume II.

For user-interface connector and cable data, refer to Appendix C.

Table 3-3. Plug-in Requirements

Function / Requirement	Priority	Details
Slot Assignment		
All slots filled	CAUTION	All slots must be filled with either a plug-in or a blanking panel. Failure to do so will compromise EMC integrity and distribution of FAN cooling air.
Universal slots		RAC, DAC, and AUX plug-ins can be fitted in any universal slot.
Restricted slots		DAC, and AUX plug-ins can be fitted in any restricted slot. The exceptions are the DAC 155oM and AUX, which must only be installed in slots 1 to 6 when they are to be configured to carry/access 9500 MXC NMS, otherwise they can be installed in slots 7 to 9.
Dedicated slots		The NCC, FAN, and NPC plug-ins have dedicated slots. The NCC and FAN are required plug-ins, the NPC is optional.
Assigning DAC 16x slots		When installing a 16xE1/DS1 DAC, use slots to the right side for easier trib cable management.
AUX		Multiple AUX plug-ins can be installed per INU/INUe.
NPC		Only one NPC is required to provide the NCC protection option. An NPC must be installed in slot 4 of an INU, or slot 10 of an INUe.
Installing / Changing Plug-ins		
ESD grounding strap	CAUTION	Always connect yourself to the INU/INUe with an ESD grounding strap before changing or removing a plug-in. Failure to do so can cause ESD damage to the plug-ins. Avoid hand contact with the PCB top and bottom.
Finger-grip fasteners	CAUTION	Plug-ins must be withdrawn and inserted using their finger-grip fasteners/pulls. Never withdraw or insert using attached cables, as damage to the plug-in connector and its PCB attachment can occur. If not complied with, the Alcatel-Lucent warranty may be voided.
Hot-swappable	CAUTION	Plug-ins are hot-swappable. Removal of an in-service plug-in will interrupt its traffic. Removal of the NCC will affect all traffic (unless protected by an NPC).

Function / Requirement	Priority	Details
Engaging backplane connector		When installing a plug-in, ensure its backplane connector is correctly engaged before applying sufficient pressure to bring the plug-in panel flush with the front panel.
Revision time lag		When swapping or installing plug-ins, up to 60 seconds can be required for the INU/INUe to show its revised status via the front panel LEDs, or via 9500 MXC CT.
EMC integrity	CAUTION	Plug-ins and blanking panels are held in place by captive finger-screws. Ensure the finger-screws are fastened as failure to do so may compromise EMC integrity and fan cooling.
RACs		
Connecting and disconnecting the ODU cable at the RAC	CAUTION	Never disconnect or reconnect an ODU cable to a RAC without first turning the power off to the INU or withdrawing the RAC from the backplane. **Note:** The ODU cable provides the power feed to the ODU. Arcing during connection and disconnection at the RAC on a live RAC can cause damage to connector contact surfaces. Power spikes caused by live connection and disconnection may also cause errors on other traffic passing through the INU/INUe. The only exception to live disconnection and connection should be for checks of protected operation at link commissioning.
Removing RAC from a powered INU	CAUTION	When removing a RAC from a powered INU, always the disengage the RAC from the backplane before disconnecting its ODU cable. Similarly before inserting an RAC, always reconnect the ODU cable before engaging the backplane.
RAC combinations for INUe		An INUe can be fitted with a maximum of six RACs for one of the following combinations: • Six non-protected links • One protected/diversity link plus four non-protected links • Two protected/diversity links plus four non-protected links • Three protected/diversity links
DACs		
DAC combinations		DACs can be fitted singly or in combination to provide a mix of interface types and capacities provided they have a common backplane configuration. The backplane can be set for E1, DS1, DS3, or STM1/OC3. Mux version DACs allow a mix of interfaces from a common E1 or DS1 backplane configuration.

Function / Requirement	Priority	Details
Increasing node capacity		To achieve a greater node capacity, two or more INUs can be interconnected via a DAC option.
DAC 16x Mini RJ-21trib cable connector	CAUTION	Ensure correct orientation of the Mini RJ-21 connector before pushing it home. This can be checked by the scalloped key to one side of the connector. Additionally, a trib cable supplied by Alcatel9500 MXC CT will have the cable exiting to the right side when viewed from the front. Ensure the connector retaining screws are not over-tightened - only use light/moderate screwdriver pressure.
General		
Maximum Capacity of 9500 MXC Node		The maximum drop, through plus drop, or through capacity of a 9500 MXC Node comprising one INU/INUe is one of the following, depending on the backplane setting: • 100x E1 • 128xDS1 • 6xDS3 • 2xSTM1/OC3
Antistatic bags	CAUTION	Enclose spare plug-ins, or plug-ins to be returned for service, in an antistatic bag. When handling a plug-in to or from an antistatic bag, do so at the INU/INUe and only when you are connected to the INU/INUe via an ESD ground strap.
Spare blank panels		Keep any removed blanking panels for future use.

Chapter 4. Installing the IDU

The IDU is the indoor unit for the 9500 MXC Terminal.

9500 MXC Nodes are described in Chapter 3.

This chapter includes:

For user-interface connector and cable data, refer to Appendix C.

IDU Options

The IDU is a rack mounted unit, which pairs with an ODU to make up the 9500 MXC Terminal. The ODUs are the ODU 300ep or ODU 300hp.

The IDUs available are:

- **IDU 20x**, data rates to 20xE1 or 16xDS1 non-protected, or to 40xE1 or 32xDS1 hot-standby or space diversity. Expanded trib mode is required above 20xE1 or 16 xDS1. QPSK to 128 QAM.
- **IDU 155o**, STM1/OC3 optical, 1+0, 1+1 hot standby, or space diversity, 16/64/128QAM.
- **IDU ES**, Ethernet to 200 Mbps with up to 8xE1/DS1 waysides, 1+0, QPSK to 128QAM.

For more information on the IDUs, including front panel layouts, refer to of Volume II, Chapter 2.

Power Cable

A power cable is supplied in the IDU Installation Kit, which has a 2-pin 2W2C fitted at one end and wire at the other. The cable is nominally 5 m (16 ft), and the wires are 4 mm^2 (AWG 12).

The blue (or red) wire must be connected to -48 Vdc (live); the black wire to ground/ +ve.

Figure 4-1. 2W2C Connector and Cable

The 2W2C DC power connector can be shorted inadvertently if applied at an angle. Always insert with correct alignment.

IDU Installation Requirements

Table 4-1. IDU Installation Requirements

Function / Requirement	Description
Restricted Access	The IDU and its associated dc power supply must be installed in a restricted access area such as a secure equipment room, closet, cabinet or the like.
Required Rack Space	The IDU requires 44.5 mm (1RU) of vertical rack space and 300 mm rack depth.
Ventilation	IDUs have two redundant axial fans for cooling. IDUs must be located such that unobstructed air passage is provide on each side for ventilation purposes. A minimum of 50 mm (2”) of side spacing to any rack panels or cable bundles should be provided for this purpose.

Function / Requirement	Description
Maximum Ambient Temperature	The IDU is specified for a maximum ambient temperature (Tmra) of +45° Celsius (113° Fahrenheit). The maximum ambient temperature (Tmra) of +45° Celsius applies to the *immediate operating environment of the IDU*, which if installed in a rack, is the ambient applying at its location within the rack.
Physical Stability	Ensure that adding an IDU to a rack does not adversely impact the physical stability of the rack.
Power Supply	The IDU has the +ve pin on its dc power supply connector connected directly to the chassis. It must be used with a -48 Vdc power supply which has a +ve ground; the power supply ground conductor is the +ve supply to the IDU. There must be no switching or disconnecting devices in the ground conductor between the dc power supply and the point of connection to an IDU.
Power Graphic	This triangle graphic is located adjacent to the power connector on the front panel to signify that the +ve pin on the connector is directly connected to the chassis. The number is the fuse rating in amps.  5A
Power Supply Location	The IDU must be installed in the same premises as its dc power supply and be located in the same immediate area (such as adjacent racks or cabinets) as any other equipment that is connected to the same dc power supply.
Power Supply Compliance and Loading	The dc power supply must be UL or IEC compliant for a -48 Vdc SELV output (60 Vdc maximum). Check to ensure that connection of a 9500 MXC system to an existing dc supply does not overload the supply, circuit protection devices and wiring. Where a new dc power supply is to be installed for an IDU, the power supply must be rated to supply a minimum 5 A.
Grounding	The IDU must be grounded to the station or master ground, which must be the same ground as used for the dc power supply. Normally this is achieved by grounding the IDU to the ground bar in its equipment rack or frame. This bar is most often located to one side of the rack or at rack top or bottom. In turn, the ground bar is grounded to the station ground

Installing an IDU

To install an IDU:

1. Fit the rack mounting ears to the IDU. Position the ear with the grounding stud to left or right side for the most direct ground wire path to the rack ground bar.
2. Locate the IDU in the equipment rack and secure it using four No.12 Phillips dome-head screws from the IDU installation kit.
3. Ground the IDU from the ground stud to the rack/frame ground bar using a length of 4 mm^2 (AWG 12) green PVC insulated stranded copper wire with a suitably sized ground lug at each end (supplied by installer).
4. If the equipment rack/frame requires grounding use 16 mm^2 (AWG 6) wire from its ground bar to the station ground.

Do not assume that an existing rack or mounting frame is correctly grounded. Always check the integrity of the ground connections, which must include a check through to the master ground for the station, which should be located at the point of cable entry to the equipment building.

5. Fit the optional jumper cable, or make up a suitable cable from the IDU to the suppressor installed at the point of cable entry to the building. Refer to Jumper Cables on page 2-20 in Chapter 2.
6. Secure the cable within the rack/frame using cable ties or similar. Do not over-tighten cable ties.
7. Fit interface cables. For information on tributary, Ethernet and auxiliary cable sets, refer to Appendix C.

Steps 8 to 13 describe the procedure for preparing the power cable, and preparing for power-on. Do not connect the power until all steps have been completed (leave the power connector disconnected or ensure the fuse holder is in the off, horizontal ‘0’ position).

8. Run the supplied power cable through to the power pick up point, which will normally be at a circuit breaker panel in the rack. A circuit breaker (or fuse) must have a capacity of 5 A.
9. Connect the blue (or red) wire to -48 Vdc (live), and the black wire to ground/+ve. The power input is polarity protected.
10. Measure the voltage on the dc power connector. The voltage should be -48 Vdc, +/ -2 Vdc (limits are -40.5 to - 60 Vdc).

This product meets the global product safety requirements for SELV (safety extra-low voltage) rated equipment and the input voltage must be guaranteed to remain within the SELV limits (48 V nominal, 60 V maximum) in the event of a single internal

fault.

Always check the integrity of the dc power supply to an IDU right to its source. Never assume that the supply provided to the pick-up point in a rack is correct.

9500 MXC dc power, IF, tributary, auxiliary and NMS cables are not to be routed with any AC mains power lines. They are also to be kept away from any AC power lines which cross them.

11. Carry out a complete check of the installation. If all is correct, and the ODU and ODU cable installation has likewise been completed and checked, the 9500 MXC Terminal is now ready for power-on.

The 2W2C DC power connector can be shorted inadvertently if applied at an angle. Always insert with correct alignment.

Once powered up the ODU will be transmitting with the pre-configured or ex-factory frequency and power settings unless the start-up transmit mute option has been invoked. (All ODUs shipped ex-factory have the transmit-mute set as the default unless otherwise specified).

If frequency and power settings are not correct, interference may be caused to other links in the same geographical area.

Next Step

The 9500 MXC Terminal is ready for configuration and antenna alignment.

- Refer to Volume IV, Chapter 4, for configuration.
- Refer to Volume III, Chapter 5, for antenna alignment.

Chapter 5. Antenna Alignment

This chapter includes:

Preparation

Before aligning antennas ensure:

- The ODUs are powered up at both ends of the link.
- Transmit and receive frequencies are correctly set.
- Transmit powers are correctly set and transmit mute is turned off.

If frequency and/or power settings are not correct for the application, interference may be caused to other links in the same geographical area. If in doubt, check RAC configuration as a priority on initial power-on, and reconfigure as necessary.

Signal Measurement

Two receive signal-strength indicators are provided to assist antenna alignment, RSL in the CT Performance screen, and the RSSI voltage at the BNC connector on the ODU. Refer to:

- Using RSL Data
- Using the RSSI Voltage at the ODU
- RSL Measurement Guidelines

Using RSL Data

As CT is accessed via connection to the INU or IDU, a separate means of communication such as two-way radio or cell phone is required between the CT operator and the person at the antenna.

To align using RSL:

1. Monitor RSL in the CT Performance screen.
2. Set antenna alignment for maximum RSL.
3. Repeat for the far end of the link.
4. Compare actual RSLs with the expected RSLs from the link installation datapack. RSL measurement accuracies for ODU 300ep and ODU 300ep are:

   ± 2 dB for levels -40 to -70 dBm, over a temperature range of 0 to +35^{o}C.

   ± 4 dB for levels -25 to -85 dBm, over an extended -33 to +55^{o}C range.

Using the RSSI Voltage at the ODU

A voltmeter, such as a multimeter, is used to measure RSSI voltage at the BNC connector on the ODU. A suitable BNC to banana-plug connecting cable is available as an optional ODU accessory.

To align using the RSSI voltage at the ODU:

1. Connect the voltmeter to the BNC connector. Center pin is positive. Use a low voltage range for best resolution, nominally 2.5 Vdc FSD.
2. Adjust antenna alignment until the voltmeter reading is at *minimum* value.
3. Repeat for the far end of the link.

4. Check and record the peak voltage at each end. The RSSI voltage provides a direct relationship with RSL. An RSSI of 0.25 Vdc ≡ -10 dBm RSL, and each additional 0.25 Vdc RSSI *increase* thereafter corresponds to a 10 dBm *decrease* in RSL, as follows:

Units	Measurement									
BNC (Vdc)	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5
RSL (dBm)	-10	-20	-30	-40	-50	-60	-70	-80	-90	-100

5. Compare actual RSLs to the expected RSLs from the link installation datapack. Refer to RSL Measurement Guidelines.
6. Replace the BNC weatherproofing cap.

Failure to replace the RSSI BNC weatherproof cap may result in damage to the ODU.

RSL Measurement Guidelines

Interference

The RSSI filter has a nominal 56 MHz bandwidth, which means that depending on the channel bandwidth used, multiple adjacent channels will be included within the filter passband[1]. Normally this will not cause a problem as antenna discrimination (beamwidth) and good frequency planning should exclude adjacent channel interferers. However at sites where this is not the case, ATPC should not be enabled.

- ATPC operates on the RSL. Any interferer that affects the RSL will adversely affect ATPC operation.
- Check for interference by muting the Tx at the far end and checking RSSI/RSL at the local end.

For co-channel XPIC operation and where there is a measurable adjacent channel RSL, do not use ATPC.

1 *RSSI filter bandwidth is not a function of, nor does it affect receiver adjacent channel C/I performance. 9500 MXC complies with relevant ETSI and FCC co and adjacent channel requirements.*

RSSI/RSL Accuracy

When checking RSSI/RSL against the predicted link values ensure appropriate allowances are made for Tx power-setting accuracy, path-loss calculation accuracy, and RSSI/RSL measurement accuracy.

- For a worst-case the overall accuracy is the sum of the individual accuracy limits, which for an ODU 300 link would be ± 4 dB of the predicted value (± 2 dB for transmit, ±2 dB for receive, 0 to 35C), aside from the path-loss calculation accuracy, which should be within limits of ±3 dB.
- Typically, where the measured RSSI/RSL is more than 4 dB lower than the expected receive level you should check the path survey results, path calculations and antenna alignment.

When checking RSSI/RSL ensure the measurement is made under normal, unfaded and interference-free path conditions.

- A discrepancy of 20 dB or greater between the measured and calculated RSSI/RSLs suggests an antenna is aligned on a side lobe, or there is a polarization mismatch.

Aligning the Antenna

Antenna alignment involves adjusting the direction of each antenna until the received signal strength reaches its maximum level at each end of the link.

Fine adjustment for azimuth (horizontal angle) and elevation (vertical angle) is built into each antenna mount. Adjustment procedures will be provided with each antenna.

If the horizontal adjuster does not provide sufficient range to locate the main beam, the antenna mounting brackets will need to be loosened and the antenna swivelled on its pole mount to locate the beam. Before doing this ensure the horizontal adjuster is set for mid-travel. Some mounts for larger antennas have a separately clamped swivel base to allow the loosened antenna to swivel on it without fear of slippage down the pole. Where such a mount is not provided a temporary swivel clamp can often be provided using a pair of pipe brackets bolted together immediately below the antenna mount.

Refer to:

- Standard Alignment Procedure
- Additional Procedures for a Protected Link
- Additional Procedures for CCDP XPIC links

Ensure antennas are aligned on the main beam, and not a side lobe. For guidance, refer to the sections Locating the Main Beam on page 5-16 and Tracking Path Error on page 5-17.

Ensure ATPC is turned off during the alignment procedure.

Standard Alignment Procedure

To align an antenna:

1. Loosen the azimuth adjuster on the antenna mount (horizontal angle) and adjust azimuth position for maximum signal strength.
2. Tighten the azimuth securing mechanism. Ensure signal strength does not drop as it is tightened.
3. Loosen the elevation adjuster (vertical angle) and adjust for maximum signal strength.
4. Tighten the elevation securing mechanism. Ensure signal strength does not drop as it is tightened.

   The terminal is now aligned and ready to carry operational traffic.
5. Record RSL and/or RSSI voltage in the commissioning log.

Additional Procedures for a Protected Link

- For a hot standby link, one RAC/ODU is transmitting, and at the receive end both are receiving. The ODUs at each end are normally coupled to a common antenna using an equal or unequal loss coupler.
- For a space diversity link, one RAC/ODU is transmitting, and at the receive end both are receiving. Each ODU has its own antenna. Normally the top antenna is assigned as primary, and the lower as secondary.
- With frequency diversity, the two links operate independently from a radio-path perspective, and the ODUs at each end are normally coupled to a common antenna using an equal loss coupler.
- With ring protection, *each link* in the ring normally operates as 1+0, though can be 1+1 protected. 1+1 protection of ring links is employed where path protection (diversity) is required, for which space diversity or frequency can be installed.
- Both receivers of a hot-standby or diversity link can be accessed to provide RSL/RSSI data regardless of which RAC is Rx online. (Rx online defines which RAC is passing traffic to the backplane bus).

Hot Standby

This procedure details the additional steps required to ensure that no Tx protection switching occurs during the alignment procedure, which may confuse results. It assumes a common antenna at each end of the link.

For all RACs the online Rx manages Rx protection-switch management and drives data to the backplane bus. This online function is not affected (no switch will occur) under no-signal conditions, so it is not necessary to lock an Rx online.

For IDU 155o and IDU 20x the primary designated IDU is default online for Tx and Rx. No Rx switch will occur under no-signal conditions, so it is not essential to lock its Rx online.

1. At each end check the type of coupler installed; equal or unequal split.
2. For an **unequal-loss coupler**, check which RAC/IDU is connected to the low-loss side, as this is the RAC/IDU which must be locked as Tx online at both ends to assist signal acquisition.
   - Default CT assignments for RACs have the primary RAC as online Tx and the secondary RAC as online Rx. Assuming defaults have been retained, the primary-designated RAC should have been assigned to the low-loss side (check) and therefore the primary RAC must be locked as Tx online.
   - For all RACs, Rx online may be left as Auto/Lock Off.
   - For all IDUs the IDU assigned to the low-loss side should be locked online for Tx and Rx. This should be the primary designated IDU (check).
   - For an **equal-loss coupler** it does not matter which RAC/ODU is Tx/Rx locked online at each end.
3. Use the CT > Diagnostics > System/Controls screen to check and set online locks.
4. Use the Standard Alignment Procedure on page 5-5 to align the antennas, but where unequal-loss couplers are installed always select the RAC/IDU connected to the low-loss side to measure RSSI/RSL (default the primary RAC/IDU).
5. Return the Protected Link controls to Auto/Lock Off on completion.

Space Diversity

This procedure details the additional steps required to ensure that all four antennas are in correct alignment and that during the alignment process no unwanted Tx switching occurs.

1. Within the CT > Diagnostics > System/Controls screen check which RAC/IDU[2] is Tx online, and which is Rx online.
   - For RACs the default status has the primary RAC as Tx online, and the secondary RAC as Rx online.
   - For IDU 155o and IDU 20x the default status has the primary IDU as Tx *and* Rx online.
2. Use the Protected Link controls to lock the primary RAC/IDU as Tx online at both ends of the link. Rx online may be left as Auto/Lock Off[3].
3. Use the Standard Alignment Procedure on page 5-5 to align each Rx antenna. If *RSL* is to be used for alignment purposes, go to the Diagnostics > Performance screen:
   - For RACs, select the required Link from the Plug-ins menu.
   - For IDUs display (side-by-side) the Diagnostics > Performance screen for both IDUs.

[2] *The IDU 155o and IDU 20x can be installed for space diversity.*

[3] *Rx online defines which receiver is passing traffic to the backplane bus/tributaries, but from a signal strength viewpoint both receivers can be accessed to provide RSL/RSSI data.*

4. Return the Protected Link controls to Auto/Lock Off on completion.

Frequency Diversity

This procedure assumes a common antenna at each end of the link and an equal loss coupler.

1. Select one (any) RAC/ODU for RSSI/RSL measurement and use the Standard Alignment Procedure on page 5-5 above to align each antenna. Providing each link is operating normally there is no need to use the System/Controls > Protected Link locks to lock a RAC to Tx or Rx online[4].

Ring

Follow the Standard Alignment Procedure on page 5-5.

Additional Procedures for CCDP XPIC links

Procedures are provided for the alignment of dual polarized antennas, and for protected XPIC links.

For CCDP (Co-channel Dual Polarized) XPIC (Cross Polarized Interference Cancellation) links it is important that antenna feeds are correctly aligned to achieve optimum XPIC performance.

While a dual-feed antenna may be specified with a cross polarization discrimination of 30 dB, unless the antenna-to-antenna alignment over a link is correct, the effective discrimination can be significantly less.

- The horizontal-to-vertical receive signal discrimination for satisfactory XPIC operation must not be less than 20 dB, and where possible should be set for optimum discrimination using this procedure.
- High performance shielded antennas typically exhibit 30 dB cross polarization discrimination whereas 40 dB is typical for purpose-designed, high polarization discrimination antennas.
- The received-signal V and H discrimination can be checked using the Diagnostics > Performance screen. The cross pole discrimination entry measures the V and H signal discrimination in dB at the input to the RAC 40s (from the antenna feeds). The improvement in signal discrimination provided by the RAC 40 XPIC function is in addition to this measurement.
- Alternatively, received-signal V and H discrimination can be checked *at the antenna* using the ODU XPD Measurement Mode. This is enabled in CT > System/Controls for a RAC 40. When selected, the RSSI signal-strength indication at the antenna is replaced with the XPOL discrimination indication. A 1:20 conversion is used, for example a voltmeter reading of 1.5V at the RSSI connector indicates an XPOL discrimination of 30 dB.

[4] Although the Diagnostics > System/Controls screen for Frequency Diversity provides locks for Tx and Rx online, they define only the traffic connections through to the Node backplane bus; they do not affect over-air status as each link operates as a distinct entity on separate frequency pairings.

This alignment procedure is intended for dual-polarized antennas, but is also generally applicable to installations using separate antennas for V and H planes.

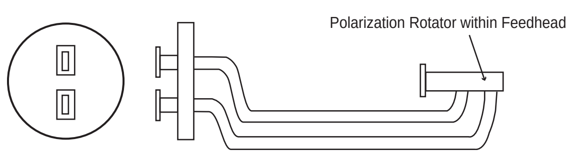
Where protected XPIC links are installed (dual ODUs on a common feed) an equal-loss coupler must be used

XPIC links must be configured for identical frequency, Tx power and bandwidth/modulation, and ATPC must not be used.

Procedure for Dual Polarized Antennas

The following alignment procedure details steps required to:

- Check and if necessary set feedhead alignment using a spirit level.
- Align the antennas at each end using just one of the feeds, H or V. (Standard co-plane antenna alignment).
  - Where the V and H waveguide ports on an antenna are not marked they can be identified by the orientation of the waveguide slots. Refer to Setting the Polarization in Volume III, Chapter 2.
  - Where a dual-polarized antenna presents the same orientation on both ports, one should have a straight waveguide feed to the antenna feedhead, the other will include a 90 degree twist or have a straight waveguide feed but with a polarization rotator in the feedhead. Generally the polarization rotator will act on the outer-most waveguide on the feedhead.
  - For *convention*, if ports are not marked for V and H, it is recommended that the port that has the straight waveguide feed or is connected to the inner-most waveguide at the feedhead is selected as the horizontal antenna feed port. The following graphic of an antenna feedhead assembly illustrates this. The top port is connected to the inner feed on the feedhead, and with the port orientation shown provides a horizontally polarized feed. The lower port has a rotator included in the feedhead to provide a vertical feed.



- Ensure the same port is selected for vertical at both ends.

  Where possible, the same ‘above and below’ relationship of the feed ports should be used at both ends. For example, if at one end the horizontal feed port is located above the vertical port, as in the example above, then the same relationship should be used at the other end.

- Check cross pole discrimination (XPD).
- Optimize alignment of the feed-heads to achieve maximum cross polarization discrimination.

This procedure assumes that the antennas used at each end of the link do comply with their cross-polarization discrimination specification. If in doubt, refer to the antenna supplier.

Procedure:

1. Static Feedhead Alignment

This procedure would normally be completed in conjunction with antenna alignment, step 2, to ensure no misalignment of skew angle is introduced during the pan and tilt process.

It should be completed before any feedhead weatherproofing is applied, so that a spirit level can be used against the flange to check and set precise physical vertical / horizontal alignment of the feeds:

- Do not rely on antenna markings as these will not be accurate where a mount is not perfectly level.
- Set the spirit level against the flange of the feedhead. Take care that only the flange of the feedhead is measured, so that no error is introduced by any minor misalignment of the mating flexible waveguide flange. See Figure 5-1.

Figure 5-1. Checking Feedhead Flange with a Spirit Level

- If not exactly vertical or horizontal, adjust the feedhead skew angle (rotate the feedhead) until correct (spirit level bubble is precisely centered). For a typical feedhead check both flanges for level, using an end point half way between the level points of the two flanges should there be any discrepancy between the two.

2. Align Antennas

Align the antennas at both ends using the standard (co-plane) alignment procedure, but using just one of the feeds, V or H. Refer to Standard Alignment Procedure on page 5-5.

If major adjustment to the pointing of the antenna is made during this process, recheck the feedhead skew angle.

When correct, proceed to step 3.

3. Check RAC 40 Operation and End-End Feedhead Alignment

Power-up both V and H RAC 40 links and check they are operating normally and are alarm-free. Use the Performance screens to check that:

- Tx power measurements are within 1 dB (typically) on all RACs. If not check Tx power settings.
- RSL measurements are within 2 dB an all RAC 40s. See Using RSL Data on page 5-2 for guidance on measurement accuracy.
- Links are operating error-free.

Where there is potential for interference from other links in the same geographical area, check by turning the far end transmitter(s) off and measuring the local end RSL on both V and H feeds.

4. Use the cross pole discrimination (XPD) measurement provided in the Performance screen for RAC 40s to measure the actual V and H signal discrimination from each antenna.

   - Where measured XPDs are better than 25 dB no further adjustment is needed.
   - Where less than 25 dB proceed to the next step.

The alignment procedures listed under steps 1 and 2 should result in a discrimination of better than 25dB, as measured in the Diagnostics > Performance screen for each RAC 40, which is comfortably within the operating limits of XPIC. However, for best results and greater operating margins during fading, feedhead alignment should be optimized using the following procedure.

5. Optimize End-End Feedhead Alignment

This procedure corrects for any minor rotational alignment between antennas at each end.

One antenna is the reference antenna and its feed-head assembly is not adjusted during this procedure.

Only check/adjust skew angles on one antenna. If both antennas are adjusted and re-adjusted there is potential for progressive misalignment to occur. Select one antenna as the reference antenna.

On long hops and where fading is prevalent there is potential for the V and H plane paths to be affected differently and to therefore exhibit variable cross-polarization discrimination. This alignment procedure must be conducted during periods of known, stable path conditions.

6. Determine which end of the link is to provide the reference antenna, and at the opposite end open windows to the CT performance screens for the V and H RAC 40s. Adjust screen sizes and position so that you can see the Cross Pole Discrimination measurements from both RACs[5].
7. Adjust the feedhead skew angle of the antenna for maximum XPD on both V and H RAC 40s. If the maximums for each are at (slightly) different angles, adjust for a mid-point.

Ensure that as you adjust the skew angle, the physical antenna alignment does not shift, which would make it necessary to repeat step 2. Check that antenna mounting bolts and azimuth and elevation adjuster locks have been correctly tightened.

The maximum points may be quite sharp, rotate the feedhead slowly to ensure they are not missed. Data in the performance screen is updated at 1.5 second intervals.

8. Check the XPD on the RAC 40s at the reference end of the link, which should be within 1 to 2 dB of the measurements at the adjusted end.
9. On completion ensure feedhead bolts are correctly tightened - check that XPDs do not change during tightening.
10. Retain feed-head adjustment data for the commissioning records.

Procedure for Protected XPIC Links

When XPIC links are protected, both V and H links must be protected.

- If just one of the co-channel links is 1+1 protected, a failure of XPIC cross-connect between the 1+0 RAC 40 and its 1+1 XPIC partner may cause both V and H receive streams to error as the discrimination provided under XPIC would be lost. An unlikely double-failure event would be needed to cause the same error if both co-channel links are 1+1 protected.

For 1+1 hot-standby protection of XPIC links a single dual polarized antenna is normally used at each end, and remote-mounted *equal-loss* combiners used to mount the ODUs.

5 *Up to four CT screens can be displayed at once. These may be from the same INU (same IP address) or from different INUs (or IDUs).*

For space diversity XPIC links, separate dual-polarized antennas are installed.

For information on the *operation* of hot-standby and space diversity protection of XPIC links, refer to Co-channel Operation, Volume II, Chapter 3.

Hot Standby Protection

Use the alignment procedure for dual polarized antennas, though first ensure the links are Tx locked to prevent 1+1 switching.

The Rx function does not need to be locked, as the RSSI/RSL indication used for antenna alignment is available from each RAC/ODU.

Procedure

- Use the CT > Diagnostics > System/Controls screen to check and set online Tx locks.
  - With an equal-loss combiner either Tx can be locked as the online Tx (The primary designated Tx is the default online Tx).
- Follow the Procedure for Dual Polarized Antennas on page 5-8.
- Return the Protected Link controls to Auto/Lock Off on completion.
- To check protected operation on each link, refer to Protection Switching, Volume V, Chapter 1. Bear in mind the remote Tx mute conditions detailed in Remote Tx Mute, Volume II, Chapter 3.

Space Diversity Protection

This alignment procedure summarizes the steps required to ensure all four antennas are in correct alignment for pan and tilt, and skew angle. It combines elements of the procedures for Cross Polarized Antennas, and for Space Diversity Antennas.

The top antenna should be connected to the primary V and H RACs; the lower antenna to the secondary V and H RACs. Figure 5-2 illustrates a CCDP space diversity configuration.

Procedure:

1. **Static feedhead skew-angle alignment**.

   Align all four antennas using the static feedhead alignment procedure described under Procedure for Dual Polarized Antennas on page 5-8. This step would normally be completed in conjunction with antenna pan and tilt.

2. **Antenna pan and tilt alignment**

   Use the CT > System Controls screen to lock the transmitters at both ends to primary.

   Each each end of the link align both top and bottom antennas using the standard (co-plane) alignment procedure. Use just one of the links for this purpose, normally the V link. Refer to Standard Alignment Procedure on page 5-5.

   When correct, proceed to step 3.

3. **Check RAC 40 Operation and End-End Feedhead Alignment**

   Check that both V and H links are operating normally and are alarm-free. Use the Performance screens to check that:

   - Tx power measurements are within 1 dB (typically) on all RACs. If not check Tx power settings.

- RSL measurements are within 2 dB an all RACs. See Using RSL Data on page 5-2 for guidance on measurement accuracy.
- Links are operating error-free.

Where there is potential for interference from other links in the same geographical area, check by turning the far end transmitter(s) off and measuring the local end RSL on both V and H feeds.

4. Use the cross pole discrimination (XPD) measurement provided in the Performance screen for RACs to measure the actual V and H signal discrimination from each antenna.
   - Where measured XPDs are better than 25 dB no further adjustment is needed.
   - Where less than 25 dB proceed to the next step.

The alignment procedures listed under steps 1 and 2 should result in a discrimination of better than 25dB, as measured in the Diagnostics > Performance screen for each RAC 40, which is comfortably within the operating limits of XPIC. However, for best results and greater operating margins during fading, feedhead alignment should be optimized using the following procedure.

5. Optimize Feedhead Skew-angle Alignment

This procedure corrects for any minor rotational alignment between antennas at each end.

One antenna is the reference antenna and its feed-head assembly is not adjusted during this procedure.

If all antennas are adjusted and re-adjusted there is potential for progressive misalignment to occur. Select one antenna as the reference antenna.

On long hops and where fading is prevalent there is potential for the V and H plane paths to be affected differently and to therefore exhibit variable cross-polarization discrimination. This alignment procedure must be conducted during periods of known, stable path conditions.

6. Lock all transmitters to primary. The receivers can be left as Auto/Lock Off[6].
7. Determine which end of the link is to provide the reference antenna, and at the opposite end open windows to the CT performance screens for all four RACs.

6 *Regardless of which RAC is online (primary or secondary) all RACs can be accessed to provide RSL/RSSI/XPD data.*

Adjust the screen size and position of each so that you can see the Cross Pole Discrimination measurement from all RACs[7].
For example, in Figure 5-2, if antenna 1 is the reference antenna, open windows to the performance screens for the primary RACs connected to Antenna 3, and to the secondary RACs connected to antenna 4.

8. Adjust the feedhead skew angle of the primary antenna for maximum XPD on both primary V and H RACs. If the maximums for each are at (slightly) different angles, adjust for a mid-point.
9. Adjust the feedhead skew angle of the secondary antenna for maximum XPD on both secondary V and H RACs. If the maximums for each are at (slightly) different angles, adjust for a mid-point.

Ensure that as you adjust the skew angle, the physical antenna alignment does not shift, which would make it necessary to repeat step 2. Check that antenna mounting bolts and azimuth and elevation adjuster locks have been correctly tightened.

The maximum points may be quite sharp, rotate the feedhead slowly to ensure they are not missed. Data in the performance screen is updated at 1.5 second intervals.

10. Check the spread of XPD measurements. All four RACs should be within a 2 dB of each other, providing RAC RSLs are within 2 dB. If higher, recheck the Tx power settings and RSLs. In some instances it may be necessary to re-optimize feedhead alignment to achieve best balance across all RACs.

    Where results are not as expected, also check for:

    - Bent antenna feeds.
    - Feeds not centered or not correctly supported, such as missing support wires.
    - Radome or shroud damaged, or sections of the shroud missing.
    - Warped or bent reflector.
    - Feed frequency range. The entire Tx/Rx range (frequency boundaries of the Tx and Rx bandwidths) must be within the antenna feed frequency range.
11. At the reference-end of the link, view the RAC performance screens for all four RACs and adjust the feedhead skew angle of the *secondary* antenna for maximum XPD on both secondary V and H RACs. If the maximums for each are at (slightly) different angles, adjust for a mid-point. Do not adjust the feedhead skew angle on the primary, reference antenna.
12. As for the remote end, check the spread of XPD measurements. All four RACs should be within a 2 dB of each other.
    - If higher, recheck the Tx power settings and RSLs. In some instances it may be necessary to re-optimize feedhead alignment to achieve best balance across all RACs
    - The XPD spread between the reference and remote end RACs should also be within 2 dB of each other.

[7] *Up to four CT screens can be displayed at once. These may be from the same INU (same IP address) or from different INUs (or IDUs).*

13. Switch all transmitters to secondary and lock-on.
14. View the XPDs on all RACs at both ends of the link to confirm that the spread of XPDs is similar to that confirmed using the primary transmitters.
    - If any fine tuning of feedhead alignment is done with the transmitters locked to secondary, go back and recheck with the transmitters locked to primary.
    - Never adjust the feedhead skew angle of the primary reference antenna.
15. On completion ensure feedhead bolts are correctly tightened - check that XPDs do not change during tightening.
16. Retain feed-head adjustment data for the commissioning records.

Example Link

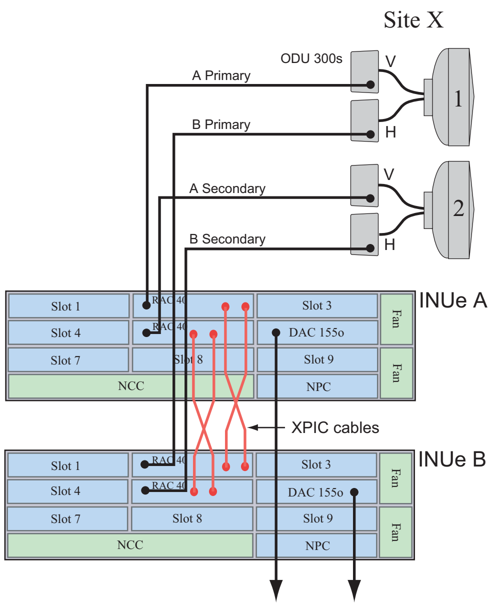
An example CCDP space diversity link is illustrated in Figure 5-2.

Site X shows the physical interconnections of XPIC and ODU cables.

If antenna 1 is nominated as the reference antenna for feedhead skew-angle alignment, the feedhead alignment process can be summarized as:

- With all transmitters locked to primary, adjust the feedhead alignments on antennas 3 and 4 for maximum RAC XPDs. Where necessary optimize to provide best (minimal) XPD spread. The spread should be within 2 dB providing RSLs are within 1 to 2 dB.
- Adjust the feedhead alignments on antenna 2 for maximum secondary RAC XPDs, and check against the RAC XPDs for antenna 1. Where necessary optimize the feedhead of antenna 2 only to provide best (minimal) XPD spread at site X. (Never adjust the feedhead alignment of the reference antenna, antenna 1).
- Check the spread of XPDs is similar between both ends of the link, sites X and Y.
- Lock all transmitters to secondary and check that all RAC XPDs are similar (nominally with 2 dB) to the XPDs obtained under primary Tx operation.

Figure 5-2. CCDP Space Diversity Link Antenna Alignment



Main Beams and Side Lobes

This section describes how to locate the main beam, and typical tracking path errors. Refer to:

- Locating the Main Beam
- Tracking Path Error

Locating the Main Beam

Ensure the antennas are aligned on the main beam, and not a side lobe.

Once a measurable signal is observed, very small alignment adjustments are required to locate the main beam. For instance, a 1.2m antenna at 23 GHz typically has 0.9° of adjustment from center of main beam to the first null (0.4° to the -3 dB point). Antenna movement across the main beam will result in a rapid rise and fall of signal level. As a guide, 1 degree of beam width is equivalent to moving approximately 1.0 mm around a standard 114 mm (4.5 in.) diameter O/D pipe.

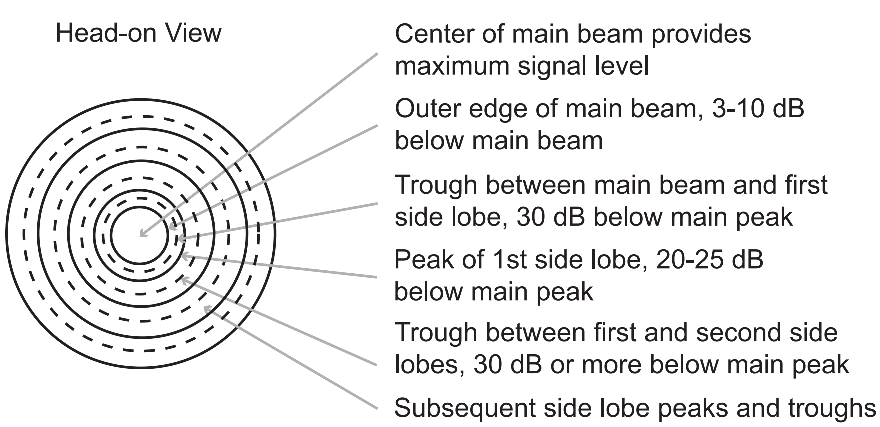
Antennas can be verified as being on main beam (as opposed to a side lobe) by comparing measured receive signal level with the calculated level.

Signal strength readings are usually measurable when at least a main beam at one end and first side lobes at the other are aligned.

The strongest signal occurs at the center of the main beam. The highest first lobe signal is typically 20–25 dB less than the main beam signal. When both antennas are aligned for maximum main beam signal strength, the receive signal level should be within 2 dB of the calculated level for the path. This calculated level should be included in the installation datapack for the link.

Figure 5-3 on page 5-16 is an example of a head-on, conceptual view of the beam signal strength, with concentric rings of side lobe peaks and troughs radiating outward from the main beam.

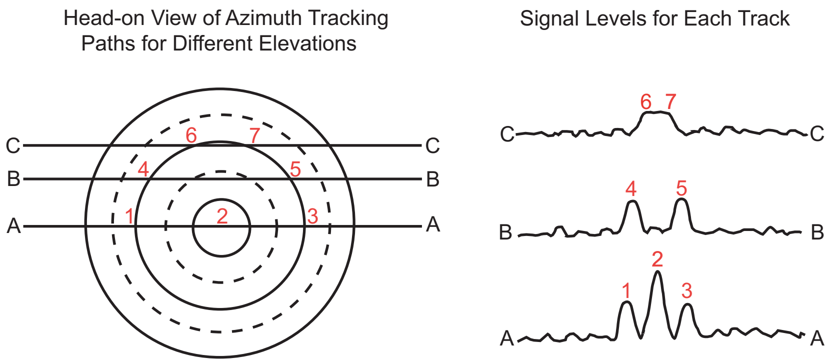
Figure 5-3. Indicative head-on signal pattern for a parabolic antenna



Tracking Path Error

Side lobe signal readings can be confused with main beam readings. This is particularly true for the first side lobe as the signal level at its center is greater than the signal level at the edges of the main beam, and if tracking on an incorrect elevation (or azimuth) a false impression of main beam reception can be obtained. Figure 5-4 shows an example of this with a simplified head-on view of an antenna radiation pattern, and tracking paths for three elevation settings.

Figure 5-4. Example Tracking Path Signals



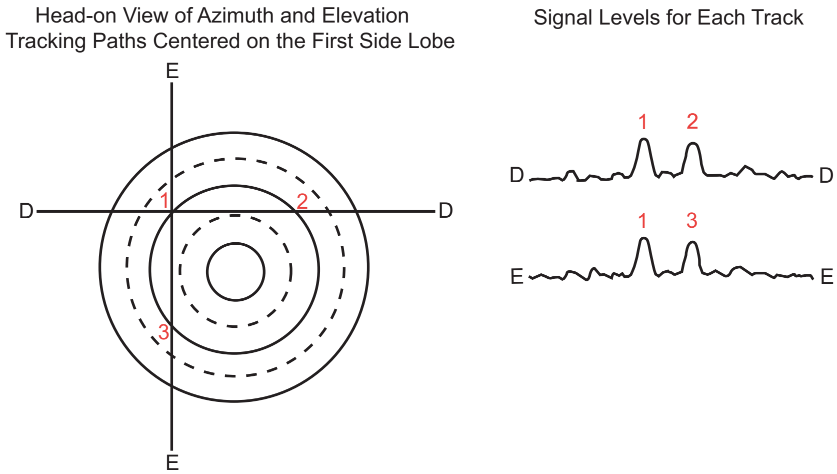
Line AA represents the azimuth tracking path of a properly aligned antenna. The main beam is at point 2, and the first side lobes at points 1 and 3.

Line BB represents the azimuth tracking path with the antenna tilted down slightly. Signal strength readings show only the first side lobe peaks, 4 and 5. In some instances the side lobe peaks are unequal due to antenna characteristics, which can lead to the larger peak being mistaken for the main beam. The correct method for locating the main beam in this case is to set the azimuth position midway between the first side lobe peaks, and then adjust the elevation for maximum signal.

Line CC represents an azimuth tracking path with the antenna tilted down further still. The first side lobe signal peaks (6 and 7) appear as one peak, leading to a mistaken interpretation of a main beam. The correct method for locating the main beam is to set the azimuth at mid peak, between 6 and 7, and then adjust elevation for maximum signal.

This first side lobe peaking is probably the most frequent cause of misalignment in both azimuth and elevation, especially so if one side lobe peaks higher than the other, as shown in Figure 5-5. A common error is to move the antenna left to right along line DD, or top to bottom along line EE, always ending up with the maximum signal at position 1.

Figure 5-5. Example Tracking Path Signals Centered on the First Side Lobe



Volume IV

9500 MXC CT

Chapter 1. 9500 MXC CT Introduction

This chapter introduces 9500 MXC CT features and functions.

The main topics are:

9500 MXC CT Screens

All 9500 MXC CT (CT) screens have the look and feel of a Windows environment. For an example screen.

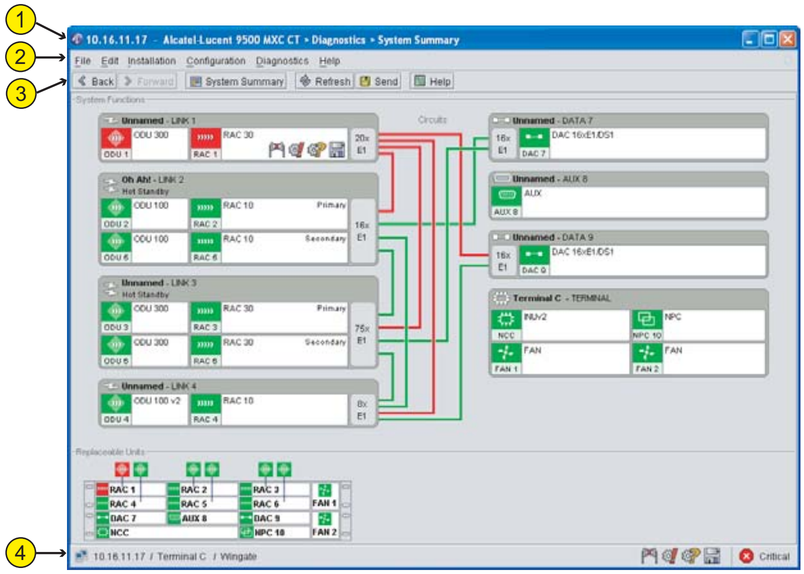
Access to on-screen features and commands is provided by mouse click and/or quick-access key commands.

The Tool Bar, Menu Bar, and Status Bar are present on *all screens*.

With few exceptions a configuration change made in one screen will immediately reflect through to all other affected screens - it is not necessary to click Send to confirm a change made in one screen to see its affect in a related screen or screens.

Each CT screen is read from the radio, with the read action on a per-screen-opened basis. During an opening (read) or sending (write) action a progress indicator shows the read/write status as shown in Figure 1-1. Once a screen is opened it stays open and is immediately readable for the duration of the CT session.

Figure 1-1. Example 9500 MXC CT Screen



Item	Description
1	Selected screen. Identifies the IP address for the terminal and the opened screen. In this example it is the System Summary screen, which is a Diagnostics screen.
2	Menu bar. Provides direct navigation to main areas of user interest. Clicking on a Menu brings up a sub-menu that provides direct access to relevant screens and commands.
3	Tool bar. Provides quick access to common actions. It includes direct access to the System Summary screen, which provides an overview of the configured terminal and its status. The System Summary screen is the CT opening screen.
4	Status bar. Shows the site name, terminal name and its IP address, plus problem graphics and a system alarm/severity icon, which provides an overall status summary for the terminal. For an Ethernet connection, the IP address displayed is the Ethernet address of the Node/Terminal. For a V.24 connection, the IP address is the default connection address.

User Hints

- Data that you can change is lettered in solid color. Non-configurable data is greyed out.
- Many on-screen items (attributes/labels/features) are supported by ToolTips. A ToolTip can be viewed by slowly moving the mouse pointer over an item.
- Use the maximize button in the top right corner of a window to go to a full screen. Click again to restore down. Or resize by clicking and dragging a corner of the window.
- A CT screen, or screens, can be re-positioned by clicking and dragging.

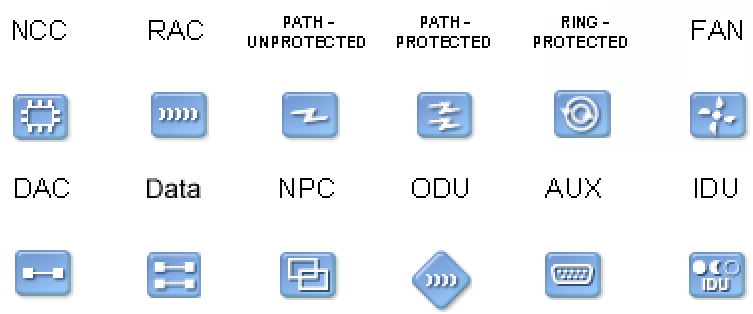
- CT memorizes the most recent screen size/position settings for future use. Two size/position situations are memorized:
  - Single screen. Applies to all CT sessions except for a protected IDU terminal.
  - Protected IDU screens. For protected IDUs two screens should be launched, one for the primary IDU and one for secondary, and the two screens positioned to sit side-by-side or above-and-below. CT memorizes the size/position for primary and secondary.

9500 MXC CT Symbols

9500 MXC CT Logos

Throughout CT, standard logos are used to assist 9500 MXC module identification. Refer to Figure 1-2.

Figure 1-2. Standardized 9500 MXC Logos



9500 MXC CT Icons

Figure 1-3 shows the system severity icons.

Figure 1-3. System Alarm Icons

1 Warning

2 Minor

3 Major

4 Critical

0 No Alarms

Figure 1-4 shows problem icons used within CT and their meanings.

Figure 1-4. Problem Icons


Software configuration problem


Plug-in needs replacing


Diagnostic or test mode is active


Plug-in missing or not the expected type


Problem detected in the transport system


Failure in the transport system


Radio path is down


Module not licensed or has exceeded its license


Module is incompatible with the backplane configuration


Invalid plug-in type

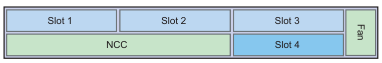
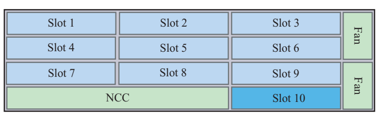

Checking the plug-in (may take up to two minutes)


Ring wrapped

9500 MXC Node Slot Numbering Conventions

The 9500 MXC Node INU and INUe icons and slot numbering conventions are detailed in Table 1-1.

Table 1-1. 9500 MXC INU and INUe Icon and Slot Numbering Conventions

Icon and Slot Numbering	Conventions
INU 	The INU slot numbering conventions are as follows: • 1, 2, 3 are universal slots for any RAC, DAC, or AUX. • 4 is a universal slot for RAC, DAC, AUX, or NPC. The NPC can only be installed in slot 4. • NCC and FAN slots are dedicated. • For protected operation, RAC and DAC 155oM plug-ins can be installed in any of the universal slots.
INUe 	The INUe slot numbering conventions are as follows: • 1, 2, 3, 4, 5, 6 are universal slots for any RAC, DAC or AUX. • 7, 8, 9 are restricted. Backplane access to NMS is not supported on these slots, meaning they may be used for all DACs and AUX *except where they are to be used to transport NMS*. This restriction will only apply to DAC 155oM and AUX (Other DACs do not support an NMS transport option). • DAC 155oM and AUX must only be installed in slots 1 to 6 where NMS access is required. • 10 is for NPC only. • NCC and FAN slots are dedicated. • For protected operation RAC or RAC/DAC155oM pairings must be in slots 1 and 4, and/or 2 and 5, and/or 3 and 6.

Slot Terminology

- Universal plug-ins are identified with their slot number. For example, a DAC plugged into slot 3 would be identified in the Plug-in screens as DAC 3
- NCC and FAN are identified with a slot letter; C and F respectively.

9500 MXC CT Naming Conventions

Within CT screens, the naming of traffic-carrying plug-ins/modules and their associated icons have the following meanings.

Table 1-2. 9500 MXC Naming Conventions

Plug-in / Module	Convention
RAC	Refers to a single RAC plug-in for the Node, and to the radio function for a Terminal.
Link	Refers to the link-end, un-protected or protected, for a RAC and ODU combination. • Where a path is not protected, Link is associated with one RAC/ODU. • Where a path is hot-standby or diversity protected, Link is associated with two RACs/ODUs. • Where ring protection is used, Ring replaces use of Link.
DAC	Refers to a DAC plug-in for the Node, and to the tributary function for a Terminal.
Data	Refers to a DAC function, unprotected or protected. • Where DACs are protected, Data is associated with two DACs.
Ring	Refers to a ring-protected configuration. Ring is associated with two RACs.
AUX	Refers to a single AUX plug-in for the Node, and to the auxiliary function in a Terminal.
NPC	Node protection card. This Node option provides redundancy for the NCC TDM bus clock, and NCC power supply functions.

9500 MXC CT Auto Version

The auto version feature within CT ensures the CT software version running on your PC automatically matches the version of embedded (system) software installed on 9500 MXC. This avoids the need to hold multiple versions of on your PC, and to select from them when connecting to a 9500 MXC radio.

Version matching is achieved through the use of difference (diff) files, each containing the difference between the CT software version files. The diff files needed to match CT to the version of 9500 MXC embedded software, are held within the embedded software set. This means that:

- For a *new* 9500 MXC installation the version of CT supplied in the Setup CD will always match the embedded software of the equipment being installed.

- In other situations, the auto version feature delivers transparent version matching to ensure the version of CT used is always compatible with 9500 MXC software.

The process used by CT to determine the version needed to communicate with 9500 MXC is as follows:

- When a CT start-up is executed (refer to Starting 9500 MXC CT on page 2-19) the highest version of CT installed on your PC is used.
- Initial communication with 9500 MXC identifies the version of CT needed.
- Where an earlier version of CT is required, CT selects the correct version and restarts itself.
- Where a later version of CT is needed (not on your PC), CT downloads the updating difference files from 9500 MXC. During this process the CT Start Up screen will indicate a later version of 9500 MXC CT is being downloaded. On completion of the download, 9500 MXC CT will automatically complete the start up process. The next time you connect to this 9500 MXC there will be no download, as the updating files are now held on your PC.
- The download time required to update to a later version depends on the number/size of the diff files needed, and whether your PC connection to 9500 MXC is by V.24 or Ethernet. Ethernet is much faster. When downloading is initiated, an on screen message provides an estimation of the time needed.
- An alternative to CT updating using 9500 MXC CT Auto Version, is to update from the 9500 MXC Setup CD supplied with the Node/Terminal. Refer to Procedure for Installing 9500 MXC CT on page 2-2. Compared to a *V.24* connection, this may provide a quicker update.

When new *9500 MXC* software is loaded into a Node/Terminal, you must re-start CT to trigger auto version matching.

Online Help

MXC 9500 Online Help is a web-based (html) helpset for the MXC 9500 User Manual. It is installed on your CT PC, and is launched when prompted from CT.

This section provides information on:

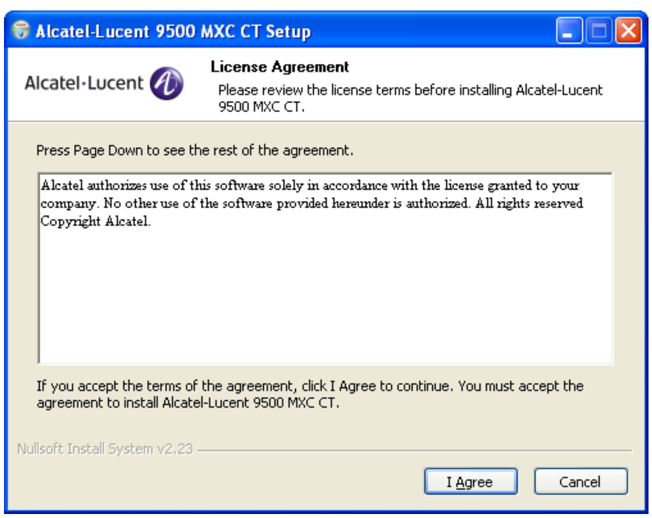
- Installing Online Help
- Using Online Help

Installing Online Help

MXC 9500 Online help is installed from a Alcatel-Lucent MXC 9500 installation file on the MXC 9500 SW Setup CD. The Installer installs both MXC 9500 Online Help and CT application software.

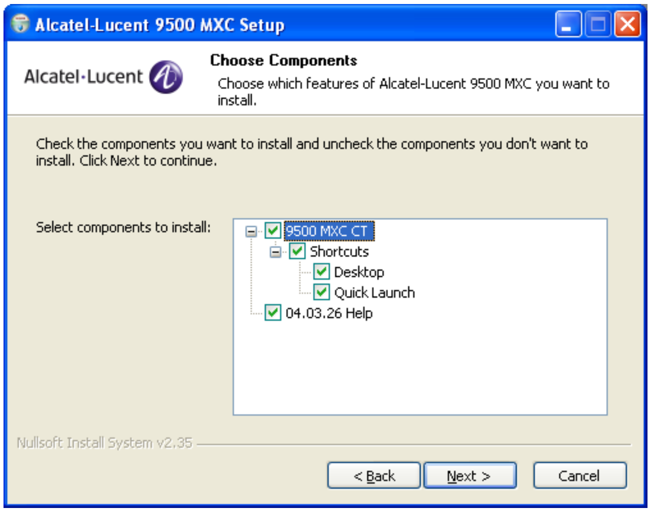
1. Two installation files are provided on the CD, one for non-Vista PCs, and one for PCs running Vista. Click one of the files to begin the install:

2. Confirm acceptance of the License Agreement:

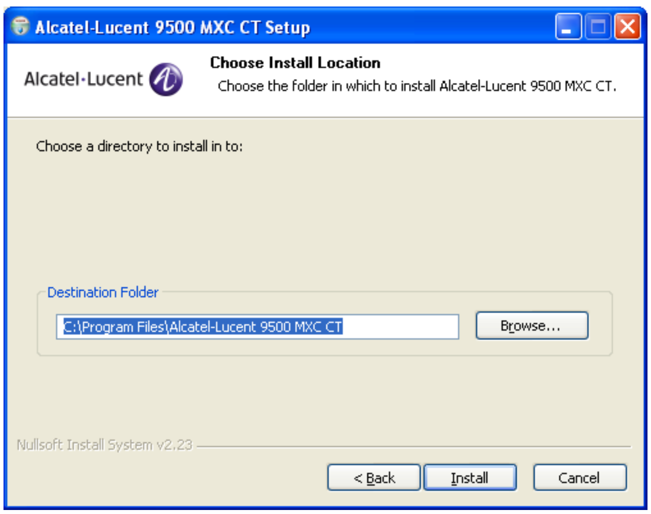


3. A Components screen allows selection of CT and/or Online Help files.
4. If CT has been previously loaded, you can elect to only load the Help file, as CT

auto-versioning will automatically capture CT updates from the radio.



5. Click next to select a destination folder. C:\Program Files\Alcatel-Lucent 9500 MXC CT is the default folder.



6. Click Install to begin the installation. A progress bar shows installation progress. Click Close on completion.
7. A CT shortcut is placed on your Desktop. Click to open:

- When subsequent versions (releases) of MXC 9500 online help are installed, they are retained along with the previous versions. There is no automatic replacement of old by new. This helps to ensure that in networks where not all radios are installed with the latest MXC 9500 software, the most relevant version of online help is used with a radio. See Using Online Help.
- A de-installer is provided in the folder holding the online help files. It is used to de-install all online files - it cannot be used to provide a selective de-install.

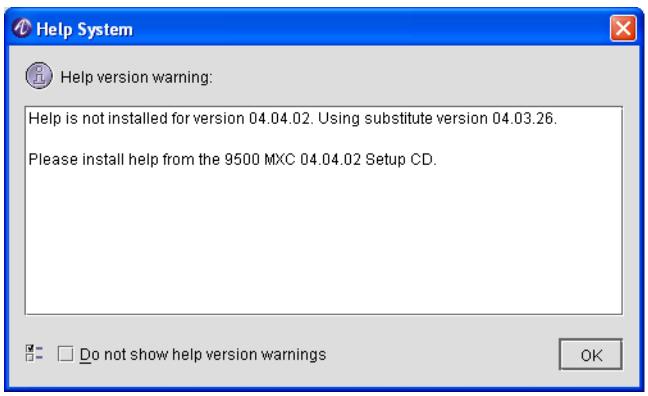
Using Online Help

MXC 9500 Online Help provides access to the MXC 9500 User Manual for general and context-sensitive viewing.

It displays using the default Web browser on your PC, and is accessed from CT to provide general or context sensitive help.

Version matching is used to ensure that the version of CT being used to communicate with the radio is matched to the relevant version of Online Help.

- Where there is an exact match, Online Help will open directly. There is a small delay when opening, which is supported by a progress window.
- Where there is not an exact match, a warning window opens to advise:



  - Click OK to launch the best-matched version of Help.
  - Where Online Help is not installed, the warning window advises the version needed.

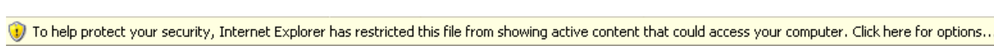
Online Help for the following options can be accessed from CT screens:

- **MXC 9500 Manual and CT Manual.** The online help for these manuals is launched by clicking Help in the CT *menu bar* and selecting MXC 9500 Manual, or CT Manual. The CT Manual is a sub-section of the MXC 9500 Manual.
- **Context sensitive help.** This is launched by clicking F1 or Help in the CT *toolbar*, or by selecting Context Help, under Help in the menu bar.
- **Context sensitive help for alarm or informational events.** This is launched by clicking the relevant tab in the Diagnostics > Event Browser, or Diagnostics > Alarms screens. Refer to Help for Event and Help for Alarm Tabs.

Once you have opened Help using a context-sensitive prompt, you have full freedom to navigate to any other page in MXC 9500 Online Help. To view the Help table of contents, click the top left tab of the help screen.

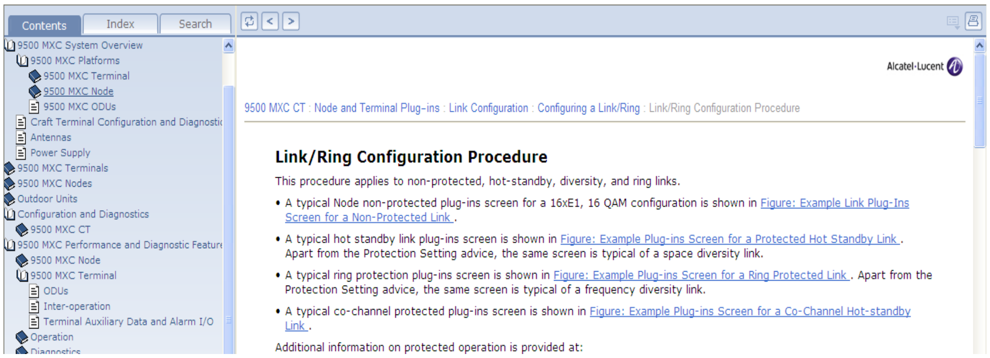
For more information on context sensitive help, refer to Diagnostics, 9500 MXC Online Help.

NOTE: If you are using Internet Explorer version 6, the following information bar may appear at the top of your browser screen. Click on the bar and select 'Allow Blocked Content' to secure full access to the Help screen. This bar will appear for all new Help screens prompted from CT. To avoid this action, use a different web browser, such as Firefox, or use a later version of Internet Explorer.



MXC 9500 Online Help displays in your default web (HTML) browser. You do not need a link to the Internet to use MXC 9500 Online Help and its features.

Each topic in the online help has its location listed at the top of the page to help you to identify related topic areas.



Navigation:

To navigate the online help, use the tabs at the top of the left of the Help screen:

- **Contents -** Enables you to view the information headings organized by subject. Expand the top-level headings to view the subtopics.
- **Index -** The index is used to find important terms and to display the related topic.
- **Search -** Enables you to search for any character string in the help set.

8. A search result lists all the topics that contain the search string, with a % ranking showing how well the topic matches the search. If you have Internet Explorer installed as your default Internet browser, all occurrences of the search string are highlighted in the help topic (highlighting will not be present with Firefox set as your default browser).

OffLine Access to MXC 9500 Online Help

To access the web-based MXC 9500 User Manual when not in CT, navigate to the Alcatel-Lucent MXC 9500 program folder on your PC (default in your PC Programs folder) and select the Help folder. Over time there will be multiple Help files in this folder - each time you install a new MXC 9500 installation file, a newer version of Help is added to this location. Be sure to select the version most appropriate to your needs - such as the most recent file.

Printed Copy

If you prefer to have printed versions of the documentation, print them from the PDF provided on the MXC 9500 Software Setup CD. You can also print individual help pages from the web browser view.

Chapter 2. Setting Up 9500 MXC CT

This chapter describes how to install 9500 MXC CT and its connection options.

The main topics are:

Installing 9500 MXC CT on Your PC

This section describes the PC requirements and procedure for installing 9500 MXC CT on a PC.

PC Requirements

Hardware Requirements

The following are the minimum PC hardware requirements:

- IBM compatible
- P3 500 MHz
- 256 MB RAM
- 80 MB free hard disk space
- CD drive
- Serial COM port (COM1 or COM2), or USB port plus external USB-to-serial adaptor for local V.24 connection, or Ethernet 10Base-T LAN port with RJ-45 connector for Ethernet local connection.
- 800 x 600 resolution, 256 color display (16-bit color recommended)
- SVGA Display Adaptor Card
- 256 Monitor colors
- 2 or 3-button Mouse
- 101-key US keyboard

Software Requirements

To run 9500 MXC CT you must have:

- Microsoft® Windows 98, 2000 Pro, XP, or Microsoft Windows NT
- TCP/IP installed and configured for LAN operation

Procedure for Installing 9500 MXC CT

9500 MXC CT is delivered with an installer file on a Setup CD, supplied as part of the 9500 MXC Installation Kit.

To install 9500 MXC CT on your PC:

1. Insert the 9500 MXC Setup CD.
2. Double-click the 9500 MXC CT Installer file on the CD.
3. Select the default directories or customize the directories.

   The 9500 MXC CT Installation Wizard completes the installation of 9500 MXC CT and installs a copy of Java Runtime. A 9500 MXC CT shortcut is created on your PC desktop.

You only need to install 9500 MXC CT once. The 9500 MXC CT Auto Version feature ensures on-going compatibility between 9500 MXC CT and 9500 MXC software. Refer to 9500 MXC CT Auto Version on page 1-6.

9500 MXC CT to 9500 MXC Connection Options

There are two PC-to-9500 MXC connection options; 10/100Base-T Ethernet or V.24.

An Ethernet connection should always be used as it provides a much faster connection and running speed, compared to a V.24 connection. Ethernet must be used for network-wide access.

An Ethernet connection requires a LAN-compatible IP address to be entered on your CT PC *for radios that are not DHCP (Dynamic Host Communications Protocol) enabled*.

Before a LAN compatible IP address can be entered on your PC, the IP address of the target radio must be known. If the address is not recorded on or with the radio, it can normally be discovered by the CT IP address auto-discovery mechanism. If not, a V.24 CT connection must be used to obtain the IP address. A V.24 cable is provided with all radios.

For radios that are DHCP enabled, a valid CT PC connection is established automatically, providing your PC is set to obtain an IP address automatically.

For information on the 9500 MXC CT (CT) PC connection options refer to Table 2-1. It provides introductory data on:

- Ethernet connection using a LAN-compatible TCP/IP address on your PC.
- Ethernet connection using DHCP.
- V.24 connection.

CT IP Address Auto-Discovery Mechanism

On connection to the radio NMS interface, CT broadcasts a UDP discovery packet. The directly connected radio and any other radios on the local LAN respond with their IP address and radio name. These are listed in the connect-to list in the CT start-up window, and carry a green tick to confirm detection by CT. This occurs even if your CT PC and the radio you are connected to, do not have non-overlapping IP addresses and netmasks.

Note that if your PC is set to obtain an IP address automatically from a DHCP server, and there is no DHCP server set on the radio you are connected to, or on any other radio in the local NMS LAN, auto discovery should still work, but only after a few minutes have elapsed.

- With no DHCP server, the network connection application on you PC will time-out and display a warning event: “Local Area Connection: This connection has little or no connectivity. You may not be able to access the Internet or some network resources.”
- At this point, CT auto discovery will operate. This is enabled by the PC assigning itself an automatic private IP address (APIPA) within the network range of 169.254.0.0, mask 255.255.0.0, which is valid for the auto discovery mechanism.

When a radio from the list is selected, a connection packet is sent from the PC to the radio, at which point the radio responds with a temporary route to the PC. However, unless the PC is configured on the same network as the radio, the PC will not be able to establish communications with the radio. At this point the TCP/IP properties of the PC must be set so that the PC is seen as a host on the radio LAN. Refer to Setting Up A TCP/IP Ethernet 9500 MXC CT Connection on page 2-6.

In most instances, because the network address on the CT PC and on the radio will not be the same, the auto-discovery mechanism is used to discover the IP address of the radio, followed by the setting of a LAN compatible TCP/IP setting on your CT PC.

Where their are multiple radios on the local LAN (two or more radios inter-connected by their NMS ports), auto-discovery will return the IP address and terminal name for all radios.

Where it is not apparent which of the radios in the connect-to list is the physically-connected radio, it can be isolated by temporarily disconnecting the NMS cable(s) to the other radio(s).

Information on the subnet mask of the connected radio is not returned by auto-discovery. When entering the auto-discovered IP address of a radio in the CT PC TCP/IP settings, and the subnet mask is not known, it may be deduced from the address. Bear in mind that in most instances a class C address range will be used, even where a class A or B address range is indicated. These will be sub-netted for class C addressing, meaning a class C mask of 255.255.255.0 will provide the capture needed.

Regardless, a Class A netmask of 255.0.0.0 can be used, which will capture all class A, B, and C addressing. Once communication with the radio has been established, the actual radio subnet mask will be displayed in its Configuration > Networking screen, whereupon the correct default gateway and netmask should be entered in the PC TCP/IP properties.

- If you only need to view the radio that your PC is physically connected to, you can stay with the 'temporary' subnet mask.
- If you need to view other radios on the local LAN, or remote radios on the NMS network, the correct gateway and subnet mask must be entered on your PC, at which point the CT connection must be re-started.

If you are using auto-discovery to learn the IP address to connect to a new, unconfigured radio, bear in mind that the configuration process will require entry of a new IP address for the radio. When the configuration is saved, the CT PC will not be able to communicate with the radio, until a new LAN-compatible IP address is entered on your PC. Normally, where your PC has a V.24 port, a V.24 cable connection is used to reconfigure the IP address for a new radio, after which point an Ethernet connection is used.

The need to set a LAN compatible IP address on your CT PC is avoided if the MXC 9500 radios are configured as DHCP servers, and your PC is set to obtain an IP address automatically.

Table 2-1. 9500 MXC CT PC Connection Options

PC-to-9500 MXC Connection Option	Description
Ethernet TCP/IP connection	**Default applies to all 9500 MXC radios.** A TCP/IP Ethernet connection has the following requirements: • Knowledge of the IP address for each 9500 MXC radio to be logged into. • Your PC must operate as a device on the NMS LAN of the physically connected radio. As each radio has its own NMS router with a unique IP address, TCP/IP settings on your PC must be changed each time you *physically connect* to a different 9500 MXC radio. Refer to Setting Up Your PC TCP/IP Properties on page 2-7. • In most instances, the CT auto-discovery mechanism will return the IP address and terminal name of the connected radio, and all other radios on the local NMS LAN. **Note:** For rules, hints, and tips on Ethernet connection to a 9500 MXC NMS network, refer to Appendix F. **Next Step:** • Setting Up A TCP/IP Ethernet 9500 MXC CT Connection on page 2-6.

PC-to-9500 MXC Connection Option	Description
Ethernet DHCP connection	**This is an option for all 9500 MXC radios.** A DHCP connection does not require knowledge of the radio IP address. DHCP connection has the following requirements: • The radio must be enabled as a DHCP server. • Your PC must have DHCP enabled (to obtain an IP address automatically). • If there are multiple radios on the local NMS LAN, and all are configured as DHCP servers (recommended), the DHCP assignment to your PC can be from any one of these radios. **Next Step:** • Setting Up A DHCP Ethernet 9500 MXC CT Connection on page 2-10.
V.24	**A V.24 connection applies to all 9500 MXC radios.** A 24 connection does not require knowledge of the radio IP address. • A V.24 cable is included in the installation kit of all Nodes/ Terminals. • V.24 is normally only used to login to a new radio where the CT auto-discovery mechanism fails to return an IP address. Once configured with an IP address, an Ethernet connection should subsequently be used because of its faster connection/running speed. **Next Step:** • Setting Up 9500 MXC CT Connection Using V.24 on page 2-12.

Setting Up A TCP/IP Ethernet 9500 MXC CT Connection

TCP/IP connection requires knowledge of the IP address of the radio you are connected to.

TCP/IP must be used for an Ethernet connection where the radio connected to is not enabled as a DHCP server.

Setting up your CT PC to connect to a 9500 MXC Node or Terminal via an Ethernet connection involves the following steps:

- Ethernet Access Requirements on page 2-6
- Setting Up Your PC TCP/IP Properties on page 2-7

Ethernet Access Requirements

A successful connection between a PC and a 9500 MXC Node or Terminal via Ethernet requires the following:

- An industry-standard 10Base-T or 10/100Base-T LAN card installed on your PC.
- The IP address and subnet mask settings for the 9500 MXC Node or Terminal to be connected to.
- A network compatible IP address and subnet mask set up on your PC. This enables your PC to be recognized on the 9500 MXC management network. Refer to Setting Up Your PC TCP/IP Properties on page 2-7.

For an existing 9500 MXC network, contact the network administrator to secure a list of IP address details for Nodes and Terminals, or use a V.24 connection to obtain details of the connected rradioadio.

If you do not know the IP address of a 9500 MXC radio, the CT auto-discovery mechanism will in most instances return the IP address and terminal name.

If CT auto-discovery cannot return an IP address, and the 9500 MXC radio has a front-panel V.24 maintenance port, refer to Using a V.24 Connection to Obtain the Ethernet IP Address on page 2-27.

If the radio has been set for DHCP connection, refer to Setting Up A DHCP Ethernet 9500 MXC CT Connection on page 2-10.

For a new 9500 MXC network or for additions to an existing network, the network administrator provides the IP address and subnet mask settings to be loaded into the new Nodes/Terminals.

Do not use the address range from 192.168.255.0 to 192.168.255.255 as these addresses are used for internal (embedded) addressing within 9500 MXC.

If in doubt about Ethernet access and PC settings, contact your network administrator or IT manager for assistance.

Setting Up Your PC TCP/IP Properties

Introduction

Your CT PC must have a LAN-compatible address installed. Each radio in a 9500 MXC network has a unique network address, unless connected on a LAN at the same site, so you must change your PC TCP/IP settings each time you physically connect to a different radio.

This requires configuration of your PC LAN card TCP/IP settings, so your PC is recognized as a device on the 9500 MXC NMS LAN.

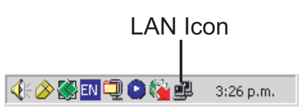
Procedures are provided for Windows 2000 and XP.

Procedure: Windows 2000

This procedure is based on a PC running Windows 2000 PC, there may be small differences with other versions of Windows.

For guidance during this procedure refer to Example - Changing TCP/IP Properties on page 2-9.

1. Click on the LAN (network connection) icon in the System Tray, located in the lower right corner of your PC screen.

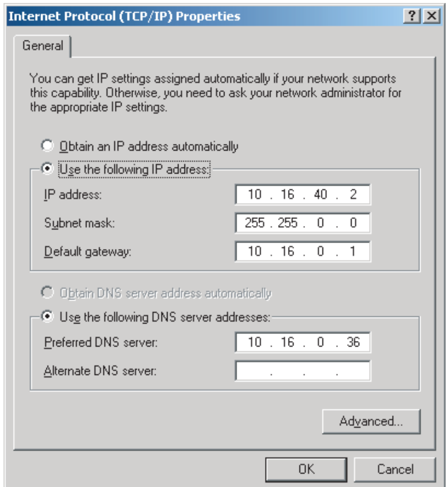
   Or, from the Control Panel of your PC, select **Network and Dial-up Connections** > **Local Area Connection**.

   The Local Area Connection Status window is displayed.

2. Click **Properties**.
3. Select **Internet Protocol (TCP/IP)**.
4. Ensure its associated box is ticked.

5. Click **Properties.**

   The Internet Protocol (TCP/IP) Properties window is displayed.



Before making any change to the settings in this window, record and retain the existing settings, which may pertain to your company LAN.

6. Select **Use the following IP address**.
7. In the IP address field enter a LAN compatible IP address for the radio:
   - The network portion of the IP address must be the same as the radio you are connecting to. The network portion is determined from the subnet mask. Except in circumstances where sub-netting is used this network portion will be indicated by subnet mask octets of 255.... In the example above the network portion is 10.16 (subnet mask of 255.255.0.0).
   - The host portion of the IP address must be set so that your CT PC is seen as a different connection on the radio LAN. It must NOT be set to the same host number as the radio you are connecting to.
   - The subnet mask must be set to be the same as the radio you are connecting to.

   Refer to Example - Changing TCP/IP Properties on page 2-9 for guidance.
8. To enable viewing of other 9500 MXC Nodes/Terminals on the network, set the default gateway to be the same as the IP address of the radio you are physically connecting to.

Existing settings for a DNS server may be ignored.

9. Click **OK**, then **OK** again to confirm the settings and exit.

This procedure must be repeated when physically connecting to other 9500 MXC Nodes/Terminals in the network.

Next Step

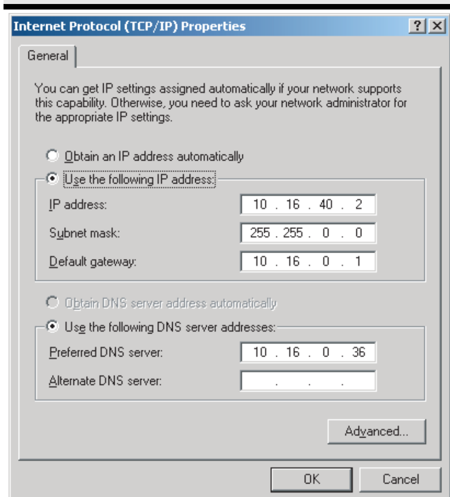
Starting 9500 MXC CT on page 2-19.

Example - Changing TCP/IP Properties

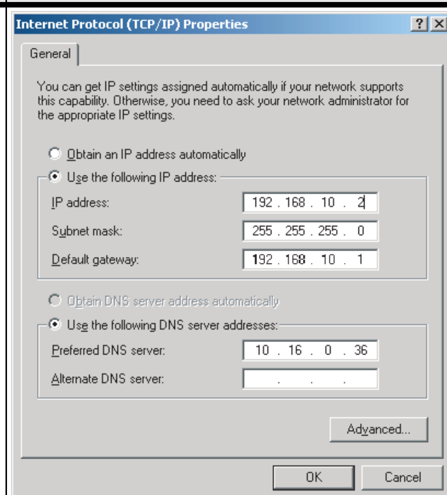
The following screens provide an example of changing the TCP/IP properties and makes note of the points you must be aware of when changing these properties.

The 9500 MXC you are connecting to has an IP address of 192.168.10.1 and a subnet mask of 255.255.255.0. The subnet mask indicates that the network portion of the IP address is 192.168.10, and that the host portion is 1.

TCP/IP Properties Before



TCP/IP Properties After



TCP / IP Properties Before	TCP / IP Properties After
This screen shows an example of existing settings. The IP address and Subnet mask must be changed. The Default gateway must be changed where access to other 9500 MXC Nodes/ Terminals on the network is required. **Note:** Another example of *existing* settings is: - 'Obtain an IP address automatically', and - 'Obtain DNS server address automatically For such selections the address entry boxes will be greyed-out (no address data). Click 'Use the following IP address' to enter an IP address.	In this example, the IP address of the 9500 MXC to which you are connecting is 192.168.10.1, with a Subnet mask of 255.255.255.0. Example IP Address 192.168.10.1 Network portion Host portion Your PC must have the same network address, 192.168.10, with the host portion set to a different number, which in this example is 2. If a second CT PC is also to be connected to the same radio, then its network portion would be the same, but its host portion must be different again, such as 3. The Default gateway has been set to the IP address of the connected device, which allows routed CT access to other 9500 MXC Nodes/Terminals via this connection.

Setting Up A DHCP Ethernet 9500 MXC CT Connection

These procedures apply to 9500 MXC radios that have a DHCP server function enabled.

The DHCP server function is an option all 9500 MXC radios.

DHCP is a client-server networking protocol, where the server automatically assigns an IP address to client PCs logging onto its LAN. By eliminating the need to assign a permanent IP address to a client PC, it eliminates the need to enter an IP address in the TCP/IP properties window of your PC, prior to connecting your PC. Instead, within your PC TCP/IP properties window, the 'Obtain IP Address Automatically' option is selected.

- DHCP automatically issues an IP addresses within a specified range to PCs on a network. For 9500 MXC radios the range is configurable in CT.
- A CT PC retains its assigned address for as long it remains connected to the network (9500 MXC Ethernet 10/100Base-T NMS port), and for a period 5 seconds thereafter (5 seconds is set as the DHCP server lease time on a 9500 MXC radio).
- DHCP-enabled is the default TCP/IP connection option on most laptop PCs.

To set up your CT PC to connect to a 9500 MXC radio that has the DHCP Server function enabled, refer to:

- DHCP Ethernet Access Requirements on page 2-11

- Setting Up Your TCP/IP Properties for DHCP on page 2-11

DHCP Ethernet Access Requirements

A successful DHCP Ethernet connection from a CT PC requires the following:

- An industry-standard 10Base-T or 10/100Base-T LAN card installed on your PC.
- DHCP enabled within the TCP/IP Properties window on your PC.
- DHCP server enabled on the 9500 MXC radio you are connecting to.

The DHCP server function is configured in the Configuration > Networking screen. Refer to DHCP Server Function on page 10-12, Volume IV, Chapter 11.

Setting Up Your TCP/IP Properties for DHCP

Introduction

Your CT PC must be configured to obtain an IP address automatically, which is set within the Local Area Connection window on your PC.

Procedure

This procedure is based on a PC running Windows 2000 PC; there may be small differences with other versions of Windows.

1. Click on the LAN (network connection) icon in the System Tray, located in the lower right corner of your PC screen.

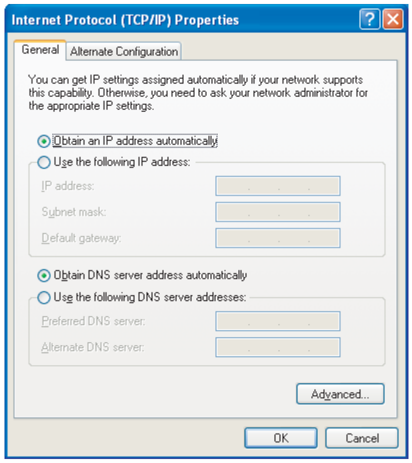
   

   Or, from the Control Panel of your PC, select **Network and Dial-up Connections** > **Local Area Connection**.

   The Local Area Connection Status window is displayed.
2. Click **Properties**.
3. Select **Internet Protocol (TCP/IP)**.
4. Ensure its associated box is ticked.

5. Click **Properties.**

   The Internet Protocol (TCP/IP) Properties window is displayed.



Before making any change to the settings in this window, record and retain the existing settings, which may pertain to your company LAN.

6. Select **Obtain IP Address Automatically** and **Obtain DNS Server Address Automatically**, as shown in the window above.
7. Click **OK**, then **OK** again to confirm the settings, and exit.

Next Step

Starting 9500 MXC CT on page 2-19.

Setting Up 9500 MXC CT Connection Using V.24

Two procedures are described, one for a PC fitted with a DB-9 serial COM port, and one for a PC fitted with a USB port.

Laptops running Windows XP generally have a USB port rather than a DB-9 serial COM port. With a USB port, an external 3rd party USB-to-serial adaptor is required.

Setting up your 9500 MXC CT PC to connect to a 9500 MXC Node or Terminal using V.24 connection involves:

- Setting Up a V.24 Connection via a DB-9 Serial COM Port on page 2-12 **OR**
- Setting Up a V.24/RS-232 Connection via a PC USB Port on page 2-16

Setting Up a V.24 Connection via a DB-9 Serial COM Port

These procedures apply to PCs fitted with a serial COM port.

Procedures are provided for Windows XP, 2000 and 98:

- **For Windows 2000 and Windows 98 the process requires**:
  - Installing 9500 MXC Modem Driver for Serial COM port and;

- Installing Dial-up Connection for Serial COM port: Windows 2000 & 98.
- **For Windows XP two procedures are detailed**:
  - A procedure is similar to that for Windows 2000 / 98 using the modem driver. Refer to Installing 9500 MXC Modem Driver for Serial COM port, and subsequently to Installing a Dial-up Connection for Serial COM Port: Windows XP and Vista.
  - A computer-to-computer comms cable procedure that does not require installation of the modem driver. Refer to Installing a COM Port Communications Cable Connection: Windows XP. **This procedure must only be attempted where there are no modem drivers set on your COM port. If existing modems are installed, they must first be removed.**
- **For Vista one procedure is detailed**:
  - The procedure is similar to that for Windows XP using the modem driver. Refer to Installing 9500 MXC Modem Driver for Serial COM port, and subsequently to Installing a Dial-up Connection for Serial COM Port: Windows XP and Vista.

Installing 9500 MXC Modem Driver for Serial COM port

This procedure applies to Windows 2000, Windows 98, Windows XP, and Vista for a dial-up modem connection.

To install the V.24/RS-232 modem:

1. From the PC control panel, select **Phone and Modem Options** > **Modems** > **Add**.

   The Install Modem Wizard window is displayed.
2. Click **Next**.
3. Select **Don't detect my modem; I will select it from a list** and click **Next**.
4. Select **Have Disk** and browse to the 9500 MXC Installation Kit CD.
5. Select the **9500 MXC V.24 Modem Driver.inf** file, and click **Open**.
6. Select **9500 MXC V.24 Modem [38400bps]** and click **Next**.
7. Select a COM port and click **Next**.
8. If a Digital Signature Not Found screen is displayed, click **Yes**.
9. To complete the installation, click **Finish**.
10. Click **OK**.

Installing Dial-up Connection for Serial COM port: Windows 2000 & 98

The 9500 MXC modem driver must first be installed.

To configure the dial-up connection:

1. From the PC Control Panel, select **Network and Dial-Up Connections** > **Make New Connection**.

   The Network Connection Wizard window is displayed.
2. Click **Next**.
3. Select **Dial up to private network** and click **Next**.
4. Select **Modem - 9500 MXC V.24 Modem [38400 bps]** and click **Next**.

If the 9500 MXC V.24 Modem is the only modem installed, it is automatically assigned to the new network connection.

5. Enter a number in the phone number box (any number) and click **Next**.
6. Type the name you want to use for this connection.
7. Select the **Add a short cut to my desktop** option.
8. To complete the installation, click **Finish**.

To check setup and operation, refer to the topic Starting 9500 MXC CT on page 2-19.

Installing a Dial-up Connection for Serial COM Port: Windows XP and Vista

This procedure sets an Internet dial-up connection. The 9500 MXC modem driver must first be installed.

To configure the connection:

1. **Windows XP**: From the PC Control Panel, select **Network Connections** > **Create a new connection**. The New Connection Wizard is displayed.

   Vista: From the PC Control Panel, select **Network and Sharing Center** > **Set up a Connection or Network**.
2. Click **Next**.
3. Select **Connect to the Internet**.
4. Select **Setup my connection manually**.
5. Select **Connect using a dial up modem**.
6. Select **9500 MXC V.24 Modem 38400bps**.
7. Type in an ISP Name or a name for the connection, such as 9500 MXC.
8. Enter any phone number, such as 1234567 (the dial up connection may not work if the phone number is left blank).
9. Select **Anyone's use**.
10. Leave the Username and Password blank and click **Next**.
11. Click on **Add a shortcut to this connection to the desktop**.
12. Click **Finish**.

To check setup and operation, refer to Starting 9500 MXC CT on page 2-19.

Installing a COM Port Communications Cable Connection: Windows XP

This procedure sets up a communications-cable connection between your CT PC and 9500 MXC. There is no need to first install the 9500 MXC modem driver.

This option is not available for Windows 2000 / 98, or Vista.

To configure the connection:

1. From the PC Control Panel, select **Network Connections** > **Create a new**

connection.

The New Connection Wizard is displayed.

2. Click **Next**.
3. Select **Set up an advanced connection** and click **Next**.
4. Select **Connect directly to another computer** and click **Next**.
5. Select **Guest** and click **Next**.
6. Enter a computer name, such as **9500 MXC**, and click **Next**.
7. Select a COM port, such as COM1, and click **Next**.

Ensure the COM port selected has not been configured to share dial-up drivers for other devices. If an existing modem driver is configured on the COM port, this communications cable procedure will not operate. Where a conflict exists, remove the competing drivers.

8. Select **Anyone's use** and click **Next**.
9. Click add a shortcut to place a shortcut on your desktop, and click **Finish** to complete.
10. The **Connect 9500 MXC** window is presented. Ignore the User name and Password fields and click **Properties**.
11. Under **General**, the **Select a device** field displays the configured COM port and parallel port options. Select **Communications cable between two computers (COM1)**[1] and click **Configure**.
12. In the **Maximum speed (bps)** field, use the drop-down menu to select **38400**. Under Hardware features check the default settings, which should only indicate a tick in **Enable hardware flow control**.
13. Click **OK**, **OK**, **Connect**, to connect to the 9500 MXC terminal. Refer to Starting 9500 MXC CT on page 2-19. If you are not physically connected to a terminal click Cancel / Exit.
14. The maximum speed must be set for 38400 bps. The network connection and max speed can be checked by going to the Control Panel > Network Connections, *right clicking* on the **9500 MXC** connection, and selecting **Properties**. **Select a device** will confirm the connection, and **Configure** will confirm the max speed. If not at 38400 bps, reset and click **OK**, **OK**.

For the Win XP communications cable connection, always disconnect the network connection on your CT PC before removing the V24 cable (click on the networking icon, lower right on your screen, and select **Disconnect**. If not, the V.24 NMS port on the NCC card can think it is still connected and not correctly answer further connection attempts. If in doubt, reboot the terminal (power off, pause, power on).

1 *The COM port number will be the number selected in step 7.*

If rebooting is not an option because of disruption to service, try the following. With the V.24 cable installed, proceed from the 9500 MXC Connect window to: Properties > Networking > Internet protocol (TCP/IP) > Properties > Advanced, and deselect (untick) the tickbox for 'Use default gateway on remote connection', followed by OK, OK, OK, Connect.

Setting Up a V.24/RS-232 Connection via a PC USB Port

This procedure is applicable to PCs running Windows XP. It is generally applicable to Windows 98 and 2000.

There may be slight differences between different versions of the XP service pack.

This is a generic guide for third-party USB to serial adaptors, such as provided by RadioShack and Edgeport. There will be slight differences in setup requirements from one manufacturer to another. These devices require driver software, which is normally supplied on a floppy disk or CDROM, though in some instances may be included in the driver suite on Windows XP.

For a PC with a USB port the procedure covers:

- Installing the USB-to-Serial Adapter
- Changing the Assigned COM port, if required
- Installing the V.24 Modem Driver for USB
- Installing V.24 Dial-up Connection for USB

Installing the USB-to-Serial Adapter

To install the USB-to-serial adapter:

1. Plug the USB-to-Serial adapter into a USB port on your computer.

   The operating system detects the device and displays a Found New Hardware Wizard.

2. *If the device driver is detected on Windows XP*, an auto-install occurs. Go to step 6.
3. Locate the CD or floppy holding the USB driver software into its drive.
4. Select **Install from a list or specific location (Advanced)** and click **Next**.
5. Select the **Search Removable Media** option and click **Next**.

   The computer searches the specified location(s) to find the drivers. When located a warning message may occur indicating that the particular driver has not passed Windows Logo testing to ensure Windows XP compatibility. Ignore, and

6. Click **Next**.

   The USB software drivers are installed.

7. To complete the installation, click **Finish**.

   The USB-to-Serial device is ready to use. Windows XP assigns an available COM port number to the device.

8. Select **Start** > **Settings** > **Control Panel**.
9. Open **System** and select the Hardware tab.
10. Open **Device Manager,** and expand the option labelled **Ports (COM & LPT)**.

    In the drop down menu there is an entry for the USB to Serial device with the number of the COM port assigned to it, such as 'RadioShack USB to Serial Cable (COM3)'.

11. Record the COM port number for use in the modem setup.

Changing the Assigned COM port, if required

In some instances the COM port assignment may not be compatible with the USB adaptor operation, in which case reassignment to COM 1 is advised. Before doing so, ensure no other application is assigned to the selected COM port (remove if necessary).

To change the assigned COM port:

1. Select the USB to Serial Device, right mouse click and select **Properties**.
2. Select the Port Settings tab and click **Advanced**.
3. Change the COM port number in the drop box to the desired selection.
4. Click **OK** and **OK** to return to the Device Manager window.
5. Close the Device Manager and click **OK** to close the System Properties window.

This completes installation of the USB adaptor and confirmation of its COM port.

To enable some USB adaptors it may be necessary to connect the adaptor before starting the computer.

Next Step

Installing the V.24 Modem Driver for USB on page 2-17.

Installing the V.24 Modem Driver for USB

To install the V.24 modem driver:

1. Select **Start** > **Settings** > **Control Panel**.
2. Select **Phone and Modem Options** > **Modems > Add**.
3. In the Add Hardware window, select **Don't detect my modem; I will select it from a list**. Click **Next.**
4. Select **Have Disk** and browse to the 9500 MXC Installation Kit CD to select the 9500 MXC V.24 Modem Driver.inf file. Click **Open**.
5. In the Install from disk window, select the CDROM drive and click **OK.**
6. If a prompt appears saying 'This driver is not digitally signed', ignore and click **Next.**

7. For a USB serial adaptor you must select the *same* COM port assignment as determined in Installing the USB-to-Serial Adapter on page 2-16, and click **Next**.
8. For a USB adaptor installation a warning message may state that the particular driver has not passed Windows Logo testing to ensure Windows XP compatibility. Ignore and click **Continue anyway**.
9. Click **Finish**, then **OK** to complete the installation.

Installing V.24 Dial-up Connection for USB

To install the V.24 dial-up connection for USB:

1. Select **Start** > **Settings** > **Control Panel**.
2. Select **Network Connections**.
3. Under new tasks, select **Create a new connection** to open a New Connection Wizard window. Click **Next** on the Wizard.
4. In New Connection Type, select **Connect to a network at my workplace** and click **Next**.
5. In Network Connection, select **Dial-up connection** and click **Next**.
6. In Select a Device, select the previously installed 9500 MXC V.24 modem driver, and click **Next**.
7. In Connection Name, enter a name, such as 9500 MXC, and click **Next**.
8. In Phone Number to Dial, enter a random telephone number, such as 1234, and click **Next**.
9. In Connection Availability, select one of the two options: **Anyone's use** or **My use only**. Click **Next**.

   The wizard confirms a successful completion.
10. Click **Add a shortcut**, to display a shortcut on your desktop.
11. Click **Finish**. The 9500 MXC CT - Start up window is displayed.
12. The V.24 dial-up connection is now installed, click **Cancel** to disconnect.

Next Step

Starting 9500 MXC CT on page 2-19

Starting 9500 MXC CT

For an **Ethernet** connection, connect your PC using a standard LAN cable and go to 9500 MXC CT Start Up on page 2-19.

For information on the LAN cable, refer to PC to 9500 MXC Cabling and Connectors on page 2-19.

For a **V.24** connection, a dial-up connection from your PC to 9500 MXC must first be established. Refer to Setting Up 9500 MXC CT Connection Using V.24 on page 2-12. For information on the connecting cable, refer to PC to 9500 MXC Cabling and Connectors on page 2-19.

PC to 9500 MXC Cabling and Connectors

Ethernet Connection

Connect from the LAN port on your PC to a 10/100Base-T port using a standard RJ-45 to RJ-45 LAN cable. The cable can be a Mdi (straight) or MdiX (crossover) type.

- 9500 MXC Node has four NMS 10/100Base-T ports on the NCC plug-in. Any port can be used.
- 9500 MXC Terminals have one or two NMS 10/100Base-T ports on the IDU. For IDUs with two ports, any port can be used.

V.24 Connection

Use the provided DB-9 to RJ-45 V.24 Maintenance cable to connect your PC to the Maintenance V.24 port on the NCC or IDU front panels.

9500 MXC CT Start Up

Procedures are described for Ethernet and V.24 connections. Refer to:

- Using a TCP/IP Connection on page 2-20
- Using an Ethernet DHCP Connection on page 2-21.
- Using a V.24 Dial Up or Comms-Cable Connection on page 2-22
- Connection Process on page 2-23
- Entering a Username and Password on page 2-24
- Lost Password Procedure on page 2-25.
- Connection Exceptions on page 2-25.
- Checking V.24 Access on page 2-26.
- Using a V.24 Connection to Obtain the Ethernet IP Address on page 2-27.

Prior to 9500 MXC CT start-up the Ethernet or V.24 cable should be connected between your PC and the 9500 MXC radio. Ensure the radio has been powered on for not less than 90 seconds.

To start CT double-click the 9500 MXC CT desktop shortcut.

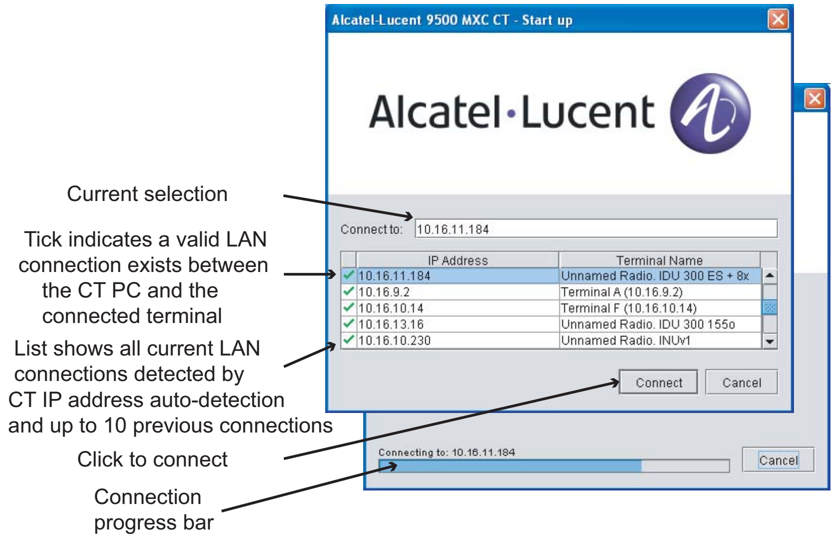
The CT start up screen is displayed.

Using a TCP/IP Connection

This procedure calls for a LAN compatible IP address to be entered on your PC. It applies to a 9500 MXC radio that has not been DHCP server-enradioabled, but may also be used to log in to a radio that has been server enabled.

1. Connect your PC to the 9500 MXC 10/100Base-T NMS port of the radio you wish to connect to.
2. Ensure the TCP/IP properties on your CT PC are configured to put the PC on the same LAN as the terminal you are connecting to.
3. Open the CT start-up screen. Refer to Figure 2-1 on page 2-21.
4. Enter the IP address of the target 9500 MXC radio in the Connect-to line, or select from the list.
   - The list shows the IP address and terminal name of the ten most recently connected radios, as well as the radios detected by the CT IP address auto-discovery mechanism. For information on CT auto-discovery, refer to 9500 MXC CT to 9500 MXC Connection Options.
   - All detected radios have a green tick entered against their IP address. Only green-ticked radios can be connected to. The green tick confirms detection - it does not confirm that your CT PC can communicate with the radio.
   - To be able to communicate with the target (green-ticked) radio, a LAN compatible IP address must be configured on your PC.
   - If you are connected to a radio that is NMS connected to another co-located radio or radios (radios are on the same LAN), a green tick will appear in the address/name line for each radio.
5. To log into the selected radio, click **Connect**. At this point the CT version installed on the terminal will be confirmed at the bottom of the window, and status and progress indicators indicate the connection process. Refer to Connection Process on page 2-23.
   - If the radio has been configured for access security, a username and password window will appear at this point. Refer to Entering a Username and Password on page 2-24.
6. Log-in is confirmed by the appearance of the CT System Summary screen. Refer to System Summary on page 15-3 of Volume IV.

Figure 2-1. 9500 MXC CT Start-up Screen for an Ethernet Connection



Using an Ethernet DHCP Connection

The procedure describes connection where a DHCP server is enabled on the 9500 MXC radio (or radios) to be connected to.

- For radios that *are* DHCP server enabled the TCP/IP properties window on your CT PC must be set to obtain an IP address automatically for the DHCP mechanism to operate. **See Setting Up A DHCP Ethernet 9500 MXC CT Connection on page 2-10.**

For rules, hints and tips on DHCP server setting and operation, refer to DHCP Server Function on page 10-12 of Volume IV, Chapter 11.

DHCP Connection

This procedure applies to a 9500 MXC radio that is DHCP server enabled.

1. Ensure your PC is configured to obtain an IP address automatically.
2. Connect your PC to the 9500 MXC 10/100Base-T NMS port of the radio you wish to connect to.
3. Open the CT start-up screen. Refer to Figure 2-1 on page 2-21.
4. From the list of terminals displayed select the target terminal.
   - The list shows the IP address and name of the ten most recently connected radios, with the most recent at the top.
   - If you are connected to a stand-alone radio (no *cabled* NMS connection to another co-located radio) a green tick will identify the IP address and name of the connected radio. Select by clicking on its address line, at which point the IP address appears on the Connect-to entry line.

- If you are connected to a radio that is also NMS connected to another co-located radio (radios are on the same LAN), a green tick will appear in the address/name line for each radio. Click to select the required radio, at which point its IP address will appear in the Connect-to entry line.

5. To log in to the selected radio, click **Connect**. At this point the CT version installed on the radio will be confirmed at the bottom of the window, and status and progress indicators indicate the connection process. Refer to Connection Process on page 2-23.
   - If the radio has been configured for access security a username and password window will appear at this point. Refer to Entering a Username and Password on page 2-24.
6. Log-in is confirmed by the appearance of the CT System Summary screen. Refer to System Summary on page 15-3 of Volume IV.

Using a V.24 Dial Up or Comms-Cable Connection

To establish a dial up connection:

1. Install the V.24 maintenance cable between your CT PC and 9500 MXC.
2. Click the Dial Up / Network Connections shortcut, located on the desk top which was created during installation of the V.24 dial up connection.
   - For Windows 2000/98 the Dial Up Connection Status window is displayed.
   - For Windows XP the Connect window is displayed.
3. Click **Dial** (Win. 2000/98) or **Connect** (Win. XP).
4. Connection to 9500 MXC is confirmed by the connection icon in the System Tray on your PC (lower right corner).

5. Open the CT start-up screen. Refer to Figure 2-2 on page 2-23.
6. The maintenance port IP address is shown in the Connect-to entry line, and maintenance port and radio name are shown in the top row of the IP address/name list.
   - The maintenance port has a fixed IP address of 192.168.255.225.
   - The list shows the IP address of the ten most recently connected radios.
   - A green tick confirms that a dial-up connection has been established.

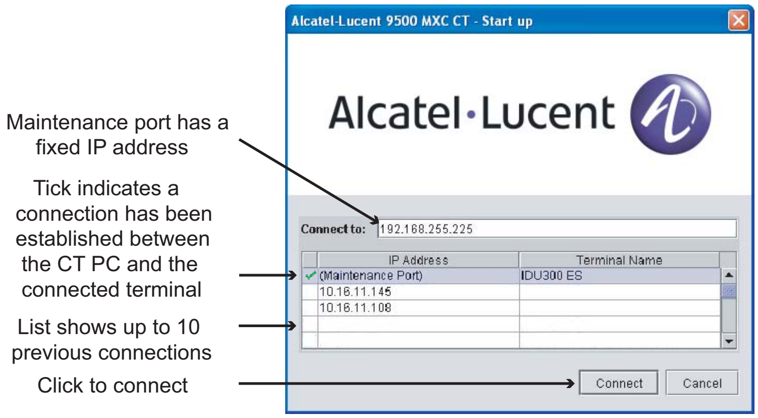
If a V.24 connection cannot be established, follow the procedures in Checking V.24 Access on page 2-26.

7. To log in to the selected radio, click **Connect**. At this point the CT version installed on the radio will be confirmed at the bottom of the window, and status and progress indicators indicate the connection process. Refer to Connection Process on page 2-23.

- If the radio has been configured for access security a username and password window will appear at this point. Refer to Entering a Username and Password on page 2-24.

8. Log-in is confirmed by the appearance of the CT System Summary screen. Refer to System Summary on page 15-3 of Volume IV.

Figure 2-2. CT Start-up Screen for a V.24 Maintenance Connection



Connection Process

When **Connect** is clicked, CT auto-versioning is immediately activated to ensure automatic version matching of CT software to the system software installed on 9500 MXC. **Auto version** progress is indicated above the connection status bar, which may show in rapid succession:

- Checking the version of 9500 MXC CT required...
- Checking if a 9500 MXC CT Update is required...
- Updating to version <version>. Estimated time <time>.
- Starting updated 9500 MXC CT session...

For information on **9500 MXC CT Auto Version**, refer to 9500 MXC CT Auto Version on page 1-6.

Additionally, if access to the selected radio has been **Password** protected, a password window is displayed on **Connect**. Refer to Entering a Username and Password on page 2-24.

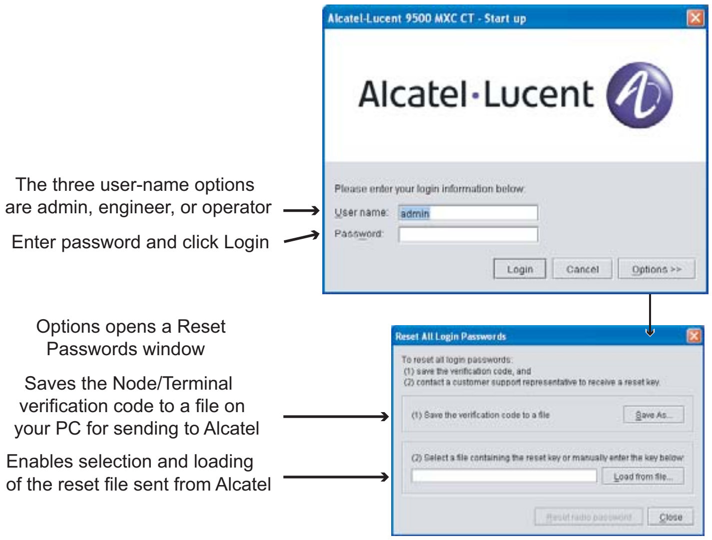
On successful connection, the Diagnostics > System Summary screen is displayed on your PC. For details of this screen, refer to System Summary on page 15-3 of Volume IV.

Entering a Username and Password

Introduction

If access to the 9500 MXC radio has been security protected, a username and password window is displayed after **Connect**.

Figure 2-3. Password Entry and Option Windows



Username Categories

Table 2-2 lists the three username options and their access levels.

Table 2-2. Usernames

Username	Enables
admin	Security and password setting. Security can be enabled/disabled, and passwords set and changed. Admin cannot view and change 9500 MXC configuration or diagnostic settings, or update software.
engineer	Read/write access. An engineer can send changes to 9500 MXC and update software, but cannot change password or security settings.
operator	Read only. An operator cannot send changes to 9500 MXC or update software, or change password or security settings.

Procedure

To login to 9500 MXC:

1. Type a valid username and password into the fields provided.
2. Click **Connect**.

   The CT Diagnostics > System Summary screen is displayed. For further details of this screen, refer to Chapter 15.

Enabling/disabling security, changing passwords, and default passwords, are detailed in Security Configuration on page 15-1.

Lost Password Procedure

If you have lost engineer or operator passwords, contact your administrator.

If the administrator password is lost (changed from default and subsequently lost), a reset key must be obtained from an Alcatel-Lucent support center.

- A reset key provides a one-time return to default security settings for the affected radio.
- The operator at the Alcatel-Lucent support center will require confirmation that the request for a reset key is from a valid source.

Procedure to Secure and Enter a Reset key

1. Click the Options tab in the Username and Password screen to open the Reset Passwords window. Refer to Figure 2-3.
2. Click on **Save As** in panel 1 to open a browser on your PC. Select a folder and click **Save**. This will create a text file (.txt) of the verification code specific to the radio, in the selected folder.
3. Email the file to an Alcatel-Lucent support center. Where email is not practical, the text file can be opened and the verification code phoned to a help desk operator.
4. Alcatel-Lucent will respond with a reset key file, which for an email response, should be saved to a file on your PC.
5. Return to the Username and Password window and browse to the reset key file and click **Open**. This will populate the line in the No. 2 panel with the reset key. Alternatively, the reset code can be typed into the panel.
6. Click **Reset radio password** to enter the reset code.

The default passwords may now be used to gain access to the radio.

For information on security enabling and disabling, refer to Chapter 14.

Connection Exceptions

If you attempt to start CT when not correctly connected or do so with an invalid IP address, the CT Start up - Connect screen times out and displays a communications error message.

If security has been enabled, and an incorrect password entered, an authentication failed message is displayed.

Error messages indicate any Auto Version operational problems and advise recommended remedial action.

Checking V.24 Access

If you have installed a modem dial-up or a computer-to-computer comms cable connection on your PC, but at Dial-Up or Connect, there is no connection, check that:

- The Maintenance Cable is undamaged and correctly plugged.
- If you are using a computer-to-computer comms cable connection to direct-connect your Windows XP PC to 9500 MXC, reboot the terminal (power off, pause, power on). Remember to always disconnect your CT PC before removing the V24 cable; click on the networking icon, lower right on your screen, and select **Disconnect**. If not done, the V.24 NMS port on the NCC card can think it is still connected and not answer further connection attempts until rebooted. If rebooting is not an option because of disruption to service, try the following:
  - With the V.24 cable installed, click on the 9500 MXC shortcut to open the Connect 9500 MXC window, select Properties > Networking > Internet protocol (TCP/IP) > Properties > Advanced, and deselect (untick) the tickbox for 'Use default gateway on remote connection', followed by OK, OK, OK, Connect.

If you have established connection to 9500 MXC (the CT Start Up window is displayed), but at **Connect** access is denied, check that the IP address for the V.24 maintenance Port is correct.

- The V.24 maintenance port uses a default IP address to secure access to the locally connected 9500 MXC Node or Terminal. IF V.24 access is denied because of a changed address, use the following procedure to check and enter the new address in the CT start-up window.

Should there be a change to the default V.24 IP address, it will most likely be as a result of a change made in the Networking screen under IP Addressing > Advanced. For more information, refer to Chapter 10.

The default V.24 IP address is 192.168.255.225

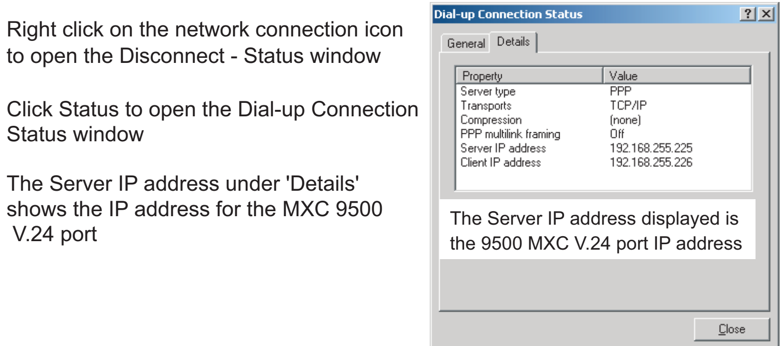
Procedure for Checking and Entering a Changed V.24 IP Address

1. Stay connected via the maintenance cable.
2. Right-click the dial-up connection icon, on your PCs system tray.

The dial-up connection menu options are displayed.

3. To open the Dial-up Connection Status window, select **Status**.

4. Click the Details tab.



5. The IP address displayed should be the same as the default **192.168.255.225**. If the Server IP address is different then take a note of this IP address.
6. **Close** the Dial-up Connection Status screen.
7. Within the CT start-up window enter the Server IP address in the **Connect to** line, and click **Connect**.

Using a V.24 Connection to Obtain the Ethernet IP Address

Use this procedure to determine the IP address of a radio. Typically this would be used where an Ethernet connection is preferred, but the IP address for the radio you wish to connect to is not known.

(Assumes the DHCP server option has not been enabled).

Procedure

1. Establish a V.24 connection to the radio.
2. Go to the **Configuration** > **Networking** screen to view IP address settings.

   For Single IP Addressing, the displayed IP address is the address required.

   For Interface Addressing (Advanced), the required IP address is the address of the Ethernet Port.

For a description of Single IP and Interface Addressing refer to the topic, 9500 MXC Address and Routing Options on page 10-2.

3. Log-off and reconnect your PC for an Ethernet connection
4. Enter the IP address from step 2, and click **Connect**.

Next Step

Table 2-3 directs you to relevant sections of the 9500 MXC CT volume.

Table 2-3. Reference Topics

9500 MXC CT Topic	Reference
System Summary screen	System Summary on page 15-3, Volume IV
Screen navigation, logos, and icons	9500 MXC CT Screens on page 1-1, Volume IV
Installation and Configuration	Procedure Overview for a New Installation on page 3-7, Volume III
Diagnostics	Volume IV, Chapter 15.

Chapter 3. Installation and Configuration Process

9500 MXC CT provides the tools needed to install and commission a link between:

- 9500 MXC Nodes
- a 9500 MXC Node and a 9500 MXC Terminal
- 9500 MXC Terminals

From new each end of the link must be locally configured. Once a link has been established, both ends can be re-configured from one end providing the re-configuration does not dis-establish the link connection.

References to Node and Terminal in this manual have the following meanings:

- **9500 MXC Node** refers to the INU or INUe with the ODU 300ep and/or ODU 300hp.
- **9500 MXC Terminal** refers to the IDU with the ODU 300ep or ODU 300hp.

The main topics are:

Essential Information

Configuration Rollback

CT includes configuration Backup and Restore functions.

- **File** > **Backup** saves a current Node/Terminal configuration (as set by the most recent Send action) to a user-selectable folder on your PC.
- **File > Restore** prompts for selection of the saved configuration from your PC, and its loading back into a Node/Terminal.

System Software Rollback

CT includes a rollback for operating system software. Refer to Software Management, Chapter 13.

Incorrect Configuration

An incorrect configuration is displayed as a **Configuration Not Supported** or **Configuration Corrupt** in the Event Browser and Alarms screens.

Disconnecting or Reconnecting an ODU Cable

- Never disconnect or reconnect an ODU cable to a RAC or IDU without first turning the power off, or for an INU/INUe withdrawing the RAC from its backplane. This is necessary to:
- Avoid arcing damage to mating surfaces on the ODU connector.
- Avoid the potential for momentary errors on other traffic passing through a Node as a consequence of the disconnection/connection power spike.

Transmit Mute Option Settings

Unless a specific configuration setup is requested by the customer, 9500 MXC Nodes and Terminals will be set to a factory default, which will have the Transmit Mute option set, meaning the ODU transmitter will be off when powered up for the first time. Its purpose is to ensure that prior to the configuration check and any required reconfiguration, there is no potential for interference to operational links in the event transmit frequency and/or power are set incorrectly for the site. Refer to Link Configuration on page 7-2.

If in doubt, check the RAC configuration as a priority on initial power on.

Configuration Updates

Any configuration update made on one screen provides real-time updates to related screens, and all updated screens will be confirmed (saved) on clicking the Send button.

Viewed Data

All data viewed in 9500 MXC CT screens is read from the CompactFlash card, except that which has changed since the last save action (Send button clicked).

- Providing the Send button is not yellow (no send/save action required) all viewed data is read from the CompactFlash card.
- Changes made *since a previous Send* are read from the relevant module, and will reflect across all relevant screens, but will not take affect until Send is clicked.

As-read Parameters

Capacity and bandwidth/modulation options plus frequency range, Tx/Rx spacing, Tx high/low and Tx power limits are read from the CT connected RAC/ODU (9500 MXC Node), Radio/ODU (9500 MXC Terminal). *It is not possible to set parameters outside as-read limits.*

Licensed Capacity

The 9500 MXC Node is capacity licensed for over-air (RAC) capacity. The license is held on the CompactFlash card, which has a unique identity (license) number.

The IDU ES is capacity licensed for Ethernet throughput. The base license is 50 Mbps, with 50 Mbps license increments to 200 Mbps. Like the Node, the license is held on the CompactFlash card.

The IDU 20x is capacity licensed for over-air capacity from a base of 20xE1/16xDS1. The license is held on the CompactFlash card.

Quick-entry to Other Screens

- Within module-based screens such as System Summary and Plug-ins, right click on any module (Plug-in) to view a short menu of selected options. Left-click a selection to go direct to the option.
  - The options provide direct links to relevant screens, and in the System Summary screen to a module renaming function.
  - A Launch Remote option is included on LINKS (RACs and DAC 155oM) providing there is an operational link to the remote end.

To return to the System Summary (previous) screen from other screens, click on the <Back tab in the toolbar.

9500 MXC CT Menus

The **File** menu supports standard file management commands plus:

- A 'New CT' prompt, which brings up the CT start-up screen for opening concurrent sessions to other Nodes/Terminals.
- Configuration **Backup** and **Restore**.
  - Backup saves the current Node/Terminal configuration (as set by the most recent Send action) to a user-selectable folder on your PC.
  - Restore prompts for selection of the saved configuration from your PC, and its loading back into a Node/Terminal.

The **Edit** menu provides access to:

- Cut, copy, paste from/to appropriate fields within CT screens, or from CT to an external document.
- Preferences supports customization of:
  - Diagnostic safety timers default to last setting used (default is On).
  - Hide *configuration* correction and warning messages - for current session (default is Off).
  - Ignore close confirmations (default is Off).]
  - CSV preferences. Selections are provided for the character to be used as the separator in CSV file exports. Options are comma, semi-colon, tab, or user-defined.

The **Installation** menu provides access to:

- Licensing screen (9500 MXC Node, IDU ES, IDU 20x).
- As-built report screen.

The **Configuration** menu provides access to:

- All configuration functions.
- Software maintenance.
- Security activation and de-activation.

All essential configuration data is captured in the CompactFlash card.

- For the 9500 MXC Node the card is fitted in the NCC.
- For 9500 MXC Terminals it is fitted through a slot in the rear of the IDU.

The CompactFlash allows the configuration to be held independent of any plug-in or chassis change.

Except for the IDU ES, the configuration menu for a *Terminal* does not display a Circuits option.

The **Diagnostics** menu provides access to:

- A system status summary, with system layout controls for an INU/INUe.
- System controls for protection locking, loopbacks, Tx muting, BER generation and measurement.
- Event browser and history screens.
- Alarms status screen.
- Backplane circuit loopbacks (9500 MXC Node only).
- Part-number screen.

The **Help** Menu provides access to:

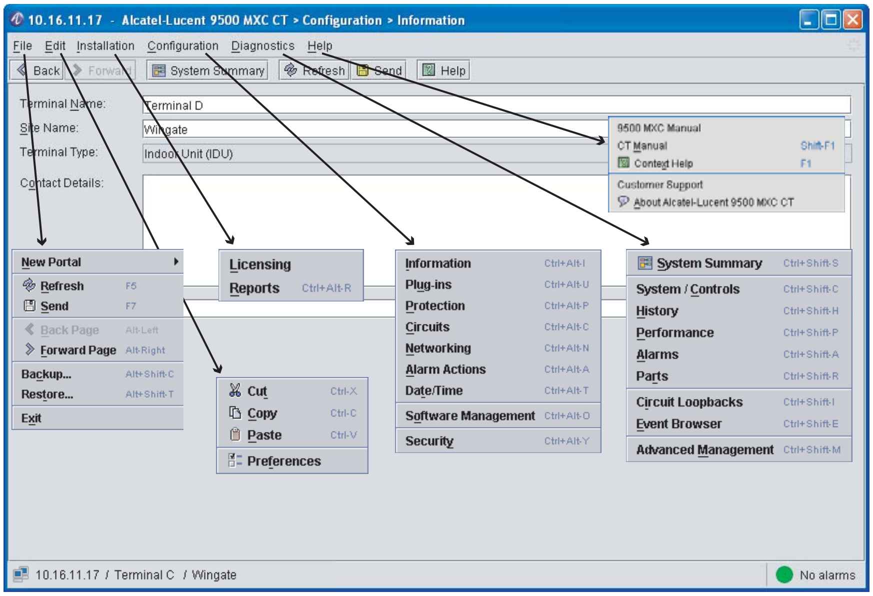
- 9500 MXC Online User Manual or CT Manual.
  - This is a web-based (html) online copy of the user manual. The CT option is a subset of the 9500 MXC manual - the manual is opened to the start of the CT sections.
  - From SW release 4.3, the installer for the online help is included with the installer for the CT application.
  - Once opened any topic can be selected and viewed using content listing or search options.
- Context Help. MXC 9500 online help is opened to a page in the user manual that corresponds to the currently viewed CT screen. Most CT screens support Context Help.
- Contact details for Alcatel-Lucent.
- Version data for 9500 MXC CT.

Refresh and **Send**

- Refresh sends a read request to the radio to provide a configuration update to the *current saved configuration*. In situations where a configuration amendment has caused an unwanted change, clicking Refresh provides a rollback to the saved configuration.
- Send sends a new configuration to the radio, to be written into the CompactFlash card. When no changes requiring a Send command have been made, the flashcard icon within the Send button will be uncolored. When a change has been made which requires a Send command, to confirm the change the flashcard icon will first flash yellow three times and then stay yellow until clicked. When clicked, a Send window with a cancel option is displayed and will remain open until the send process has been completed.

Figure 3-1 shows the menu-bar menus for a 9500 MXC Node.

Figure 3-1. 9500 MXC CT Menu-Bar Menus



Procedure Overview for a New Installation

This procedure assumes a new, unconfigured radio (IP address not configured).

1. Check the hardware installation is complete at both ends of the link and the 9500 MXC Nodes/Terminals are ready for power-on. For hardware installation details, refer to Volume 3, 9500 MXC Installation.
2. Power on the Node/Terminal at the front panel by inserting the power connector. An INU/INUe/IDU must be powered on for 90 seconds before a CT connection is possible.
   - If connection is attempted during this start up phase, an error message may be returned advising *CT cannot determine the type of terminal at...*. If such an error message is returned, close and reopen CT.
3. Connect your CT PC to 9500 MXC and open CT to the Start Up screen:
   - Connect using the supplied V.24 cable. (In the event the IP address of the radio is known, an Ethernet connection should be used to take advantage of its superior speed).

Once powered up the ODU(s) will be transmitting with the pre-configured or ex-factory frequency and power settings unless the transmit mute option has been invoked as the start-up default. If mute default has not been selected and if frequency and/or power settings are not correct for the application, interference may be caused to other links in the same geographical area. If in doubt, check Link configuration as a priority on initial power-on, and reconfigure as necessary. Refer to Link Configuration on page 7-2. Alternatively, for a Node, RACs may be withdrawn from the backplane until you are ready to configure them.

Always turn the power off to an INU/INUe or withdraw the RAC from its backplane before disconnecting or reconnecting an ODU cable at the RAC.

4. Installation: **Licensing**

9500 MXC Node	9500 MXC Terminal
Within 9500 MXC CT, select **Installation** > **Licensing** to view the licensed capabilities for the Node. If licensed capabilities are not exceeded, or will not be exceeded for the planned node capacity, go to step 6. If exceeded, the capabilities table displays a cross against the offending RAC plug-in with details of the mismatch. Refer to Node License on page 4-2 for details.	Applies only to: • The IDU ES for Ethernet throughputs above the base 50 Mbps license. • The IDU 20x for DS rate capacities above the base 16xDS1. (For E rates, licensing does not apply; the base rate of 40xE1 represents the maximum capacity) Select **Installation** > **Licensing** to view licensed capabilities. Refer to IDU ES License on page 4-3, or to IDU 20x License on page 4-4.

5. Configuration: **Information**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Information** and enter data in the user configurable fields for terminal and site name, contact details and site grid. Refer to Node and Terminal Information on page 6-1 for details.	Select **Configuration** > **Information** and enter data in the user configurable fields for terminal and site name, contact details and site grid. Refer to Node and Terminal Information on page 6-1 for details.

6. Configuration: **System Layout**

9500 MXC Node	9500 MXC Terminal
Select **System Summary** to check what plug-ins have been installed in each IDC slot, and that the existing plug-in configuration for the slot matches the plug-in type installed. A tab option is provided within each module to accept or decline the plug-in type installed. Refer to System Summary on page 15-3 for details.	System layout does not apply to the Terminal (layout is fixed).

7. Configuration: **Plug-ins**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Plug-Ins** to view settings for the plug-in. Edit, if required, using the settings specified in the installation datapack. Remove the Tx Mute, if set. Refer to Node and Terminal Plug-ins on page 7-1 for details.	Select **Configuration** > **Plug-Ins** to view settings for the Terminal modules. Edit, if required, using the settings specified in the installation datapack. Remove the Tx Mute, if set. Refer to Node and Terminal Plug-ins on page 7-1 for details.

8. Configuration: **Protection**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Protection** to view and configure protection settings. Refer to Node Protection on page 8-1 for details.	Select **Configuration** > **Protection** to view and configure protection settings. Refer to Terminal Protection on page 8-15 for details.

9. Configuration: **Circuits**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Circuits** to view and set circuit connections. Refer to Circuits on page 9-1 for details.	PDH and SDH IDUs do not present a Circuits screen option. The IDU ES includes a Circuits screen - functionality for its Ethernet and tributary modules is identical to the Node. Select **Configuration** > **Circuits** to view and set. Refer to Circuits on page 9-1 for details.

10. Configuration: **Networking**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Networking** to set IP addressing and routing, and if required, trap destinations. Refer to Networking Configuration on page 10-1 for details.	Select **Configuration** > **Networking** to set IP addressing and routing, and if required, trap destinations. Refer to Networking Configuration on page 10-1 for details.

11. Configuration: **Alarm Actions**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Alarm Actions** to configure Alarm I/O mapping (if required). Refer to 9500 MXC Node and Terminal Alarm Actions on page 11-1 details.	Select **Configuration** > **Alarm Actions** to configure Alarm I/O mapping (if required). Refer to 9500 MXC Node and Terminal Alarm Actions on page 11-1 details.

12. Configuration: **Date/Time**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Date/Time** to set the Node date and time. For details refer to Date and Time Configuration on page 12-1	Select **Configuration** > **Date/Time** to set the Terminal date and time. For details refer to Date and Time Configuration on page 12-1

13. Configuration: **Software Management**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Software Management** to check and compare the loaded software against the version supplied on the Installation CD. Where different, load the version from the CD, which is the latest version at the time of shipping from Alcatel-Lucent. Refer to Software Management on page 13-1 for details.	Select **Configuration** > **Software Management** to check and compare the loaded software against the version supplied on the Installation CD. Where different, load the version from the CD, which is the latest version at the time of shipping from Alcatel-Lucent. Refer to Software Management on page 13-1 for details.

14. Configuration: **Security**

9500 MXC Node	9500 MXC Terminal
Select **Configuration** > **Security** to enable login security for 9500 MXC CT, and to set new passwords. Refer to Security Configuration on page 14-1 for details.	Select **Configuration** > **Security** to enable login security for 9500 MXC CT, and to set new passwords. Refer to Security Configuration on page 14-1 for details.

15. Align the antenna using either the RSSI voltage at the BNC connector on the ODU or the RSL value on 9500 MXC CT.

To view the RSL value select **Diagnostics** > **Performance**. For details refer to Performance, Volume IV, Chapter 15.

16. Repeat steps 2 to 16 for the other end of the link.
17. Record the RSL at both ends of the link and check values against the expected RSLs in the installation datapack.
18. Complete a BER test. Loopbacks are available within CT under Diagnostics > System/Controls. For details refer to System/Controls, Volume IV, Chapter 15.
19. For details, refer to System/Controls on page 15-35.
20. Configuration: **As Built**

9500 MXC Node	9500 MXC Terminal
Select **Installation** > **As-Built Report** to capture configuration and other site/installation data for appending to a final commissioning report. Refer to Reports on page 5-1 for details.	Select **Installation** > **As-Built Report** to capture configuration and other site/installation data for appending to a final commissioning report. Refer to Reports on page 5-1 for details.

21. Complete capture of commissioning data.

The link is now ready for use.

Configuration Changes to An Existing

Installation

Where changes are to be made to an existing installation/configuration, follow the configuration process relevant to the required change(s) in the preceding section, Procedure Overview for a New Installation. However before doing so you may wish to save the current configuration for subsequent restoration (rollback) in the event of difficulties with the new configuration:

- Within CT select **File** > **Backup** to save a current Node/Terminal configuration (as set by the most recent Send action) to a user-selectable folder on your PC.
- Select **File** > **Restore** to prompt for selection of the saved configuration from your PC, and its loading back into a Node/Terminal. Follow the on-screen prompts to complete the restoration process.

Chapter 4. Licensing

The information in this chapter applies to 9500 MXC Nodes, IDU ES, and to IDU 20x.

For a 9500 MXC Node:

- A license “unlocks” over-air capacity for RAC/ODUs installed in an INU or INUe. License levels allow incremental capacity selection up to100xE1 (200 Mbps Ethernet), 127xDS1 (200 Mbps Ethernet), or 2xSTM1/OC3 (300 Mbps Ethernet), for each RAC/ODU.
- Each INU/INUe has one license, a Node license that applies to all RAC/ODUs, whether installed or spare. The baseline default license (no license payment required) is 40xE1 (80 Mbps), or 16xDS1 (25 Mbps), meaning the baseline supports up to up to three such links when installed in an INU, or six in an INUe.

For an IDU ES:

- A license unlocks link throughput from a base of 50 Mbps to a maximum 200 Mbps.

For an IDU 20x:

- A license unlocks link throughput from a base of 20xE1/28xDS1 to a maximum 40xE1 or 32xDS1.

The main licensing topics are:

- CompactFlash Card on page 4-2
- License Steps on page 4-2
- License Configuration Screen on page 4-5
- Upgrading a License on page 4-6

Licenses are capacity-based; modulation is not licensed.

A license supports all equal or lower-value capacities based on the value (cost) of the license.

CompactFlash Card

The license is held within a CompactFlash card, which is identified by a unique license serial number (The Compactflash card number is the license number). This card inserts into the side of the NCC plug-in, or into the rear of an IDU. The CompactFlash also stores the configuration and support data.

A CompactFlash card can be moved to another 9500 MXC Node or Terminal, which acquires the licensed capability and configuration data from the previous Node/ Terminal (Terminals must be compatible).

When a license is upgraded, the upgrade is specific to a CompactFlash card.

License Steps

Refer to:

- Node License
- IDU ES License
- IDU 20x License

Node License

From the base 40xE1/16xDS1 license for six RACs, Node capacity is licensed in “up-to” increments for *each RAC* in an INU or INUe.

Type of Operation	Licensed Increments
E rate	• 40xE1, 52xE1, 75xE1, 100xE1
DS rate	• 16xDS1, 28xDS1, 32xDS1, 56xDS1, 70xDS1, 84xDS1, 100xDS1, 127xDS1 • 1xDS3 through 6xDS3
STM1/OC3	• 1xSTM1/OC3, 2xSTM1/OC3

“Up-to” means that each RAC can be configured for any capacity less than or equal to its dollar value. For example, a 52xE1 license supports configuration of all lower NxE1 capacities, plus 56xDS1, 3xE3, 3xDS3, 1xSTM1, and 1xOC3.

Capacity Upgrade

When selecting capacities for individual RAC/ODUs, it is important to ensure the maximum throughput capacity for a Node is not exceeded, and that the mix of capacities is backplane compatible. Otherwise the requested upgrade will be signalled as invalid. For instance, a 64xE1 selection for all six RAC/ODUs is clearly in excess of the Node throughput capability.

Upgrading to Protection

When upgrading from non-protected to hot-standby or diversity operation, the licensed capacity for the additional RAC/ODU must at least match the capacity of its partner RAC/ODU.

Modulation

Modulation is not licensed, so can be selected in CT within each licensed capacity, subject to the bandwidth options provided for the selected capacity. For instance, a 20xE1 capacity selection has two modulation options: 16QAM or QPSK.

IDU ES License

An IDU ES includes a base license for 50 Mbps data throughput. Higher throughputs are obtained by ordering additional capacity upgrades at time of order, or subsequently as downloadable software licenses.

- The base license is included with an IDU ES.
- A license is identified by the nominal Ethernet data capacity (throughput) supported. In effect a license enables the number of E1 or DS1 link circuits required to support the capacity.
- The licensed steps and associated capacities, modulation and channel bandwidths are shown in Table 4-1 for ETSI, and in Table 4-2 for ANSI.
- For ETSI, capacity sub-options of 20, 30 or 40 Mbps are supported. All are enabled within the base license.
- Licenses are up-to licences. For example ETSI IDU ES 100 may be configured to support throughputs from 20 to 100 Mbps.

Table 4-1. License Steps and Capacity Breaks for ETSI

IDU ES Option	Nominal Capacity	License
IDU ES 50	50 Mbps	Base license enables 65.5 Mbps.
IDU ES 100	100 Mbps	Base license + 50 Mbps upgrade. Enables 106.5 Mbps.
IDU ES 150	150 Mbps	Base license + 100 Mbps upgrade. Enables 153.6 Mbps.
IDU ES 200	200 Mbps	Base license + 150 Mbps upgrade. Enables 217 Mbps.

Table 4-2. License Steps and Capacity Breaks for ANSI

Connect Option	Nominal Capacity	License
Connect ES 50	50 Mbps	Base license enables 49.4 Mbps.
Connect ES 100	100 Mbps	Base license + 50 Mbps upgrade. Enables 108.1 Mbps.
Connect ES 150	150 Mbps	Base license + 100 Mbps upgrade. Enables 154.4 Mbps.
Connect ES 200	200 Mbps	Base license + 150 Mbps upgrade. Enables 196.1 Mbps.

IDU 20x License

From the base 20xE1/28xDS1 capacity the IDU 20x is licensed in ‘up-to’ increments:

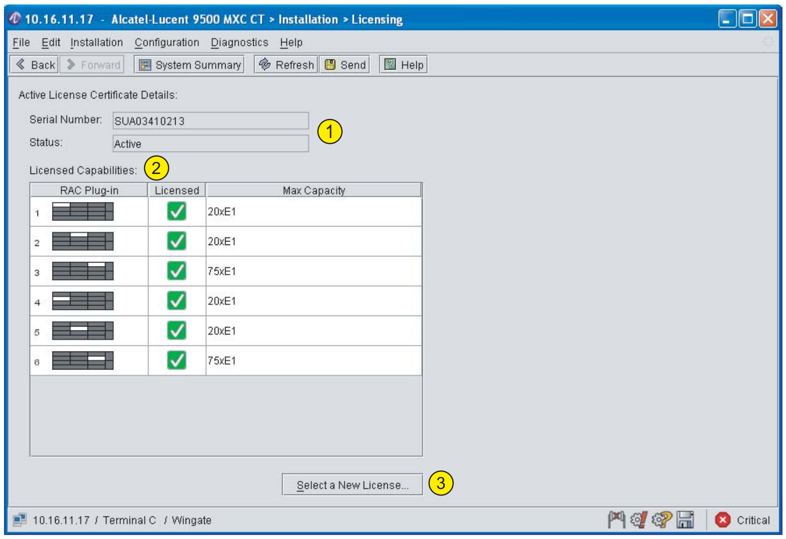
Type of Operation	Base License	License Steps
E rate	20xE1	40xE1
DS rate	28xDS1	32xDS1

‘Up-to’ means that an IDU 20x can be configured for any capacity less than or equal to its maximum licensed capacity. For example, a 40xE1 license also supports configuration of 5xE1, 10xE1, 20xE1, or 32xE1.

License Configuration Screen

The Licensing screen is accessed under **Installation** > **Licensing**. Figure 4-1 shows a typical window. It provides information on the license, the licensed maximum per slot, license status, and management of a license upgrade.

Figure 4-1. Typical Licensing Screen for 9500 MXC Node



Item	Description
1	Indicates the license serial number and license status. • The CompactFlash number is the license number. • The Status field should always be active. Status failed indicates a fault condition. Check that the CompactFlash card is correctly installed and reboot (power off - pause - power on). A CompactFlash card intended for an INU/INUe will not operate in an IDU, and vice-versa.
2	Licensed capabilities window: • RAC Plug-in column indicates the position of all RACs in an INU/INUe. • Licensed column confirms with a green/tick icon that the relevant RAC is licensed. Unused/unconfigured RAC license is indicated with a grey/dash icon (INU/INUe only). • Max Capacity indicates the maximum capacity permitted within the license on a per-RAC/Radio basis.
3	Select a new license. Click to select and load a new license. Refer to Upgrading a License.

NOTE: Where the configured capacity exceeds the licensed capacity a configuration not supported alarm and a license violation alarm is raised. These are major alarms.

Upgrading a License

This section describes the process required to secure an upgraded license from Alcatel-Lucent. It addresses the steps needed to confirm the required new license capacity, the upgrade price, and the purchase and delivery mechanisms.

It is a software-only process. The upgrade to be loaded into the CompactFlash is provided as a file by email or on a CD.

The support for this process is provided by our customer technical service desks, which may be contacted by phone or email at the locations listed in the front matter of this manual. Ultimately this license upgrade service will be supported by a web site.

Upgrade Process

1. Before contacting Alcatel-Lucent, have the following information available. Or if preferred, you can contact a service desk and request a license upgrade form, which prompts for the required information.

Item	Description
License Serial Number	This may be determined from the CompactFlash card label, or retrieved via CT. If the capacity of an existing link to be increased, both ends of the link may need license upgrades. Similarly, if a new link is to be added (Node only), the licensed capacity at each end must be checked and, if necessary, upgraded.
Node Upgrade Requirements	This information can be provided as: • Where an existing link, or links, are to be capacity or protection upgraded, the existing and new capacity for the specific RAC(s) is required. It is important to identify which RACs of the three possible RAC locations for an INU, or six for an INUe are to be capacity upgraded. Or • Alternatively, provide the new node configuration by listing *all* the RAC capacities for the node (those that are new or to be increased in capacity, plus those that are to remain unchanged). In this instance, information on the existing license configuration is not needed. Or • Or, if you know the part number for the required new license, simply provide this number.
IDU Link Upgrade Requirements	Where an existing IDU link is to be capacity upgraded, the existing and new capacity for each IDU is required.
Shipment Method and Delivery	Delivery can be by email, or for a CD file, by mail or courier.

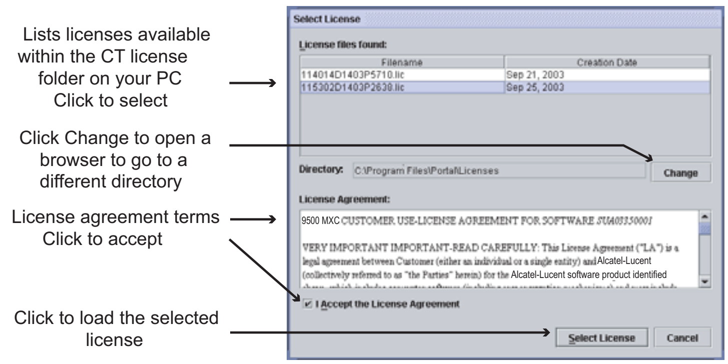
2. Once the help desk has all the required information and has confirmed the requested upgrade is valid, the operator will provide a quote for the upgrade. On acceptance, a purchase order will be required before the license is shipped.
3. On receipt of the license file, it must be loaded into the CT PC that will be used to connect to the Node/Terminal to be upgraded. To load the license upgrade into the CompactFlash, refer to the Procedure for Loading a License on page 4-7.

Procedure for Loading a License

To load an upgrade license:

1. On your 9500 MXC CT PC, copy the new license file into the default 9500 MXC CT program folder C:\Program Files\9500 MXC CT or load it into a new license sub-folder such as, C:\Program Files\9500 MXC CT\License.
2. Log into the Node/Terminal and from the Licensing screen, click the **Select a New License** button.

   The Select License window is displayed, with a listing of the matching license file(s) held in the 9500 MXC CT program folder of your PC:



If the required license is located in another directory, click the **Change** button to display your PC browser, and navigate to the required folder.

Only the license (or licenses) matching the serial number of the Node/Terminal are visible. This serial number is held within the CompactFlash card.

3. Highlight the required license and review the License Agreement statement.
4. To accept the license agreement, click **Select License** to confirm the selected license.
5. To load and enable the new license, click **Send**.

   The changes in the licensed capabilities can be confirmed by viewing the Licensed capabilities on the Licensing screen.

Chapter 5. Reports

The Reports screen is under the Installation menu. It supports two reports, an as-built report and a helpdesk data file. Both are for saving to a folder on your PC. Refer to Reports Screen on page 5-1.

As Built Report

- The file is in a user-accessible csv, Excel compatible format.
- Its purpose is to enable capture of configuration and other site/installation data for appending to a final commissioning report.
- It would normally only be used on completion of an installation or reconfiguration. However, if significant reconfiguration of an existing installation is to be conducted, capturing before and after files can be of value for fault-finding purposes in the event of a problem with reconfiguration.
- Report data is always current to the time of saving to your PC - no action is required to put data into the report file.

Helpdesk Data File

- The file is not user accessible. It captures relevant configuration, status and historical log data in a format that is solely for use by Alcatel-Lucent service personnel in troubleshooting.
  - When reporting a problem on a 9500 MXC Node or Terminal to an Alcatel-Lucent support center you may be asked to save and forward this file.
- Report data is always current to the time of saving to your PC - no action is required to put data into the helpdesk data file.
- If a Node/Terminal is rebooted (power off - pause - power on) all historical data is lost. This loss can be prevented where a reboot is required by using the software reset function; see Advanced Management on page 15-61 of Diagnostics, Volume IV, Chapter 16. A software reset emulates a hard reset (reboot) but at the time of reset it automatically saves the helpdesk data file to C:\Program Files\9500 MXC CT\Reset Logs\ on your CT PC.

Reports Screen

Refer to:

- As Built Report on page 5-2
- Helpdesk Data File on page 5-3

Figure 5-1. Reports Screen

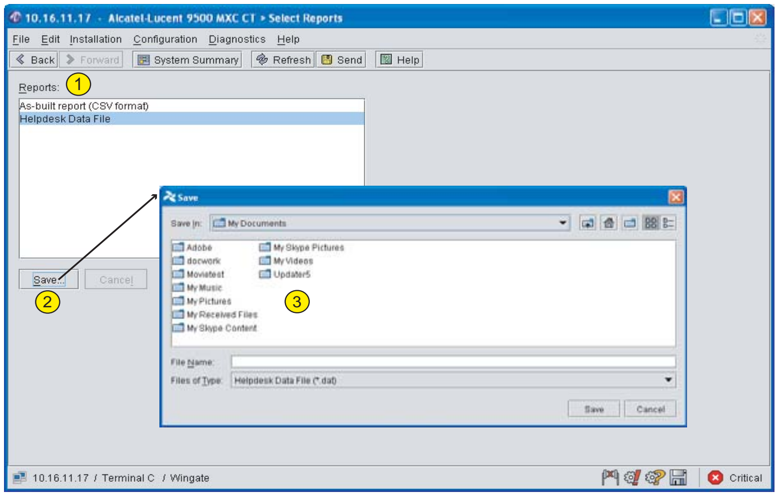


Table 5-1. Reports Screen: Navigation

Item	Description
1	Click to select the required report type.
2	Click **Save** to open a Browser on your PC.
3	Select an appropriate directory, enter a file name and click **Save** within the Browser window.

As Built Report

Once saved to your PC the report can be opened for viewing and editing in Excel. There are both defined, and not-defined entries:

Defined Entries

Defined entries are those which have data read into them from the Node/Terminal.

Not-Defined Entries

Not-defined entries are those which have not had data entered into them in CT, or are not editable in CT.

Before saving a report, ensure the current radio configuration is saved.

- Where CT user-configurable fields, such as terminal name and site name are not entered, their relevant entries in the csv file are labelled 'not defined'. Where appropriate, the entries should be made in CT, and the As Built Report resaved. Alternatively, an entry can be made directly in the csv file.
- Other entries, such as antenna type and antenna height, are not required in CT, so are labelled 'not defined'. Such entries can only be captured by entering data directly into the csv file, or into a more user-friendly Excel save-as of the file.

Helpdesk Data File

This file is saved to a folder on your PC for subsequent emailing to an Alcatel-Lucent support center.

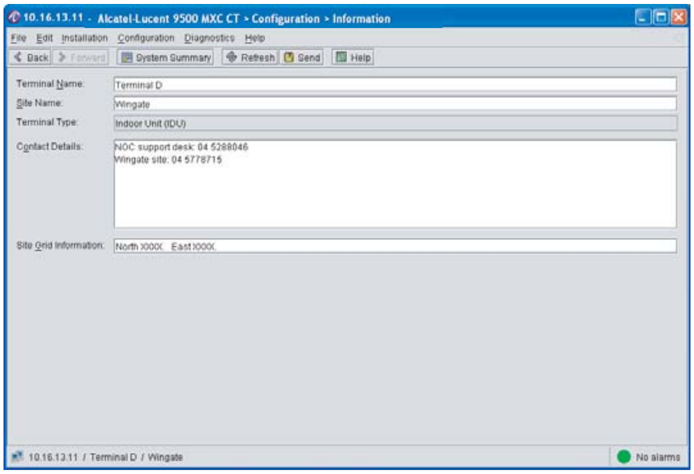
If a software reset is performed (see Advanced Management on page 15-61 of Diagnostics, Volume IV, Chapter 16) the helpdesk data file is automatically saved to a default folder on your CT PC at C:\Program Files\9500 MXC CT\Reset Logs\.

For support center locations refer to the Contact Information in the introductory pages.

Chapter 6. Node and Terminal Information

The Information screen provides user configurable fields for terminal and site name, site grid, contact details and notes. Refer to Figure 6-1.

Figure 6-1. Information Screen



The terminal name and site name set in this screen are displayed in the status bar on all screens.

- The terminal name is also displayed in the module name-line for the NCC (the NCC name is the terminal name).
- The terminal name can also be changed in the System Summary screen by right-clicking in the NCC module and selecting the Rename option.

Chapter 7. Node and Terminal Plug-ins

The plug-ins screen is used for Node and Terminal configuration. Table 7-1 lists module references used within the screens.

Table 7-1. Module References for Node and Terminal

Function	Node/Terminal Module References
Radio	LINK or RING. A LINK comprises one RAC/IDU for a non-protected link, two for a protected link. A RING comprises east and west pairings of RAC/RAC, RAC/DAC 155oM, or DAC 155oM / DAC 155oM.
Tributary	DATA for PDH and SDH tributaries. DATA comprises one DAC/IDU for a non-protected trib configuration, two for protected. DAC for Ethernet DACs and the IDU ES Ethernet port module.
Auxiliary	AUX

Refer to:

- Plug-Ins Screens on page 7-1
- Link Configuration on page 7-2
- DAC/Tributary Configuration on page 7-22
- AUX Configuration on page 7-73

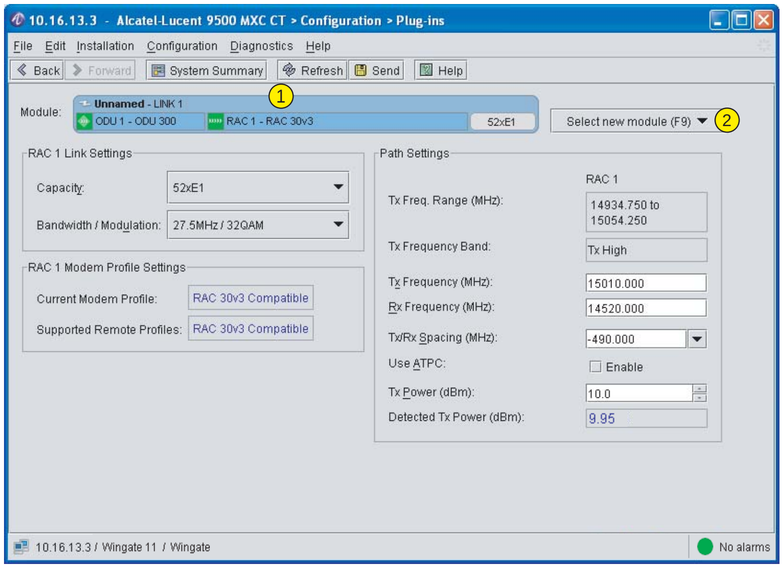
Plug-Ins Screens

For a Node, the Plug-ins screen opens in slot order number (used slots only). In Figure 7-1 on page 7-2, slot 1 is fitted with a RAC, so RAC 1 is displayed as the opening plug-in.

For the Terminal, the Plug-in screen opens to the Link module.

Click the Plug-in line to display a submenu for other plug-ins. Figure 7-1 on page 7-2 shows an example submenu for the 9500 MXC Node. Clicking on any plug-in line within the submenu displays its configuration screen. Although the NCC and FAN can be selected, they are not CT configurable.

Figure 7-1. Typical 9500 MXC Node Plug-ins Screen



Item	Description
1	Screen shows Plug-in configuration data for Link 1 module.The Plug-ins screen default opens to the first populated slot. The number following a module or plug-in indicates its slot location.
2	Click **Select new module** to view a list of other installed modules. Click a module to view its Plug-in configuration data.

Link Configuration

For the **Node**, link configuration applies to a RAC/ODU module (non-protected), or 2x RAC/ODUs for protected.

For the **Terminal**, link configuration applies to its RAC/ODU module (non-protected), or to the RAC/ODU modules of a protected Terminal pairing.

When a Node is configured for ring protection, the RAC/ODU pairing is referred to as a Ring rather than a Link.

From one Node/Terminal you can launch CT screens for its immediate remote partner(s) by right-clicking on the relevant RAC or DAC 155oM within a LINK, RING or DATA module (applies to all module-based screens such as System Summary and Plug-ins), and selecting the Launch Remote option (requires an operational connection to the remote end).

Refer to:

- Configuring a Link/Ring on page 7-3
- Protection Options on page 7-12
- Protection Settings on page 7-15
- Coupler Losses on page 7-17
- ATPC Guidelines on page 7-17

Configuring a Link/Ring

For a 9500 MXC Node, the Link/Ring plug-ins screen supports configuration of capacity, modulation/bandwidth, frequency, TR spacing, Tx power, and ATPC.

For a 9500 MXC Terminal, the screen support is identical to that provided for the Node, dependent on Terminal type.

- The configuration procedure is described at: Link/Ring Configuration Procedure on page 7-4
- Additional guidelines for protected and co-channel XPIC operation, are provided at:
  - Protected Links and Rings
  - Co-Channel XPIC Operation

Protected Links and Rings

Where a protected link or ring is required, the protection configuration *must first be established in the Protection screen*. Refer to Volume IV, Chapter 8.

- Protection options are described at:
  - Protection Options on page 7-12.

    Includes example screens for protected configurations.
  - Protection Settings on page 7-15.

    With a 9500 MXC Node there is automatic synchronization of RAC settings depending on the protection option, such that the secondary RAC is synchronized to the primary, or West with East in the case of a ring. Table 7-3 on page 7-16 details synchronized RAC settings.

    For a 9500 MXC Terminal there is no automatic synchronization of IDU settings. Each IDU must be independently configured for identical operation. For easy configuration, display the screens for both IDUs so you can view them simultaneously and click between each.

- For single antenna protected operation, equal-loss and unequal-loss coupler options are available. Refer to Table 7-4 on page 7-17.
- For protected links the licensed capacity of an INU must support both RACs - each must be separately 'licensed'.
- Similarly, each IDU of a protected pairing requires its own license.

Co-Channel XPIC Operation

Where two RAC 40s are installed for co-channel XPIC link operation they must be configured as two independent RACs; there are no common RAC settings.

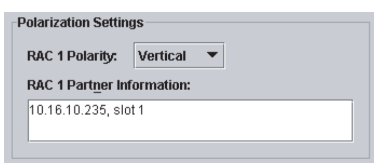
- For co-channel operation each must be configured for identical frequency, Tx power, and capacity/bandwidth options.
- Capacity options are restricted to 52/64/75xE1, 70/84/100xDS1, STM1.
- All capacity options are provided within a 27.5/28 MHz mask (channel spacing) for ETSI rates, or within a 30 MHz mask for ANSI rates.
- ATPC must not be used.

The plug-ins screen for each RAC 40 includes a Polarization Settings panel immediately below Protection Settings.

The panel prompts for polarization (vertical or horizontal), and partner information, such as IP address and terminal name and/or slot number of the partner XPIC RAC. While the polarization settings must be correctly set for XPIC operation, the partner information is informational only. Figure 7-2 shows the panel with an entry displaying the IP address for a co-located INU and the slot number used.

The Diagnostics > Performance screen includes a cross polarization discrimination measurement for RAC 40 pairings, which measures the native V and H signal discrimination in dB at the input to the RAC 40s (from the antenna feeds). The improvement in signal discrimination provided by the RAC 40 XPIC function is in addition to this measurement.

Figure 7-2. Polarization Settings Panel



Co-channel links can be hot-standby or diversity protected. Refer to Figure 7-6 on page 7-15 for an example hot-standby protected screen.

Link/Ring Configuration Procedure

This procedure applies to non-protected, hot-standby, diversity, and ring links.

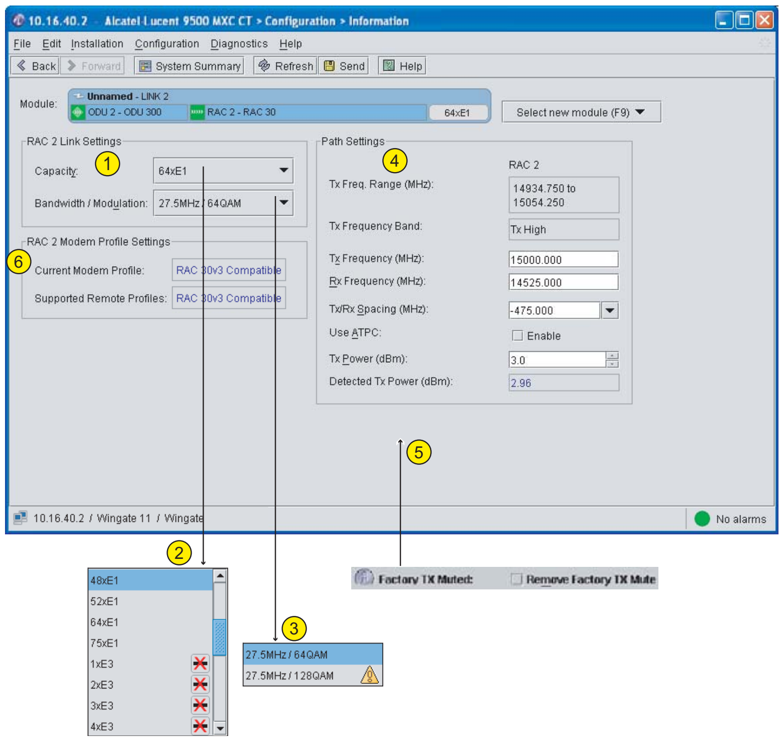
- A typical Node non-protected plug-ins screen for a 16xE1, 16 QAM configuration is shown in Figure 7-3 on page 7-5.
- A typical hot standby link plug-ins screen is shown in Figure 7-4 on page 7-13. Apart from the Protection Setting advice, the same screen is typical of a space diversity link.
- A typical ring protection plug-ins screen is shown in Figure 7-5 on page 7-14. Apart from the Protection Setting advice, the same screen is typical of a frequency diversity link.

- A typical co-channel protected plug-ins screen is shown in Figure 7-6 on page 7-15.

Additional information on protected operation is provided at:

- Protection Options on page 7-12
- Protection Settings on page 7-15
- Coupler Losses on page 7-17

Figure 7-3. Example Link Plug-Ins Screen for a Non-Protected Link

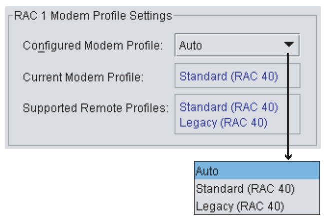


Item	Description
1	Select and set link capacity and bandwidth/modulation from drop-down menus.

2	Example link capacity menu (RAC/ODU). Click to select the required capacity.
	• A cross icon indicates this capacity option is incompatible with the backplane setting (change backplane type in the Circuits screen).
	• A triangle icon indicates an obsolete modem setting. The setting remains available but has been superseded with a new modem profile that provides:
	  • The same capacity in the same bandwidth but with a lower modulation rate for higher system gain, or
	  • Higher capacity for the same modulation rate and bandwidth.

3	Shows the bandwidth / modulation options for the selected capacity. Click to select. • A triangle icon indicates an obsolete modem setting.

Item	Description
4	Path settings window: • Set Tx and Rx frequencies, Tx power. • Provides an ATPC option. • Indicates Tx power (measured). The displayed Tx Frequency Range, Tx high or Tx low, and the choices of Tx/Rx spacing are read from the installed ODU. Settings outside the allowable ranges are not accepted.
5	Factory Tx Muted is an ex-factory default setting and appears above the Tx Power line. Once removed it will not appear again.
6	Confirms the supported modem profile settings and the current setting for the selected RAC. For the RAC 30 it confirms compatibility action and options between RAC 30 versions, while for the RAC 40 it confirms and supports compatibility options between software versions: **RAC 30** For the RAC 30 it is used to determine the current over-air compatibility status supported by RAC 30 plug-ins. **RAC 40** RAC 40s operating with a Legacy modem profile cannot operate correctly with RAC 40s operating with a Standard profile. • A RAC 40 operating with SW 3.3 or earlier has a 'Legacy' modem profile. • A RAC 40 operating with SW 3.4 or later has a 'Standard' modem profile, which was introduced to provide better performance on the horizontal plane. • A RAC 40 operating with SW releases 3.4, 3.5, 3.6, or 3.7 cannot operate with RAC 40s running 3.3 SW or earlier. However, with 4.0 SW and later a capability is provided to support over-air compatibility by allowing selection between Legacy or Standard modem profiles, and to auto-configure both ends to Standard when both are running 4.0 SW or later. This capability means there will be minimal disruption to traffic during the SW upgrade process - one end can be upgraded before the other. • Selection of Auto (default), Standard or Legacy is provided in the RAC 40 modem profile panel in the RAC 40 Plug-ins screen. For more information, refer to RAC 40, Volume II, Chapter 3. **Tip:** With both ends operating on SW 4.0 or later the RAC 40s auto select 'Standard'. No user configuration of the RAC 40 modem profile is required. Background: Software versions before 3.4 cannot establish both V and H radio links when RAC 40s at the other end of the link are operating with software versions 3.4, 3.6 or 3.7. • For SW versions 3.4, 3.5, 3.6 and 3.7 only the Standard modem profile is supported. For 3.5, 3.6 and 3.7 this is indicated in the modem profile panel in the RAC 40 Plug-ins screen where 'Standard (RAC 40)' is indicated for the Configured Modem Profile and also for the Supported Remote Profile. Configured Modem Profile does not apply. • In other words, for these SW releases there is no support for compatibility with a Legacy RAC 40 (SW version 3.3 or earlier) at the other end of the link. Only the Standard modem profile is supported and both ends of the link. With 4.0 SW and later a capability is provided to support Legacy and Standard modem profiles.

Item	Description
	Selection of Auto (default), Standard or Legacy is provided in the RAC 40 modem profile panel in the RAC 40 Plug-ins screen. See below. These selection options are designed to support RAC 40 to RAC 40 operation during SW upgrades (one end is upgraded before the other): • The Legacy setting is used where a RAC 40 (SW 4.0 or later) must communicate with a RAC 40 using SW 3.3 or earlier. • The Standard setting is used where a RAC 40 (SW 4.0 or later) must communicate with a RAC 40 operating on SW 3.4, 3.5, 3.6, or 3.7. • The Auto (default) setting is used where both ends are running 4.0 or later. • A RAC 40 will continue to use its prior modem profile, even when upgraded or when an INU/INUe is power-cycled.  Upgrade Process: The upgrade processes supported by this SW capability are as follows. In all cases, after SW is updated to 4.0 or later, the modem profile setting on the RAC 40 Plug-ins screen will have Auto as its Configured Modem profile, but its Current Modem Profile will be the profile used *with its previous version of SW until both ends are upgraded to 4.0 or later*, whereupon the Auto selection will ensure both ends negotiate to a Current Modem Profile of ‘Standard’. **Tip:** RAC 40s should be left in the Auto (default) mode in all instances except that where a link must be repaired - refer below to the application for repairing a link running 3.3 on one end and 3.4 to 3.7 on the other. Upgrading one end of a 3.3 link to 4.0: With one end upgraded to 4.0, the upgraded end will continue to use the Legacy modem profile to ensure continued operation. This means it is possible to upgrade one site in a network without upgrading the entire network.

Item	Description
	Upgrading a 3.3 link to 4.0: After upgrading one end to 4.0, the upgraded end will continue to use the Legacy modem profile (as above). After upgrading the other end to 4.0, the upgraded link uses the Legacy modem profile until NMS communications is established, whereupon the terminals auto-negotiate to switch the modem profile from Legacy to Standard. Both ends must have Auto confirmed as their Configured Modem profile Repairing a link running 3.3 on one end and 3.4 to 3.7 on the other: Normal co-channel operation is not possible if one end is operating with 3.3 SW or earlier, and the other with 3.4, 3.5, 3.6, or 3.7. To restore operation, first one end of the link is upgraded to 4.0. Note that it will continue to use the same Current Modem Profile it was previously using. • If the 3.3 end is upgraded the link will remain non-operational as the retained modem profile is Legacy, but by manually setting the Configured Modem Profile of the upgraded end to match the Standard profile required by the other (3.4 to 3.7) end, a link is established and it will commence carrying traffic. • If the 3.4 to 3.7 end is upgraded the link will remain non-operational as the retained modem profile is Standard, but by manually setting the Configured Modem Profile of the upgraded end to match the Legacy profile required by the 3.3 end, a link will be established. • With both ends upgraded to 4.0 or later, and with their Configured Modem Profiles set to Auto, both ends will auto-negotiate to confirm Standard as their Current Modem Profile. With 4.0 SW software installed, the *Supported Remote Profiles* are those detected as being supported at the remote end of the link. If the remote end has 4.0 SW, the Supported Remote Profiles will indicate Standard and Legacy. If the remote end has 3.3 SW or earlier, it will indicate Legacy. If the remote end has 3.4 to 3.7 SW, it will indicate Standard. Protected RAC 40 operation is essentially the same as for non-protected, but where a conflict occurs, the decision falls in favour of the Standard modem profile. These conflicts are only likely to occur after reconfiguration of INU/INUe slots from existing links to new links. Both RACs will always use the same modem profile. If either RAC is forced to use Standard or Legacy, then both RACs are forced to that modem profile. If one is forced to Standard and the other to Legacy, then both will use the Standard modem profile.

Procedure:

1. From the Plug-ins screen, select the required module.
   - For a protected Node link, two RACs are displayed within one Link or Ring module. RACs are labelled primary and secondary for a hot standby or diversity link, or east and west for a ring configuration.
   - For a protected Terminal link, the primary and secondary Terminals are displayed on separate screens.
   - For a protected Node link, the degree of synchronization between RACs for frequency, modulation, Tx power and ATPC settings depends on the type of protection selected. Where not synchronized, separate configuration of relevant settings is prompted/required.

2. **Capacity**. Click Capacity to view and select an option from the submenu.
   - The options *shown* are those permitted within the capabilities of the installed RAC/ODU, or IDU/ODU combination.
   - The options *permitted* are those which are not flagged with a warning icon. Cross icons are displayed against capacities requiring a different backplane bus setting.

     For a Node, the selected capacity type (E1, DS1, E3, DS3 or STM1/OC3) must have a matching backplane bus. When a selected capacity option does not match with the bus, a 'cross' icon is displayed against it. For example, if an NxSTM1 capacity option is selected, the bus must also be configured for STM1 operation. This backplane configuration is selected in the Circuits screen. E1 is the default backplane configuration.

     The selected capacity must be supported by the licensed capacity. If the configured capacity exceeds the licensed capacity a configuration not supported alarm is raised. This is a major alarm.
   - An enhanced system gain option is included for RAC 30v3 for 1xSTM1, 128QAM. This is in addition to the standard option provided for this capacity/bandwidth.
     - The enhanced system gain option, 1xSTM1+, improves Rx threshold and system gain by 1.5dB compared to the standard 1xSTM1 option.
     - The enhanced system gain option requires compatible software at both ends of the link. For STM1, SW 3.7 or later is required. For OC3, SW 4.3 or later is required.
   - For all protected configurations except Ring, the selected *capacity* is common to both RACs.
   - Both RACs in a protected pairing must have a valid license.

The Node backplane bus connection size must be set to match the capacity type selected in the plug-ins screen. The selection options are:
2.048 Mbps (E1 capable),
34.368 Mbps (E3 capable),
1.544 Mbps (DS1 capable),
44.736 Mbps (DS3 capable),
155.52 Mbps (STM1/OC3 capable).

Configuration of the bus is made in the Circuits screen.

3. **Bandwidth / Modulation**. Select bandwidth / modulation from its submenu.
   - The bandwidth / modulation options presented are only those permitted by the selected capacity for the RAC/ODU or IDU/ODU type installed.
   - For all Node protected configurations except Ring, the selected bandwidth / modulation is common to both RACs.

9500 MXC Node modulation options are QPSK, 16QAM, 32QAM, 64QAM, 128QAM or 256QAM, but in the Bandwidth/Modulation menu only the modulation options appropriate to the selected capacity and RAC type installed are presented. For example, 16xE1 only presents Bandwidth/ Modulation options of 28 MHz / QPSK or 14 MHz / 16QAM. Similarly, for the Terminal, modulation options also depend on the IDU/ODU type and selected capacity.

4. **Modem Profile Settings**. The modem profile(s) for the RAC Plug-in is displayed.
   - For a RAC 30 it confirms compatibility action and options between RAC 30 versions V1, V2 and V3.
   - For a RAC 40 under SW 4.0 or later, it indicates current and supported settings of Auto, Standard, or Legacy. Selection should be left at Auto (default) in all instances except where it is necessary to repair link operation between a RAC 40 under SW 3.3 or earlier, and a RAC 40 under SW 3.4.to 3.7. For more information refer to RAC 40 under Configuring a Link/Ring on page 7-3.
   - For a RAC 3x it indicates Standard RAC 3x.
5. **Polarization Settings**. This panel is only prompted for a co-channel link (RAC 40). For correct XPIC operation, polarity must be set correctly for each RAC of the XPIC pair. Information may be entered (optional) in the partner information box, such as terminal name, IP address, and/or slot number for the partner RAC.
6. **Frequency**. The displayed Tx Frequency Range, Tx high or Tx low, and the choices of Tx/Rx spacing are read from the installed ODU. Settings outside the allowable ranges are not accepted.
   - For ODU 300hp and ep the T/R spacing can be set to a spacing outside the menued T/Rs for frequency bands 18 GHz and below, providing it is within constraints determined by the ODU/diplexer. For higher bands the T/R can only be selected from the T/R drop-down menu.
   - Setting Tx frequency and T/R spacing automatically sets the Rx frequency. Tx frequency is direct entered in 250 kHz steps. Values outside the 250 kHz step points are not accepted. Tx/Rx spacing may be selected from its drop-down menu, or direct entered.
   - Tx/Rx spacing shows as a +ve MHz value for a Tx low ODU and as -ve value for Tx high.
   - Rx frequency can be direct entered if preferred, whereupon the Tx frequency is set automatically based on the selected Tx/Rx spacing. Again, such selection is only be permitted within the constraints of the allowable frequency steps and Tx/Rx Spacing.

The allowable minimum and maximum Tx and Rx frequency settings are modified according to the Bandwidth/Modulation selection such that band edges and spacings are not infringed.

7. Enter a **Tx Power** value, which can be set in 0.1 dB steps
   OR
   Enable ATPC by clicking the Use Automatic Power Control checkbox. The

additional ATPC fields displayed are detailed in ATPC Guidelines on page 7-17.

The **Detected Tx Power** displays the measured Tx power at the ODU, for direct comparison with the set Tx Power value. Accuracy is +/- 2 dB over temperature and range.

Do not use ATPC for RAC 40 co-channel links.

Do not use ATPC where significant interference is apparent. See ATPC Guidelines on page 7-17.

8. **Factory Tx Mute** is a one-time action. Removing the mute will remove all reference to this feature. Its purpose is to ensure that on initial power-on there is no transmitted signal until the ex-factory settings for frequency and Tx power are checked, and if necessary, reset.
9. **Name**. Enter a Link or Ring name by right-clicking in the Link or Ring module within the System Summary screen, selecting **Rename**, and typing. The default name is 'unnamed'.
   - The Link or Ring name entered will appear in all CT screens where link or ring modules are identified. Includes Plug-ins, Protection, Circuits, Networking, System Summary, System/Controls, History.

Protection Options

Table 7-2 describes 9500 MXC protection options.

- The Node supports all options.
- Paired IDU 155o and IDU 20x Terminals support hot standby or space diversity.

Before configuring a protected LINK or RING, the protection primary/ secondary pairings must first be established in the Protection screen.

Table 7-2. Protection Types

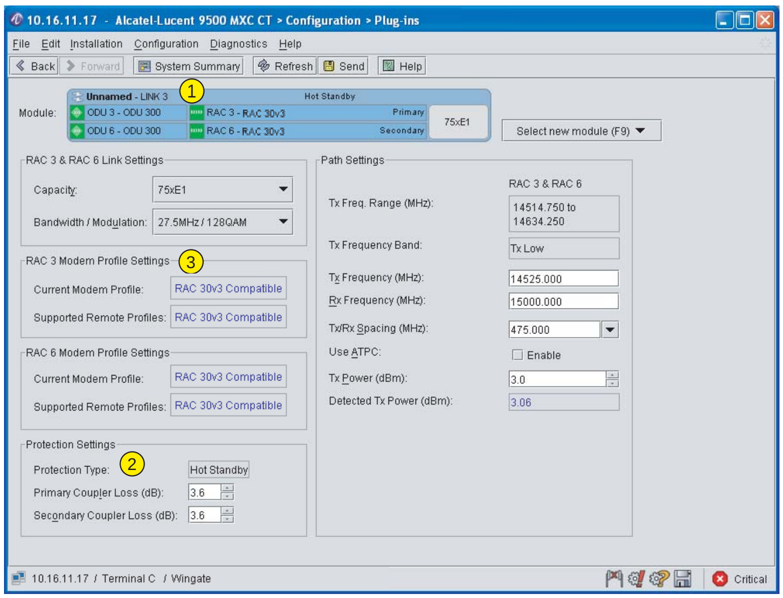
Protection Type	Description
Hot Standby	Hot standby is normally configured for use with a single antenna, where the two ODUs, set to the same frequency, are connected to the antenna via a coupler. For the Node, both RAC/ODU combinations are receiving, with the least errored receive stream being selected on a block-by-block basis. For the Terminal both IDU/ODU combinations are receiving. IDU 155o and IDU 20x support hitless path protection, with the least errored receive stream selected on a block-by-block basis.
Frequency Diversity	Frequency Diversity is normally configured for use with a single antenna, where the two ODUs, set to different frequencies, are connected to the antenna via a coupler. Both RAC/ODU combinations are on-line transmitting and receiving the same traffic, with the least errored receive stream being selected on a block-by-block basis.
Space Diversity	Space diversity requires two antennas, each with an ODU. The primary RAC/ODU or IDU/ODU should be assigned to the top antenna. Both receivers are receiving, with the least errored receive stream being selected on a block-by-block basis.
Ring Protection	Ring protection requires two antennas, each with an ODU; one each for the East and West facing directions. If operating on the same frequency band, the co-located ODUs would normally both be Tx high, or Tx low (and set to different frequencies). They operate as two back-to-back non-protected radios, with protection provided by circuit wrapping at E1 or DS1 around the ring.

Example Plug-ins Screens for Protected Options

The displayed data and setting options depends on the type of protection selected in the *Protection* screen.

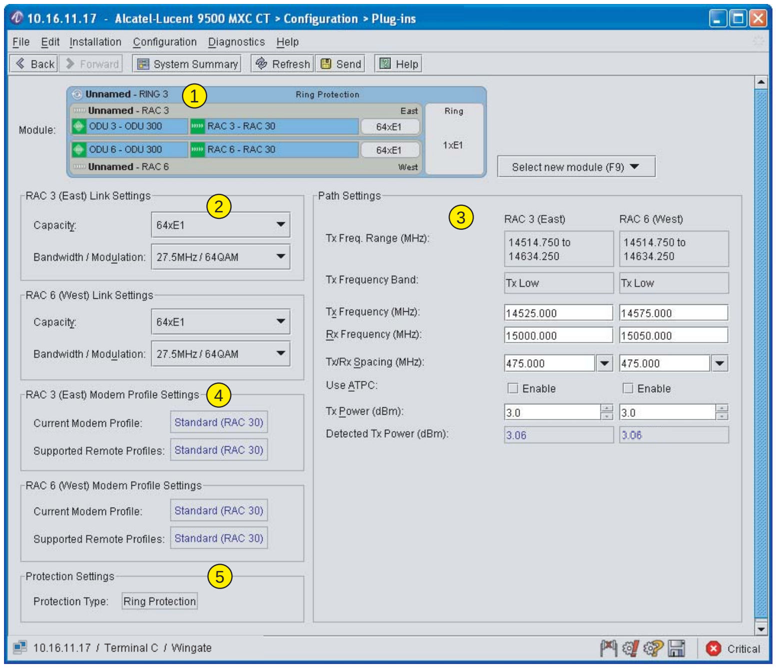
The larger size of the ring protection and frequency diversity screens means they open with scroll bars. To achieve a full screen view, use the maximize button in the top right corner of the screen, or click and drag one corner of the screen.

Figure 7-4. Example Plug-ins Screen for a Protected Hot Standby Link



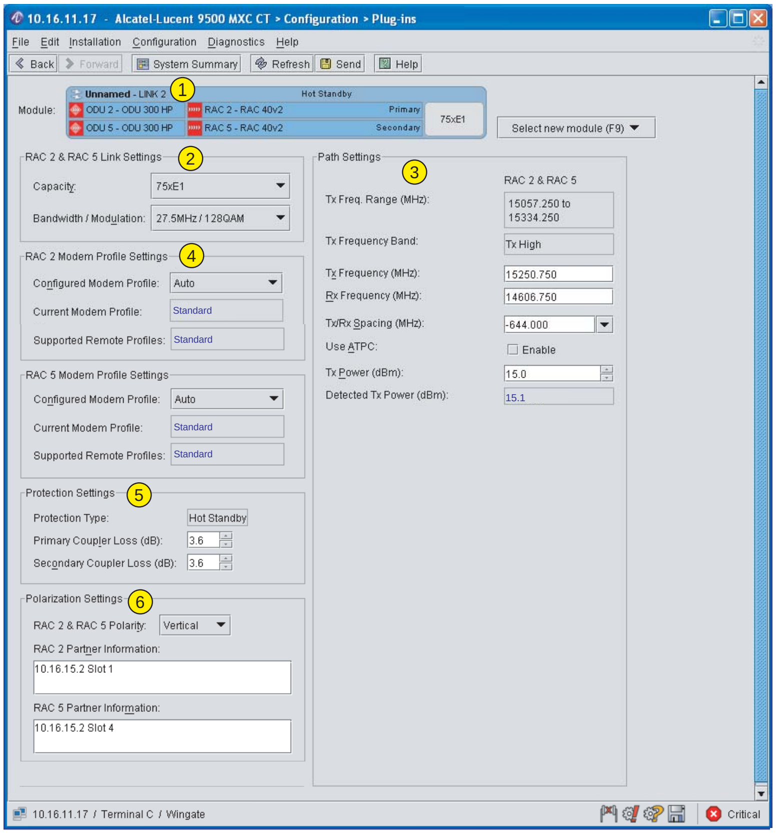
Item	Description
1	Module shows a protected STM1 Link: RACs in slots 1 & 4 with RAC 1 the primary RAC and RAC 4 the secondary. For hot-standby the link/path settings are commoned so only one Path Settings panel is shown.
2	The Protection Settings panel confirms protection type and, for a hot-standby or frequency diversity link, a coupler-loss entry is prompted.
3	Modem Profile Settings are confirmed for both RACs.

Figure 7-5. Example Plug-ins Screen for a Ring Protected Link



Item	Description
1	Module shows ring-protected STM1 links with RACs in slots 1 & 4.
2	East and West links are independently set for capacity and bandwidth/modulation.
3	Path settings are independently set for the East and West links.
4	Modem profile settings are confirmed for both RACs.
5	The Protection Settings Panel simply confirms that ring protection has been set.

Figure 7-6. Example Plug-ins Screen for a Co-Channel Hot-standby Link



Item	Description
1	Module shows a hot-standby protected link using RAC 40s in slots 2 & 5, with RAC 2 the primary RAC and RAC 5 the secondary.
2, 3	The link/path settings are commoned (hot-standby) so only one Link Settings panel and one Path Settings panel are shown. **For co-channel operation ATPC must not be selected.**
4	Modem profile settings are separately confirmed for both RAC 40s.
5	The Protection Settings panel confirms protection type (hot-standby) and a coupler-loss entry is prompted. **For co-channel operation equal-loss couplers must be used.**
6	Enter the polarization and location of the protected co-channel partner RAC 40s.

Protection Settings

For the **Node**, the displayed options depend on the protection type selected in the Protection screen.

For protected **Terminals**, the Plug-ins screen does not indicate protection settings. Each Terminal (primary and secondary) is separately configured.

Within a Node Plug-ins screen the Protection Settings panel provides:

- Confirmation of the protection type selected in the Protection screen.
- For **hot-standby and frequency diversity** (single antenna operation), a Coupler Loss menu for user entry of the loss values for primary and secondary plug-ins (RACs). The entered losses are purely informational; they do not offset Tx power and RSL indications. Coupler losses must therefore be manually accounted for in the calculation of effective radiated power and of receive signal level for fade margin purposes.

  Two types of coupler are provided; an equal split coupler with insertion losses of nominally 3.5 dB per side, and an unequal split coupler, which has a nominal split of 1.5 / 6.5 dB. Refer to Table 7-4 on page 7-17 for details of the losses by frequency band for the equal and unequal options.

  For the unequal split coupler, the low-loss side must be assigned to the primary RAC. (The primary RAC must be the RAC/ODU combination connected to the primary arm of the coupler)

  Loss figures can be entered directly or by using the up-down tabs.

  The losses apply for Tx and Rx. For instance, if the primary side has an insertion loss of 1.6 dB, then the total additional primary-primary path loss due to the coupler at each end of the link will be 3.2 dB.
- For a **hot-standby, co-channel link** (protected RAC 40 operation), a panel will appear prompting entry for polarization and locations of the partner co-channel RACs. The entered data is purely informational; it does not impact operation.

  For protected co-channel operation:

  - ATPC must not be used.

  - An equal-loss coupler must be used.

  - The co-channel RACs must be set for the same capacity and modulation.

Synchronized Node Protection Settings

Table 7-3. Synchronized RAC Protection Settings

Protection Type	Synchronized RAC Settings
Hot Standby	Frequency, Capacity, Modulation, Tx Power, ATPC
Space Diversity	Frequency, Capacity, Modulation, Tx Power, ATPC
Frequency Diversity	Capacity, Modulation
Ring Protection	None

Coupler Losses

Table 7-4. Nominal Losses for Equal and Unequal Couplers

Frequency Bands GHz	Primary Arm Insertion Loss dB	Secondary Arm Insertion Loss dB
37.0 - 40.0	4.0 (Equal), 2.0 (Unequal)	4.0 (Equal), 7.0 (Unequal)
31.9 - 33.4 27.5 - 31.3 24.25 - 26.5 21.2 - 23.6	3.8 (Equal), 1.8 (Unequal)	3.8 (Equal), 6.8 (Unequal)
17.7 - 19.7 14.4 - 15.35 12.75 - 13.25 10.7 - 11.7 7.11 - 8.5 5.925 - 7.11	3.6 (Equal), 1.6 (Unequal)	3.6 (Equal), 6.6 (Unequal)
4.0 - 5.0	3.5 (Equal), 1.5 (Unequal)	3.5 (Equal), 6.4 (Unequal)

ATPC Guidelines

Automatic Transmit Power Control (ATPC) is an optional setting. It allows radio links to maintain set thresholds for fade margin, and to maintain overall link performance at an otherwise lower than maximum transmit power. If path conditions deteriorate due to fading, ATPC gradually increases the transmitted power to maintain the remote fade margin. When the condition causing the fade ens, the TX power level is reduced back to the minimum level.

Benefits of ATPC

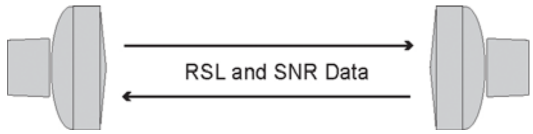
ATPC supports greater re-use of radio channels in a network. If a given link can still operate within suitable receive thresholds with a lower transmitted power level, that link will pose less risk of interference to other links running in co or adjacent channels. This enables a higher level of channel reuse. For ATPC to be effective, all links in the same geographic area must be running ATPC.

In areas that have high link densities, a license authority (regulator) may include within an operating license the requirement for ATPC and the maximum transmit power permitted under ATPC control.

ATPC Operation

ATPC in 9500 MXC is based on two monitored values, Receive Signal Strength (RSL) and Signal to Noise Ratio (SNR).

Each 9500 MXC terminal transmits information about its RSL and SNR levels to its partner terminal. The terminals analyze this information, and each adjusts its Tx power to maintain the target fade margin settings



ATPC calculates the remote terminals' fade margin based on current RSL and receiver/ modulation specifications. If a path fade reduces the fade margin on the remote terminal, the local transmitter increases its power level to return the remote fade margin to the target settings. When the fading condition passes and the fade margin increases, the local transmitter reduces its power level to keep the remote fade margin at the desired level.

- The ATPC algorithm does not adjust Tx power when a link is running normally, and the RSL and SNR values are within normal limits.
- If the local terminal determines that RSL at the remote terminal is too low, then it increases its power level in 0.1 db increments until the RSL is within the specified range.
- "If the RSL value is within range, but the SNR is low, then the transmit power is increased until the SNR is within the specified range.
- ATPC power changes can occur at a rate of 6 dB/second to provide compensation for rapid fading conditions.
- ATPC will fail to maintain the remote target threshold settings if the fading condition is severe enough to require more local transmit power than set as the maximum TX power, or if the power level required is beyond the capability of the transmitter.

Interference and ATPC

It is possible for a radio to have a good receive signal (high RSL), but poor residual BER performance (poor SNR), such as can occur when there is co/adjacent interference. SNR is therefore also used as a factor in ATPC operation, preventing bit errors occurring due to link fade beyond the point where Forward Error Correction (FEC) is able to recover errored blocks.

- The ATPC process calculates the SNR based on the signal level derived from the demodulator and uses this information to maintain the SNR by adjusting the Tx power at the local terminal.
- The transmit power at the local terminal is increased when the SNR at the remote terminal falls to the SNR calculated for an RSL 6dB above the 10^{-6} threshold. The dB value will vary slightly, depending on the ODU/modulation combination.

RSL and SNR Interoperation

The ATPC algorithm uses both RSL and SNR inputs to set remote Tx power.

- An above-range RSL will initiate a *reduction* in remote Tx power.
- When both RSL and SNR are within range, no ATPC action is taken.
- When the RSL is within range but the SNR is below range, SNR will initiate an *increase* in remote Tx power.

With low levels of interference ATPC can, depending on the settings and the degree of interference, optimize the remote Tx power. But with high levels of interference ATPC action will not be effective.

Check for interference by muting the Tx at the far end and checking RSSI/RSL at the local end. Where there is a measurable RSL under this condition, do not use ATPC.

- Note that the RSSI (RSL) filter has a nominal 56 MHz bandwidth, which means that depending on the channel bandwidth used, multiple adjacent channels can be included within the filter passband[1]. Normally this will not cause a problem as antenna discrimination (beamwidth) and good frequency planning should exclude co and adjacent channel RSL interferers.

For co-channel XPIC operation do not use ATPC.

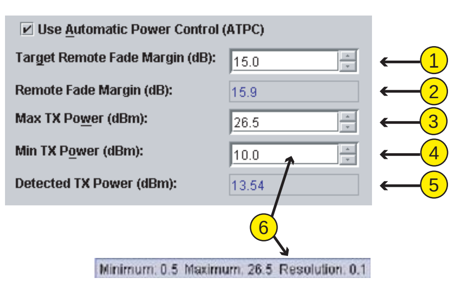
For all other modes of operation, do not use ATPC where there is a measurable RSL when the remote-end Tx is muted.

Where ATPC is configured, its operation should be monitored for a period after installation to ensure it is providing the expected benefits under the prevailing path conditions. Where indicated, ATPC settings should be optimized, or in situations of frequent, fast and high fading it may be best to disable ATPC.

Setting ATPC

This procedure is based on the prevailing path conditions being typical during the setup procedure, that is, not subject to rain fade or other fade conditions and assumes the Target Fade Margin is the primary driver for establishing the settings.

The objective is to check that Remote Fade Margin and the Detected Tx Power are within +/- 3 dB of the planned figures for the link, and that there is appropriate Tx Power headroom for correct ATPC operation.



1 *RSSI filter bandwidth is not a function of, nor does it affect receiver adjacent channel C/I performance. 9500 MXC complies with relevant ETSI and FCC co and adjacent channel requirements.*

Item	Description
1	Set the fade margin for the remote end
2	Calculated remote end fade margin
3	Set maximum local end Tx power
4	Set minimum local end Tx power
5	Detected local end Tx power
6	Mouse-over for tooltip advice

Caution: On CCDP XPIC links ATPC must be OFF on both links to avoid abnormal ATPC operation. (ATPC operation is driven by its remote-end RSSI/RSL, which for co-channel links is modified by the interference caused on one link by the other).

For co-channel XPIC links do not use ATPC.

Where a link license specifies a maximum Tx power, the maximum Tx power setting for ATPC must be set no higher than the licensed maximum.

Table 7-5. ATPC Functions and Descriptions

Function	Description
Target Remote Fade Margin	This is the desired fade margin for the remote-end RAC/ODU, or Radio/ODU. Depending on the path design this should be set at a level which will allow head room for the local Tx power, while ensuring an adequate fade margin.

Function	Description
Remote Fade Margin	This is the calculated fade margin for the remote end. The remote radio transmits its current RSL and SNR to the local end once every 100 ms. The local radio then determines a fade margin by offsetting these RSL and SNR values from the calculated 10^{-6} receive threshold level for the modulation and bandwidth option selected. If the RSL and SNR values satisfy the Target Fade Margin range, then the ATPC algorithm does not adjust the local Tx power (a small tolerance prevents unnecessary small fluctuations in power). If the RSL and/or SNR values are too low then the local Tx power is increased until the Target Fade Margin is achieved, or until the maximum Tx power setting is reached, whichever occurs first. Similarly, if the RSL and/or SNR values are too high, then the local Tx power is decreased until the target fade margin is achieved, or until the minimum Tx power setting is reached, whichever occurs first. Under normal operating conditions the Target Remote Fade Margin and the Remote Fade Margin should indicate within 2 dB of each other. **Note:** 9500 MXC compensates for fades of up to 6 dB per second.
Max Tx Power	This can be set up to the maximum for the capacity and bandwidth option selected. Mouse-over for maximum and minimum values. Note that a link licence from the local radio regulation authority may limit the maximum allowable power to a setting below the maximum capability of the radio for short to medium distance hops, in which case set the Max Tx Power to the licensed maximum.
Min Tx Power	Mouse-over to view the minimum power setting for the capacity and bandwidth option selected. The minimum power must be set such that under normal operating conditions a satisfactory fade margin is preserved.
Detected Tx Power	This is the detected/measured Tx power. With ATPC enabled it provides an indication of the actual Tx power, which under normal conditions should be inside the maximum and minimum Tx power settings (not hard up against the max and min). When ATPC is disabled, the Detected Tx Power indication should be within 1.5 dB of the Tx Power figure.

To ensure correct ATPC operation:

1. Set Max Tx Power to the maximum for the capacity and bandwidth option of the link. Set Min Tx Power to the minimum.
2. Set the Remote Fade Margin to the figure indicated in the path planning data sheet for the link.
3. To confirm the Max/Min Tx Power and Target Remote Fade Margin, click **Send**.
4. Read the resulting Remote Fade Margin and verify it is within 3 dB of the planned fade margin for the link.
5. Read the Detected Tx Power for the link and verify it is within 3 dB of the planned Tx power for the link.
6. Reset the Max Tx Power, if required to a lower level. This can be the level specified by the local radio regulation authority. It must be set for a power level not less than

7 dB above the Detected Tx Power, to provide headway for ATPC action in the event of a path fade.

7. Reset the Min Tx Power to the normal (prevailing) Detected Tx Power, or to a level not more than 3 dB to 6 dB below the Detected Tx Power. This setting will safe-limit the minimum in the event the fade conditions lead to rapid and large Tx power movement.
8. To commit the configuration, click **Send**.

DAC/Tributary Configuration

For a **9500 MXC Node** the DAC provides the link between the user interface and the TDM backplane. Different DACs provide NxE1/DS1, NxE3/DS3, NxSTM1/OC3, or Ethernet 10/100/1000 interfaces. E3/DS3 and STM1/OC3 DACs may be paired to provide redundancy in the event of a DAC failure.

For a **9500 MXC Terminal**, the available tributary interface options depend on the IDU variant.

- For the **IDU 20x**, trib screen functionality is identical to DAC 4x or DAC 16x.
- For the **IDU 155o**, trib screen functionality is as for the DAC 155o.
- For the **IDU ES**, screen functionality is as for the DAC ES for its Ethernet transport options, and as for the DAC 4/16x for its wayside tributary options.
- The protectable IDUs provide terminal-based protection, meaning switching occurs on all tribs in the event of a switching event.

Table 7-6 lists available DACs for 9500 MXC Node, and shows which DACs can be protected.

Table 7-6. DAC Variants

Refer to:	Connection	Protectable
DAC 16x	16xE1/DS1	No
DAC 4x	4xE1/DS1	No
DAC 3xE3/DS3M	1/2/3xE3/DS3, E13/D13, or 34 Mbps transparent	Yes
DAC 1x155o	1xSTM1/OC3	Yes
DAC 2x155o	2xSTM1/OC3	Yes
DAC 155oM	1xSTM1/OC3 optical to NxE1/DS1 multiplexer	Yes
DAC 2x155e	2xSTM1 electrical	Yes
DAC ES	10/100Base-T Ethernet	No
DAC GE	Gigabit Ethernet	No

Refer to:

- Naming on page 7-23
- Tributary Protection on page 7-23
- DAC 16x, DAC 4x and IDU E1/DS1Trib Configuration on page 7-26
- DAC 3xE3/DS3M Configuration on page 7-29
- DAC 155o, 2x155o and 2x155e Configuration on page 7-33
- DAC 155oM Configuration on page 7-35
- DAC ES and IDU ES Configuration on page 7-41
- DAC GE Configuration on page 7-49
- Auxiliary Data and NMS Functions on page 7-73
- AUX Configuration on page 7-77
- Alarm I/O Configuration on page 7-78

Naming

DATA/DAC (Module) Name. A name can be entered or a name changed by right-clicking within the DATA module in the System Summary screen, selecting Rename, and typing. The default name is 'unnamed'.

- The name entered will appear in all CT screens where the DATA module function is identified. Includes Plug-ins, Protection, Circuits, System Summary, and System/Controls screens.

Trib Naming. Trib names should relate to its circuit name to permit easy association of trib with circuit when setting a DAC BER test using the circuit loopback feature. Trib names are entered in the DAC Plug-ins screens; circuit names are entered in the Circuits screen.

Tributary Protection

Tributary protection on a **Node** is provided by operating two identical DACs as a protected pair. For configuration information, refer to Node Protection, Volume IV, Chapter 8.

Tributary protection on a protected **Terminal** is provided by operating two identical IDUs as a protected pair. For configuration information, refer to Terminal Protection, Volume IV, Chapter 8.

Two tributary protection options are provided on the IDU 155o, three on the IDU 20x. **Tributary protection** and **tributary always-on** applies to both IDUs; **hot standby: no tributary protection** applies only to the IDU 20x.

Tributary Protection (TT)

- 'Y' cables connect the paired DACs/IDUs to customer equipment.
- In the Rx direction (from the customer) both DAC/IDUs receive data, but only the online Rx DAC/IDU sends this data to the bus/radio.
- In the Tx direction, the online Tx DAC/IDU sends data to customer equipment, the other 'mutes' its Tx line interface.

Tributary Always On (TA)

- Separate cables connect each DAC/IDU to customer equipment.
- In the Rx direction (from the customer) both DAC/IDUs receive data, but only the online Rx DAC/IDU sends this data to the bus/radio.
- In the transmit direction both DAC/IDUs send data to customer equipment, and the customer equipment switches between these two 'always on' tributaries.
- TA protection can also used where two 9500 MXC INU/INUes are trib-interfaced using protected DACs, or where two pairs of protected IDUs are trib interfaced, but doing so will reduce the level of protection on offer compared to TT protection (Y cables).
  - For example, in the event of a trib module failure both the failed and connected DACs must switch to the standby DACs using TA protection, whereas with TT protection only the failed DAC is switched.

Hot Standby: No Tributary Protection

- This only applies to the IDU 20x when configured for Hot Standby: No Tributary Protection, which is required for capacities above 20xE1 / 16xDS1. For more information, refer to Additional Procedures for IDU 20x on page 8-20.

In protected mode the DAC/IDUs are configured as primary and secondary. The primary is the default DAC/IDU for online Rx and Tx.

- For a Node the protection DAC switching operates independently for Rx and Tx, meaning it is possible for one of the DACs to be the online Tx, and the other online Rx. The exception is DAC 155oM; when a switch event occurs both Rx and Tx are simultaneously transferred to the standby DAC 155oM.
- For a Terminal the DAC Tx and Rx online functions follow the IDU Tx and Rx online status. The primary-designated IDU is default online for Tx and Rx
  - In the event of an IDU Tx switch, Rx online is also switched such that Tx and Rx online are with the same IDU.
  - In the event of an IDU Rx online switch, IDU Tx is not switched, meaning one IDU is online Tx, and the other online Rx.

When a DAC/trib switching event occurs, all Tx and/or Rx tributaries are switched to the protection partner.

Ethernet Traffic Protection

9500 MXC supports protection for Ethernet traffic using one or more of the following mechanisms:

- **Protected wireless links**. Ethernet and/or TDM data is transported using the 9500 MXC Node for hot standby, diversity or Super PDH ring links.
- **RSTP protection**. 9500 MXC links are configured point-to-point in a ring or mesh topology, and an RSTP switch is used at the link nodes to provide the Ethernet spanning tree protection mechanism.
  - DAC GE includes an RSTP (RWPR ^{TM}) switch. DAC ES does not.
  - Both DAC GE and DAC ES can be operated with an external RSTP switch.

- **Link aggregation**. Two or more co-path 9500 MXC links are configured for L2 (layer 2) or L1(layer 1) link aggregation. If one of the links fails, its traffic is raised on the remaining link, or links. Providing there is sufficient bandwidth all traffic will continue to get through; otherwise, with suitable priority settings, all high priority traffic will continue to get through.
  - L2 and L1 link aggregation is supported on the INUs. L2 aggregation uses the 802.3ad protocol installed in the DAC GE card. L1 aggregation uses the INU backplane bus to evenly split traffic over two links. L2 aggregation can be used across multiple link paths / INUs; L1 aggregation applies to a maximum of two links using one INU.
  - From one INU, a 300 Mbps Ethernet connection can be carried as two parallel-path 150 Mbps links on one 28 or 30 MHz channel using CCDP (Co-channel Dual Polarized) RAC 40 links. L2 or L1 aggregation is used.
  - Using three INUs, each with a DAC GE, a 900 Mbps Ethernet connection can be carried as three parallel-path 300 Mbps links. Requires L2 aggregation.
- **Interface protection**. In the three protection mechanisms described above, the Ethernet interface is not protected. Where users require a *protection for the path and Ethernet interface* the options are:
  - **Parallel-path operation**: Two links are configured for same-path 1+0 operation to provide two independent DAC GE or DAC ES connections. An external switch is used to provide an L2 link-aggregated customer interface, with a capacity that is sum of the capacities provided by each link. In effect the external switch provides the redundant path mechanism; 9500 MXC link protection options are not used.

    For 9500 MXC Node, the links can be operated in CCDP mode so that both links operate in the same radio channel.
  - **Split-path operation**: Using 9500 MXC Node, a 1+1 protected link (hot-standby or diversity) is configured and its circuit capacity split between two separate DAC GE or DAC ES cards. For example, on a 200 Mbps protected link, 100 Mbps is mapped to one DAC GE and 100 Mbps to the other. An external switch is used to provide a single L2 link-aggregated customer interface. In effect 9500 MXC link protection protects the radio path and equipment, and the external switch provides the redundancy mechanism for the DAC GE or DAC ES cards.

Note that where an industry-standard external switch is used to provide L2 link aggregation (redundancy), it will not be 1+1 protected. Full 1+1 protection of an Ethernet interface requires speclialised equipment.

DAC 16x, DAC 4x and IDU E1/DS1Trib Configuration

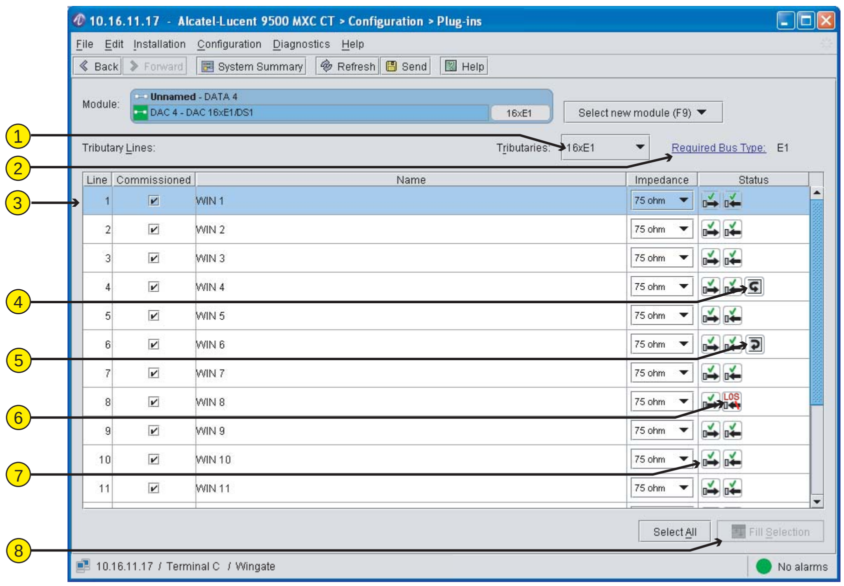
For **9500 MXC Node**, this section describes DATA > DAC 16x and DAC 4x tributary configuration.

For **9500 MXC Terminal**, this section describes DATA > DAC E1/DS1 tributary configuration. Functionality is identical to DAC 16x or DAC 4x.

DAC 16x and DAC 4x Screen

Figure 7-7 shows a typical DAC 16x screen.

Figure 7-7. Typical DAC 16x Plug-in



Item	Description
1	Select E1 or DS1.
2	Link to circuits screen to select backplane bus type. Bus type must be set to match the E1 or DS1 selection.
3	Tributary Lines user-defined entries: • Commissioned. Configured tribs should be ticked as commissioned. When commissioned, LOS alarms are raised if LOS is detected, and AIS alarms are raised if AIS is detected. • Name. Each trib can be individually named/identified. • Impedance. Select 75 ohm unbalanced or 120 ohm balanced.
4	Icon indicates an active line-facing loopback.
5	Icon indicates an active radio-facing loopback.
6	Icon indicates a trib LOS alarm - no input signal.

Item	Description
7	Icons indicate trib in/out OK.
8	Fill Selection sets all selected (high-lighted) tribs to the same setting as the top-most selected trib.

Procedure for DAC 16x, DAC 4x or IDU Tributary Configuration

Figure 6-5 shows a typical DAC Tributary Lines screen for a DAC 16x (16xE1 or 16xDS1), which for the shown E1 setting provides a view/change capability by line for commissioned/uncommissioned, tributary name, tributary impedance/encoding and tributary status.

To configure E1/DS1 tributaries:

1. From the Plug-ins screen, select the required module.

9500 MXC Node	9500 MXC Terminal
Click on the required DAC to bring up its Tributary Lines screen.	Click on the DAC module to bring up its Tributary Lines screen.

2. Select the required Tributary Type, E1 or DS1.
3. Check/set Required Bus Type.When changing a tributary type, the backplane bus must be set to match the selection. Reset using the Bus Configuration selector in the Circuits screen; click Required Bus Type to go directly to the Circuits screen. If not set correctly, the Required Bus Type displays a warning icon.

When entering data in the Tributary Lines field (steps 3 to 6 below) the Select All and Fill Selection tabs can be used to quickly populate lines with identical settings.

Where all tribs require the same settings, complete data entry for the first line then click Select All to highlight all trib lines, followed by Fill Selection.

Alternatively use standard Windows procedures (Ctrl+Click, Shift+Click or drag) to highlight just the lines required, then click Fill Selection.

Fill Selection populates all highlighted lines with data from the top-most highlighted line.

4. Click (tick) Commissioned for the traffic-carrying tribs.

   A commissioned selection supports alarm conditions for the unexpected loss or presence of traffic:

   - For unprotected DACs a commissioned selection has no effect on traffic.

- For protected DACs LOS is a switching condition.

Trib uncommissioned	Trib Commissioned
• LOS alarms are suppressed. • AIS alarms are suppressed. • Received traffic causes an uncommissioned traffic alarm.	• LOS alarms are raised if LOS is detected. Front panel Status LED indicates red for an LOS alarm. • AIS alarms are raised if AIS is detected.

For protected DACs and IDUs LOS on any trib interface is a switching condition. Ensure all traffic-carrying tribs are commissioned (commissioned tick-box for relevant trib(s) is ticked).

So that invalid alarms are not raised, ensure all tribs not carrying traffic are not commissioned (not ticked).

5. To enter a tributary name by clicking in the Name field and typing. Entering a name is optional.

   Names entered are also displayed in the System/Controls screen for the same DAC/Tributary.

It is recommended the trib name has the same name as its circuit, which is entered in the Circuits screen, or include a reference to it in the circuit name, so there is an easy association of trib and circuit names when setting a Circuit Loopback for a trib BER test.

6. Select the required tributary impedance/encoding.
   - For an E1 Tributary Type selection, the impedance options are 75 ohm unbalanced or 120 ohms balanced.
   - For a DS1 Tributary Type selection options are presented for encoding and tributary line length. The encoding options are AMI or B8ZS. Length is entered in whole feet, up to a 655 ft maximum. Line impedance is fixed at 100 ohms balanced.

     An AMI or B8ZS selection is fixed for tribs 1-8 and separately for tribs 9-16, which is NOT currently indicated in CT (CT allows AMI or B8ZS selection on a trib-by-trib basis). Tribs 1-8 must all be set for AMI or B8ZS. Similarly, tribs 9-16 must all be set for AMI or B8ZS.
7. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.
8. Commit the configuration by clicking **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic, Volume IV, Chapter 9.

DAC 3xE3 / DS3M Configuration

DAC 3xE3/DS3M supports multiple operational modes. It may be configured as:

- A 3xE3/DS3 trib card.
- An E13 or M13 multiplexer to multiplex 2xE3 or 2xDS3 customer interfaces to/from an E1/DS1 bus backplane.
- Transparent E3 to multiplex 2x34 Mbps customer interfaces to/from an E1 bus backplane.

It has three Tx/Rx interfaces on paired, unbalanced 75 ohm mini-BNC female connectors. All three are active for a 3xE3/DS3 configuration. For the E13, M13 and Transparent E3 modes, only Tx/Rx 1 and Tx/Rx 2 are active.

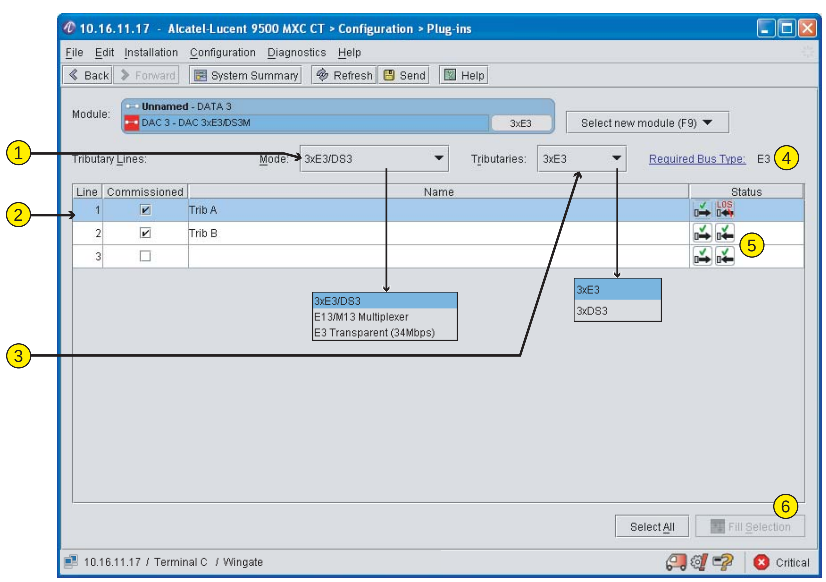
For more information on functions, refer to DAC 3xE3/DS3M on page 3-29, Volume II, Chapter 3.

For protected DACs LOS on any trib interface is a switching condition. Ensure all traffic-carrying tribs are commissioned (commissioned tick-box for relevant trib(s) is ticked). Equally, so that invalid alarms are not raised, ensure that all tribs not carrying traffic are not commissioned (not ticked).

DAC 3xE3 / DS3M Screen

Figure 7-8 shows a typical Plug-ins screen.

Figure 7-8. DAC 3xE3/DS3M Screen



Item	Description
1	Select operational mode: 3xE3/DS3, E13/M13 Multiplexer, or E3 Transparent.
2	Tributary Lines provides user-defined entries for: • Commissioned. Configured tribs should be ticked as commissioned. When commissioned, LOS alarms are raised if LOS is detected. • Name. Each trib can be individually named/identified.
3	Select trib type for a 3xE3/DS3 operational mode.
4	Link to circuits screen to select backplane bus type.
5	Icons indicate trib in/out status. Mouse-over for tooltip support. The example screen shows an LOS alarm on Trib A.
6	Fill Selection sets all selected (high-lighted) tribs to the same setting as the top-most selected trib.

Procedures for DAC 3xE3/DS3M

1. From the Plug-ins screen, select the required module.
2. Select the required Mode: 3xE3/DS3, E13/M13 Multiplexer, or Transparent E3.

Procedure for 3xE3/DS3 Mode

Native E3 is not a supported RAC capacity (RAC 30v3, RAC 3X, RAC 40). Where E3 tribs are required, select the E13 multiplexer mode.

1. Select the 3xE3/DS3 mode and Tributary type (DS3).
2. Check/set Required Bus Type (DS3). When changing a tributary type, the backplane bus must be set to match the selection. Reset using the Bus Configuration selector in the Circuits screen; click Required Bus Type to go directly to the Circuits screen. If not set correctly, the Required Bus Type displays a warning.
3. Click (tick) Commissioned for the traffic-carrying tribs.
   - Traffic-carrying tribs must be commissioned.
   - A commissioned trib displays an LOS alarm when input traffic is lost (no valid E3 or DS3 connection).

- For protected DACs LOS is a switching condition.

Trib Uncommissioned	Trib Commissioned
• LOS alarms are suppressed. • Received traffic causes an uncommissioned traffic alarm.	• Traffic is enabled. • LOS alarms are raised if LOS is detected. Front panel Status LED indicates red for an LOS alarm.

For protected DACs, LOS on any trib interface is a switching condition. Ensure all traffic-carrying tribs are commissioned (commissioned tick-box for relevant trib(s) is ticked).

So that invalid alarms are not raised, ensure that tribs not carrying traffic are not commissioned (not ticked).

4. Enter a tributary name by clicking in the **Name** field and typing (optional).

   Trib names entered in this column are also displayed in the System/Controls screen for the same DAC.

5. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.

6. Commit the configuration by clicking **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic on page 9-10, Volume IV, Chapter 9.

Procedure for E13/M13 Multiplexer Mode

1. Select the E13/M13 mode.

2. Check/set the Required Bus Type. For the E13 selection an E1 backplane is required. DS1 is required for M13. If not set correctly, Required Bus Type displays a warning icon. To reset, click Required Bus Type to go straight to the Circuits screen, and make the change in the Bus Configuration selector.

3. Click (tick) Commissioned for the traffic-carrying tribs.

- Traffic-carrying tribs must be commissioned.
- A commissioned trib displays an LOS alarm when input traffic is lost (no valid E3 or DS3 connection).
- For protected DACs, LOS is a switching condition.

Trib Uncommissioned	Trib Commissioned
• Traffic is not enabled. • LOS alarms are suppressed. • Received traffic causes an uncommissioned traffic alarm.	• Traffic is enabled. • LOS alarms are raised if LOS is detected. Front panel Status LED indicates red for an LOS alarm.

4. Enter a tributary name by clicking in the Name field and typing (optional).

   Trib names entered in this column are also displayed in the System/Controls screen for the DAC.

5. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.

6. Commit the configuration by clicking **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic on page 9-10, Volume IV, Chapter 9.

Procedure for 34 Mbps Transparent

1. Select the E3 Transparent mode.

2. Check/set the Required Bus Type. For the E3 Transparent mode an E1 backplane bus is required. If not set correctly, the Required Bus Type displays a warning icon. To reset, click on Required Bus Type to go straight to the Circuits screen, and make the change in the Bus Configuration selector.

3. Click (tick) Commissioned for the traffic-carrying tribs.

   • Traffic-carrying tribs must be commissioned.

   • A commissioned trib displays an LOS alarm when input traffic is lost (no valid E3 or DS3 connection).

   • For protected DACs LOS is a switching condition

Trib Uncommissioned	Trib Commissioned
• Traffic is not enabled. • LOS alarms are suppressed. • Received traffic causes an uncommissioned traffic alarm.	• Traffic is enabled. • LOS alarms are raised if LOS is detected. Front panel Status LED indicates red for an LOS alarm.

4. Enter a tributary name by clicking in the Name field and typing (optional).

   Trib names entered in this column are also displayed in the System Controls screen for the same DAC.

5. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.

6. Commit the configuration by clicking **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic on page 9-10, Volume IV, Chapter 9.

DAC 155o, 2x155o and 2x155e Configuration

For a **9500 MXC Node**, this section describes tributary configuration for:

- **DAC 155o and 2x155o.** Provides STM1/OC3 single mode SC optical interfaces; one for the 155o, two for the 2x155o. The receive-level range is -31 dBm (max sensitivity) to -7 dBm (max input power). The transmit-level range is Min -15 dBm to Max -8 dBm.
- **DAC 2x155e.** Provides two G.703 electrical STM1, 75 ohm unbalanced, BNC interfaces.

For **9500 MXC IDU 155o** this section describes configuration of its STM1/OC3 single mode SC optical interface. The receive-level range is -31 dBm (max sensitivity) to -7 dBm (max input power). The transmit-level range is Min -15 dBm to Max -8 dBm (as for DAC 155o).

Before connecting fiber-optic cables, check optical levels at both ends to ensure compatibility. An under or over-driven optical receiver will cause bit errors. If necessary use a fiber-optic power meter to measure levels.

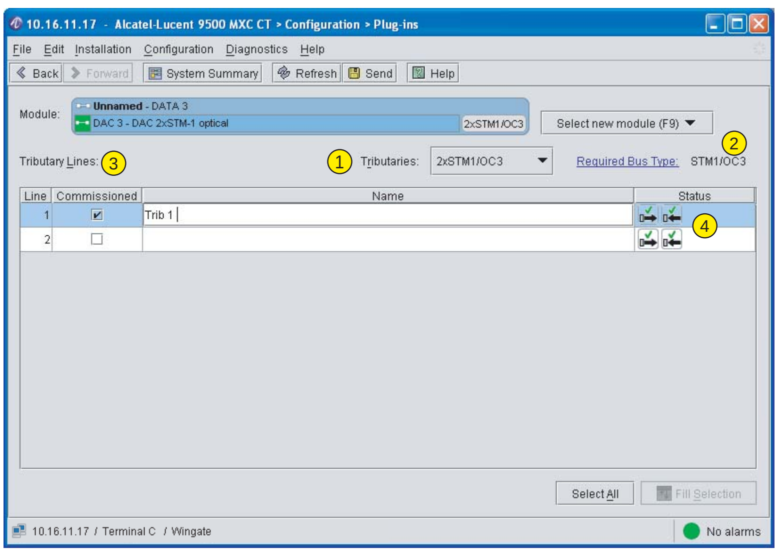
Attenuator cables are available as optional accessories.

DAC 1x155o, 2x155o and 2x155e Screens

Figure 7-9 shows a typical DAC 2x155o Plug-ins screen.

- The 1x155o screen is identical except for a single trib line.
- The 2x155e screen is identical.

Figure 7-9. Typical DAC 2x155o Plug-ins Screen



Item	Description
1	Tributary type is fixed for STM1/OC3.
2	Link to circuits screen to select backplane bus. Bus type must be set to STM1.
3	Tributary Lines. User-defined entries for: • Commissioned. Configured tribs must be ticked as commissioned. When commissioned LOS alarms are raised if LOS is detected. • Name. Each trib can be individually named/identified.
4	Icons indicate trib in/out status. Mouse-over for tooltip support.

Procedure for Configuring DAC 1x155o, 2x155o or 2x155e

1. From the Plug-ins screen, select the required module.
   - For the optical DACs the tributary type is fixed for STM1/OC3.
   - For the 2x155e DAC the tributary is fixed for STM1.
2. Check/set the Required Bus Type. An STM1 backplane bus is required. If not set correctly, the Required Bus Type displays a warning icon. To reset, click on Required Bus Type to go straight to the Circuits screen, and make the change in the Bus Configuration selector.
3. Click (tick) Commissioned for the traffic-carrying tribs.
   - Traffic-carrying tribs must be commissioned.
   - A commissioned trib displays an LOS alarm when input traffic is lost (no valid E3 or DS3 connection).
   - For protected DACs LOS is a switching condition.

If a Trib is Uncommissioned...	If a Trib is Commissioned...
• LOS alarms are suppressed. • The interface is disabled (Tx to customer is disabled). • Received traffic causes an uncommissioned traffic alarm.	• Trib is enabled. • LOS alarms are raised if LOS is detected. Front panel Status LED indicates red for an LOS alarm.

For protected DACs and IDUs, LOS on any trib interface is a switching condition.

Ensure all traffic-carrying tribs are commissioned (commissioned tick-box for relevant trib(s) is ticked).

So that invalid alarms are not raised, ensure that all tribs not carrying traffic are not commissioned (not ticked).

4. Enter a tributary name by clicking in the Name field and typing (optional).

   Trib names entered in this column are also displayed in the System Controls screen for the same DAC.

5. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is 'unnamed'.

6. Commit the configuration by clicking **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic, Volume IV, Chapter 9.

DAC 155oM Configuration

The DAC 155oM multiplexes a 155 Mbps STM1/OC3 optical line interface to/from a 63xE1 or 84xDS1 backplane bus connection.

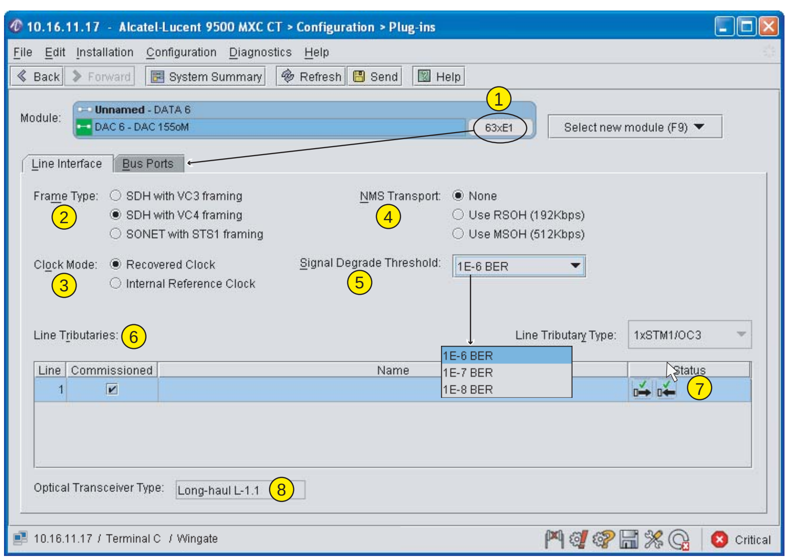
If NMS transport is required, the DAC 155oM must be installed only in slots 1 to 6, of the INUe. This does not apply to the INU; any option slot may be used.

DAC 155oM Screens

Figure 7-10 shows a typical Line Interface screen for the DAC 155oM.

Figure 7-11 on page 7-36 shows the corresponding Backplane Ports screen.

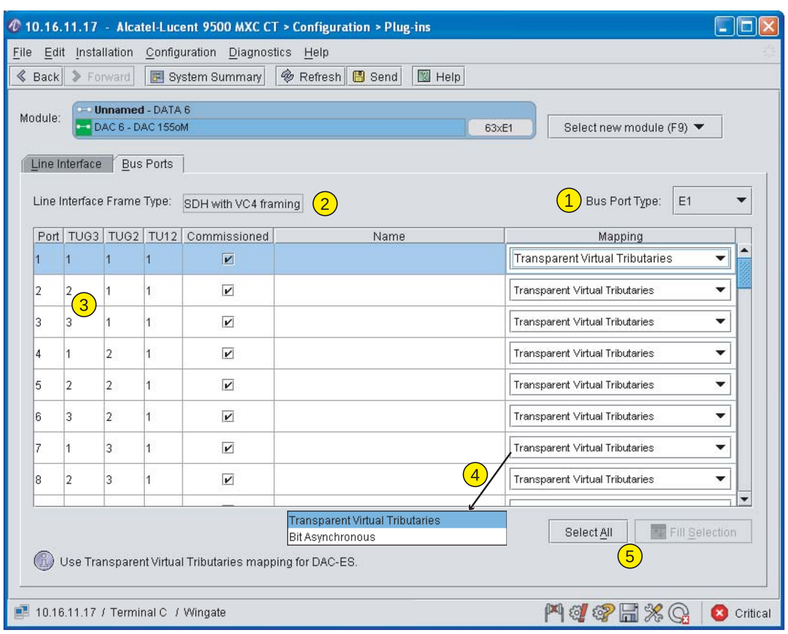
Figure 7-10. Typical DAC 155oM Line Interface Screen



Item	Description
1	Module graphic shows an E1 backplane bus selection (STM1/OC3 trib multiplexed to/from a 63xE1 backplane bus). Go to Bus Ports to select between 63xE1 or 84xDS1 bus (multiplexer) operation.
2	Select required frame type. SDH operation supports VC3 or VC4 framing options. SONET operation uses STS1 framing.

Item	Description
3	Select clock mode: • Recovered takes the clock from the incoming STM1/OC3 signal (loop timing). Used for most applications. • Internal selects an internally generated clock source.
4	NMS transport. Select between None, RSOH or MSOH. When a DAC 155oM link is installed in a 9500 MXC SDH ring, MSOH would normally be used.
5	Signal degrade threshold. Select between the BER default of 10^{-6}, and options for 10^{-7} or 10^{-8}. When the threshold is exceeded an alarm is raised in the Events Browser and Alarms screens.
6	Tributary Lines. User-defined entries for: • Commissioned. The trib must be ticked as commissioned for it to carry traffic. When commissioned an LOS alarm is raised if LOS is detected, and an AIS alarm is raised if AIS is detected. • Name. The trib can be named/identified.
7	Icons indicate trib in/out status. Mouse-over for tooltip support.
8	Indicates the optical line transceiver type installed, short or long range.

Figure 7-11. Typical DAC 155oM Bus Ports Screen



Item	Description
1	Select between E1 or DS1 backplane mapping. The same selection must also be set as the backplane bus type in the Circuits screen.

Item	Description

2	Ports field. Scroll down to view all ports for:
	• Tributary mapping. See item 3.
	• Commissioned. Configured tribs must be ticked as commissioned so that:
	  • AIS, RDI, LOP, LOM, RPSLM alarms are detected, and
	  • The signal label identifier in the VT/VC overhead is set. (Set to bit synchronous or byte synchronous depending on the configuration).
	• Name. The bus ports can be individually named/identified.

3	For an SDH selection each port (Bus trib) is referenced to its TU-12 (VT-2) tributary mapping within the STM1frame. For a SONET selection each port (Bus trib) is referenced to its TU-11 (VT-1.5) tributary mapping within the OC3 frame. This data is applicable when BER testing a PDH trib on an SDH/SONET signal using a PDH/SDH test set. The port numbering used conforms to G.707. The numbering format is based on the mux heirachy
4	Click to select Bit Asynchronous or Transparent Virtual Tribs (TVT). TVT required where the DAC 155oM is used to transport DAC ES or DAC GE Ethernet traffic (Ethernet over NxE1 or NxDS1).
5	Select All, selects (highlights) all bus ports. Fill Selection sets all selected (highlighted) ports to the same setting as the top-most selected bus port.

Procedure for DAC 155oM Configuration

Before You Begin

There are two screens involved in configuring the DAC 155oM:

- Line Interface
- Bus Ports

Figure 7-10 on page 7-35 shows a typical Line Interface screen for a DAC 155oM. Depending on the E1 or DS1 selection made in the Backplane Ports screen, the Plug-in identifier displays 63xE1 or 84xDS1 respectively, 63xE1 is default.

Figure 7-11 on page 7-36 shows a typical DAC 155oM Bus Ports screen.

If the DAC 155oM is to be used to close a PDH ring protected network, the protection configuration must be established first. Refer to Protection on page 8-1.

Procedure

To configure the DAC 155oM:

1. In the plug-ins screen select the required DAC 155oM from the New Module menu. Its Line Interface screen default indicates a 63xE1multiplexed tributary.
   - If an 84xDS1 tributary is required, click the Bus Ports tab followed by section of DS1 under Bus Port Type.
2. Within the Line Interface screen select the Frame Type.
   - **SDH with VC3 framing** is likely to be used where interoperability between SDH devices deployed in configurations such as terminal, add/drop, repeater, and cross-connect are required. Three VC3s are mapped into an STM1 signal, each containing up to 21xVC12. In turn each VC12 contains 1xE1.
   - **SDH with VC4 framing** is used to directly map up to 63xVC12 into an STM1 signal. In turn each VC12 contains 1xE1. VC4 framing simplifies configuration of Terminal and Regenerator SDH applications, though may reduce interoperability with legacy SDH equipment. VC4 framing would normally be used where the DAC155oM is used to fiber-close a super PDH Ring.
   - **SONET with STS1 framing** maps three STS1 signals into a 155 Mbps STS3 signal. Each STS1 contains up to 28xVT-1.5, with each VT-1.5 containing 1xDS1.
3. Select Clock Mode:
   - **Recovered Clock:** Selects the clock source from the incoming STM1/OC3 signal (loop timing). Used for most applications.
   - **Internal Reference Clock:** Selects the internally generated clock source. Used where the DAC 155oM is used to close a Super PDH ring. In this configuration both ends may be set to Internal reference, or one may be set to Internal Reference and the other to Recovered
4. Use the Line Tributaries field to enter commissioned/uncommissioned, port name, and signal label data for the STM1/OC3 tributary.
   - Use the commissioned tick-box to set tributary port status:

Where the tributary is uncommissioned	Where the tributary is commissioned
• LOS alarms are suppressed • AIS alarms are suppressed • At the optical interfaces the output is disabled • Receive traffic will cause an ‘uncommissioned traffic alarm’ in Events Browser and Alarms screens	• Trib traffic is enabled • LOS alarm is raised if LOS is detected • AIS alarm is raised if AIS is detected

For protected DAC 155oMs, LOS on the line interface is a switching condition.

Ensure the line trib is commissioned (commissioned tick-box is ticked).

- In the tributary name field enter a tributary name/identifier.

  The name entered in this field is also displayed in the System/Controls screen for the same DAC.

- The Status icons provide a direct indication of any tributary input or output problems. The icons shown in the Figure 7-10 example indicate no problems exist.

- The tributary port is provided via a plug-in single-mode LC transceiver sub-assembly. Two different sub-assemblies are available; short range, and long range. Both meet Class 1 eye safety.

  For the preferred APAC Opto^{tm} transceivers:

  Short range specifies a minimum input power of -34 dBm (max. sensitivity), and a maximum input power of 0 dBm (saturation). The transmit level limits are: min. -15 dBm, max. -8 dBm. Center Tx wavelength is between 1261 and 1360 nm (typically 1310 nm).

  Long range specifies a minimum input power of -35 dBm (max. sensitivity), and a maximum input power of 0 dBm (saturation). The transmit level limits are: min. -5 dBm, max. 0 dBm. Center transmit wavelength is between 1260 and 1355 nm (typically 1310 nm).

5. Select NMS Transport.

   When the DAC 155oM is used to close a super PDH ring with fiber, the NMS must be mapped into the SONET/SDH frame. In most instances the higher capacity MSOH should be used, as the 9500 MXC network is the source and the sink of the NMS signal (there is no competing use of the overhead).

   When the DAC 155oM is used at the edge of a network (connecting a 9500 MXC PDH network to an SDH trunk or ring) the network operator may wish to map the NMS into the SONET/SDH frame to carry it to the ultimate destination of this tributary, but in doing so the overhead bits available to carry this overhead, D1-D3 (RSOH) or D4-D12 (MSOH), must first be considered, as the overhead may already be in use for other purposes. It must also be understood that to enable extraction of the NMS information, the terminating equipment at the ultimate destination of the NMS must be 9500 MXC.

   The selection options are:

- **None**. No provision for 9500 MXC NMS transport is provided on the optical interface.

- **Use RSOH**. 9500 MXC NMS data is assigned to the Regenerator Section Overhead.

- **Use MSOH**. 9500 MXC MMS data is assigned to the Multiplexer Section Overhead.

6. Select Signal Degrade Threshold to enter the required BER option.

   When the threshold is exceeded an alarm is raised in the Events Browser and Alarms screens.

7. Go to the Bus Ports screen.

8. Select Bus Port Type. Options of E1 or DS1 are provided:

- When E1 is selected (default), the DAC 155oM is configured as a 1xSTM1-to-63xE1 multiplexer.

- When DS1 is selected it is configured as an OC3-to-84xDS1 multiplexer.

   The selection is confirmed in both the Line Interface and Bus Ports screens.

9. Use the Bus Ports field to enter data for commissioned/uncommissioned, port name, and signal label. The field also indicates the tributary mapping used for an SDH or SONET selection.

When entering data in the Bus Ports field the Select All and Fill Selection tabs can be used to quickly populate lines with identical settings.

Where all ports require the same settings, first complete data entry for the first line, then click Select All to highlight all port lines, followed by Fill Selection.

Alternatively use standard Windows procedures (Ctrl+Click, Shift+Click or drag) to highlight just the lines required, then click Fill Selection.

Fill Selection populates all highlighted lines with data from the top-most highlighted line.

- Use the commissioned tick-box to set port status:

If a port is uncommissioned	If a port is commissioned
• AIS, RDI, LOP, LOM, RPSLM alarms are suppressed. • The signal label identifier in the VT/VC overhead will bet set to unequipped.	• AIS, RDI, LOP, LOM, RPSLM alarms are detected. • The signal label identifier in the VT/VC overhead will be set to bit synchronous or byte synchronous depending on the configuration.

- Enter a port name/identifier in the name field (optional).

  The name entered in this field is also displayed in the System/Controls > Bus Ports screen for the same DAC.
- Under Signal Label, use the sub-menu to select Bit asynchronous or Transparent Virtual Tributary:
  - Bit asynchronous is used for all traffic except Ethernet. Asynchronous mapping means the E1/DS1 signals are not (do not need to be) synchronized to the SDH signal. It imposes no signal structure requirements so E1s or DS1s do not need to be framed.
  - Transparent Virtual Tributary (TVT) must be selected on tribs used to transport Ethernet (to maintain the byte boundaries used with Ethernet on the backplane bus). TVT must also be selected at the remote end termination. While TVT uses the same 010 value as bit asynchronous (V5 bits 5-7), it is a separately identified mode on compliant muxes.
  - Where Ethernet data is transported over a 9500 MXC PDH network to an SDH core and the SDH core network muxes do not support TVT (transparent mapping), consideration should be given to using an Ethernet interface between the 9500 MXC and SDH networks (9500 MXC DAC ES to SDH mux Ethernet LAN card).

- The TVT mode is not compatible with byte synchronous mapping, though if a byte synchronous payload is injected into the 9500 MXC network through a DAC 155oM, it should be configured for TVT to try to preserve the byte alignment. Note however that if this payload is delivered through a DAC 16x or DAC 4x it will lose its byte boundary. (Byte synchronous mapping synchronizes both rate and framing of an E1/DS1 signal to the SDH signal, meaning G.704 framing is required on the E1/DS1 signals).

10. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.
11. To commit the configuration, click **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic, Volume IV, Chapter 9.

DAC ES and IDU ES Configuration

This section applies to the DAC ES and to configuration of the Ethernet module of the IDU ES. Their Ethernet ‘engines’ are identical.

Both support 10/100Base-T traffic for transparent (broadcast), mixed, or VLAN operation.

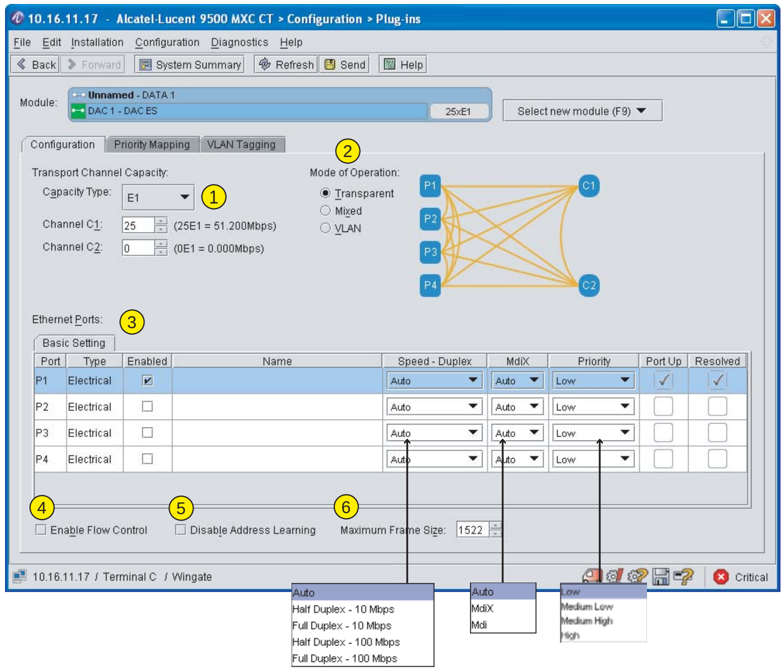
- DAC ES traffic can be directed over Link (RAC), Ring (RAC), or Data (DAC 155oM) links.
- IDU ES traffic can only be carried over the radio Link.

For IDU ES NxE1/DS1 trib configuration, refer to DAC 16x, DAC 4x and IDU E1/DS1Trib Configuration on page 7-26.

DAC ES Configuration Screen

Figure 7-12 shows a typical DAC ES Plug-ins screen. The same screen supports the Ethernet module in the IDU ES.

Figure 7-12. Typical DAC ES Configuration screen



Item	Description
1	Transport Channel Capacity: Select an E1 or DS1 channel type then one or both channels (C1 or C2) and the capacity per channel, where each E1 selection supports 2.048 Mbps, and each DS1 supports 1.544 Mbps.
2	Select mode of operation; Transparent, Mixed or VLAN.
3	Ethernet Ports - Basic Setting: • Ports. The four DAC ES ports P1 to P4 are individually configurable. • Type is fixed as Electrical. • Enabled. Click to enable required ports. A port must be enabled to allow traffic flow. • Name. Each port can be named/identified. Optional. • Duplex-Speed. Select auto-detect or a specific connection type from the drop-down menu. • MdiX. Select auto-detect or a specific cable type from the drop-down menu. • Priority. Select the required port priority from the drop-down menu. • Port Up. Indicates detection of a valid Ethernet connection. • Resolved. Indicates that the port connection has been resolved for an Auto Speed-Duplex selection.
4	Click to enable flow control (full duplex connections only).

Item	Description
5	Click Disable MAC address learning.
6	Set the maximum frame size. Setable range is 64 to 1536 bytes, but for any selection from 64 to 1518 bytes the maximum frame size is set at 1522 bytes. For a frame size selection above 1522 bytes, the maximum frame size is set at 1536 bytes.

Procedure for DAC ES and IDU ES Ethernet Configuration

Figure 7-12 shows a typical screen, which provides a view/change capability for operational mode, channel capacities, and port parameters.

The main window displays three option tabs:

- **Configuration**. This is the default window.
- **Priority Mapping**. Use to select the priority mode, priority level, and priority mapping.
- **VLAN Tagging**. Not applicable to DAC ES / IDU ES.

To configure Ethernet traffic:

1. From the Plug-Ins screen, click the Select New Module tab to view a menu of all plug-ins installed. Both the 9500 MXC Node (with DAC ES) and Terminal (IDU ES) identify the Fast Ethernet module function as DAC ES.
2. **Transport Channel Capacity:** Select the capacity required per link channel. Capacity options are displayed in multiple of 2 Mbps or 1.5 Mbps, depending on the setting of the backplane bus connection size in the Circuits screen. Capacity can be set using the scroll tabs, or direct-entered. Equivalent E1 or DS1 capacity is also indicated.

   Nx2 Mbps selection: DAC ES

   - The maximum C1 *or* C2 capacity is 98 Mbps.
   - Both C1 and C2 can be configured to their 98 Mbps maximum.
   - The C1 *and* C2 maximums can be used to support ring operation up to 98 Mbps west, and 98 Mbps east. They can also be used to support separate co-path 98 Mbps links.
   - C1 *and* C2 can be configured for same-link operation:

     RAC 30 or RAC 40 support link capacities to 150 Mbps, which means the sum of the C1 and C2 capacities cannot exceed this figure.

     RAC 3X supports link capacities to 200 Mbps, which means the C1 and C2 capacities can each be at their 98 Mbps maximums for a total capacity of 196 Mbps.

   Nx2 Mbps selection: IDU ES

   - The maximum C1 *or* C2 capacity is 98 Mbps.
   - C1 *and* C2 can be configured for same-link operation up to their 98 Mbps maximums for a total capacity of 196 Mbps.

   Nx1.5 Mbps selection: DAC ES

   - The maximum C1 *or* C2 capacity is 100 Mbps.
   - The sum of the C1 and C2 capacities cannot exceed 173 Mbps[2].

- For ring operation the maximum supported by a single DAC ES using C1 *and* C2 settings is 86 Mbps west and 86 Mbps east (or any other east/west C1 and C2 capacity combination up to a total of 173 Mbps).
- C1 *and* C2 can be configured for same-link operation:

  With a RAC 30, RAC 3X or RAC 40, the sum of the C1 and C2 capacities cannot exceed the 100xDS1 / 154 Mbps RAC/Link maximums.

NxDS1 selection: IDU ES

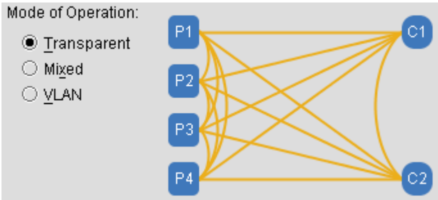
- The maximum C1 *or* C2 capacity is 100 Mbps / 65xDS1.
- C1 *and* C2 can both be configured for same-link operation up to total combined capacity of 196 Mbps / 127xDS1.

The capacity(s) must be set within the maximum for the link (RAC/ Licence) capacity, and take into account any capacity to be assigned to parallel NxE1 (or NxDS1) channels over the same path.

3. **Operational Mode**: Select Transparent, Mixed or VLAN mode of operation for the Ethernet bridging-switching function.

   - **Transparent** is the default, broadcast mode; all ports and channels are interconnected. It supports four customer connections (Ports 1 to 4) with bridging to two separate channels (C1 *or* C2). Where a single path (link) is used select only C1 (or C2) to avoid a traffic-loop. On the DAC ES C1 *and* C2 may be used to support two star or ring links where each channel is assigned to its own RAC (or RAC and DAC 155oM). It is particularly applicable to ring networks using 9500 MXC ring-wrap protection, with one channel assigned to the east, the other to the west.

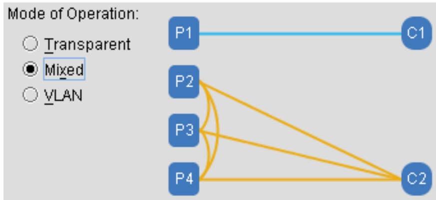
Figure 7-13. Transparent Mode



   - **Mixed** Mode provides a two-channel VLAN/broadcast solution where VLAN P1-C1 provides dedicated transport for high priority, Port 1 traffic. A second transparent, broadcast mode connection is provided with Ports 1, 2 and 3 and C2 interconnected. The two channels can be assigned on the same link or used to support separate links. Mixed Mode is particularly applicable to east and west links in an IP ring where alternate-path protection is provided by an external RSTP switch.

[2] *DAC ES supports a maximum 112 circuit connections to the backplane bus (2 Mbps or 1.5 Mbps circuits), which for 1.5 Mbps / DS1 operation means that while one channel can be set for its maximum 100 Mbps / 65xDS1, only 173 / 112xDS1 can be shared between channels when both C1 and C2 are selected.*

Figure 7-14. Mixed Mode

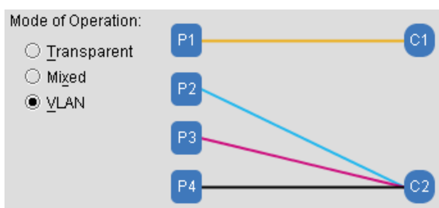


Transparent mode is used where 9500 MXC ring-wrapping provides the protection mechanism.

Mixed mode is used where an external RSTP switch provides the protection mechanism.

- **VLAN** Mode supports four separate LANs - each is held separate from the other. VLAN 1 is the same as for Mixed Mode, where dedicated transport is provided for high priority Port 1 traffic. For Ports 2, 3 and 4, three separate VLANs (VLANs 2, 3 and 4) are supported over C2, with internal VLAN tagging of the packets ensuring correct end-to-end matching of ports over the link. The two channels would normally be assigned on the same link, but can be used to support separate links.

Figure 7-15. VLAN Mode



4. **Basic Port Settings**:

4.1 **Enabled**: Click to enable or disable the required ports. A port must be enabled to allow traffic flow. This enabling/disabling function does not affect the Port Up and Resolved status indications.

4.2 **Name**: Enter the port name or other relevant port data.

4.3 **Duplex - Speed**: Click to view and select auto-detect or a specified connection type and speed. The normal setting is Auto, where the auto negotiation feature senses and sets the speed (10 or 100Base-T) and connection for half or full duplex operation. The fixed options would be used in instances where auto negotiation fails to provide the expected result or where a fixed setting is preferred:

- Auto negotiation is not 100% reliable, particularly so where the connected equipment is using an older auto-sensing mechanism.
- Links with a duplex mismatch will operate, but will generate a large number of errors and will slow throughput.
- Generally, for auto negotiation to work, both interfaces must be set to auto for speed and duplex.

- *Full-duplex* can only be achieved if *both* interfaces are either set for auto-negotiation *or* are manually configured to use full duplex.
- Full duplex will not operate via a hub/repeater. These are half duplex devices.
- If auto-negotiation is enabled on only one side of the link, it will *always* default to half-duplex, regardless of what the other side of the link is forced to.
- If one side of a link is forced to full duplex and the other is set to auto-negotiation, a duplex mismatch will occur.
- You can force a new auto-negotiation by simply unplugging a host cable for 10 seconds.
- Most 10 Mb interfaces can run only in 10 Mb half-duplex mode.
- Most 10/100 Mb interfaces support auto-negotiation and most 10/100 Mb interfaces with RJ-45 twisted-pair can run in full-duplex mode.
- Any network connected via an AUI port (Attachment Unit Interface), such as on an external Ethernet transceiver, can run only in 10Mb half-duplex mode.

4.4 **Mdi/MdiX**: Sets a port connection to match the required send/receive cable terminations from the far-end port. Click to view and select from Auto, Mdi, or MdiX. The normal setting is Auto, where the auto negotiation protocol senses and sets the port connection to Mdi or MdiX (straight or cross-over respectively). Most RJ-45 Ethernet cables are Mdi. Note that if a port at the far end of the cable is set for Auto, the local end can be set for Auto, Mdi, or MdiX, regardless of the cable type, straight or crossover. If the far end is set for Mdi, and a straight cable is used, MdiX or Auto must be selected on the local port. Similarly, if the far end port is set for MdiX and a straight cable is used, Mdi or Auto must be selected on the local terminal.

4.5 **Priority**: Sets the port priority. The options are high, medium high, medium low, and low. To change, select from the priority menu. Each port can be prioritized in this way.

- This prioritization only has relevance where two or more ports use a common channel, C1 or C2.
- Ports with a higher priority have their traffic accepted by the queue controller ahead of traffic from lower priority ports on a 8:4:2:1 weighted basis where, for example, 8 high priority packets will be sent for every one low priority packet. Refer to Step 10, Priority Mapping, for more information on traffic prioritization.
- Port Default must be selected in the Priority Mapping screen for this option. If any other option is selected, port priority is invalidated.

4.6 **Port Up**: A tick indicates detection of a valid Ethernet connection with valid Ethernet framing.

4.7 **Resolved**: A tick indicates that a port has been resolved for speed-duplex. This process only acts on data sensed from the locally connected equipment, it

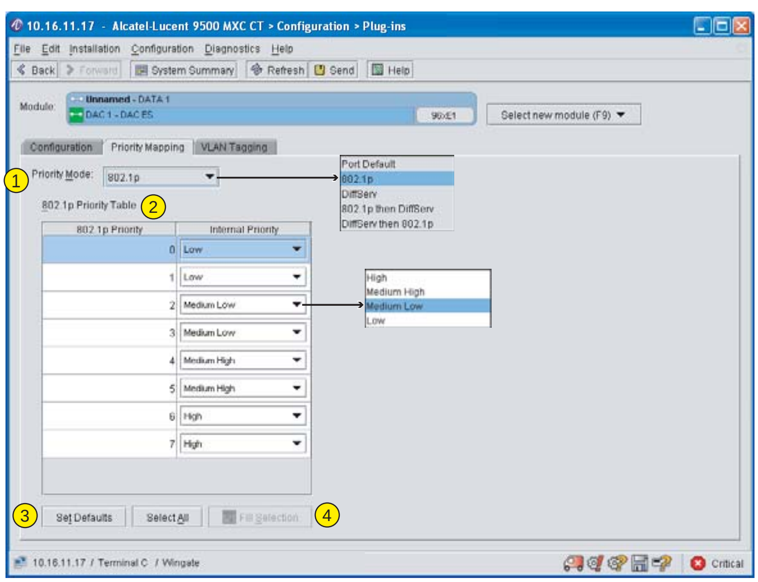
5. **Maximum Frame Size** sets the maximum frame size for the interface, which determines the largest datagram (packet) than can be transmitted without it being broken down into smaller units (fragmented)[3]. A setable range from 64 to 1536 bytes is indicated, but if the value selected is less than or equal to 1522, the maximum frame size is set to 1522, otherwise it is set to 1536. For a typical 1500 byte packet the frame size for an untagged frame is 1518 bytes. If the frame is VLAN tagged the frame size increases by four bytes to 1522. The default setting is 1522

[3] *The setting only supports this interface. Some other link/interface in the path may have a smaller MTU, at which point the datagram will be fragmented if its size is greater.*

bytes.

6. **Enable Flow Control**: Flow control is applicable to full-duplex links only. It is implemented by the IEEE 802.3x pause frame mechanism, which tells the remote node to stop or restart transmission to ensure that the amount of data in the receive buffer does not exceed a 'high water mark'.
   - The receiver signals to the transmitter to stop transmitting until sufficient data has been read from the buffer, triggered by a 'low water mark', at which point the receiver signals to the transmitter to resume transmission.
   - To be effective, flow control must be established from the originating source through to the end point, and vice versa, which means the equipment connected to the DAC ES / IDU ES ports and beyond must also be enabled for flow control.
7. **Address Learning**: Address Learning is default implemented to support efficient management of Ethernet traffic in multi-host situations. The option to disable Address Learning is used where the DAC ES connection is supported from an external switch, such as in a ring/mesh Ethernet network where protection is provided by an external RSTP switch. To avoid conflict between the self-learning functions within the DAC ES and external RSTP switches during path failure situations, the DAC ES capability must be disabled. Failure to do so means that in the event of an Ethernet path failure, and subsequent re-direction of traffic by the external switch to an alternate path, the DAC ES will inhibit re-direction of current/recent traffic until its address register matures and deletes unused/un-responsive destination addresses, which may take several minutes.
8. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is 'unnamed'.
9. **Priority Mapping**: Click the Priority Mapping tag to display the priority mode window. The default mode is Port Default. Click on the Priority Mode box to view and select from the mode menu. A mode selection applies to all ports. Refer to Figure 7-16.

Figure 7-16. DAC ES Priority Mapping Window



Item	Description
1	Priority Mode. Select from the drop-down menu.
2	Priority Table. Presents the priority mapping used to convert the 8 priority levels of 802.1p and the 64 levels of DiffServ to the 4 levels supported by the DAC ES priority stack: high, medium high, medium low, and low. The mapping shown is default mapping for 802.1p. To change mapping click and select from the Internal priority sub-menus.
3	Set Defaults returns priority mapping to its default settings.
4	Select All selects (highlights) all rows. Fill Selection sets all selected (highlighted) rows to the mapping set in the top-most row.

Priority Mode Options

- Port Default sets the queue controller priority on a port basis - it ignores any 802.1p VLAN priority tags or IP DiffServ priority values on incoming traffic. Port priority settings are made per-port in the Priority column in the Configuration window. Refer to Step 4.5.

  The settings support four-level port prioritization, which is weighed on a 8:4:2:1 basis whereby a port set for high priority has packets sent 2-for-1, 4-for-1, or 8-for-1 against the medium high, medium low, and low priority settings respectively. Compared to a fixed priority where all higher priority packets must be sent before others, the weighed solution guarantees that lower priority port queues do get some bandwidth.
- 802.1p provides prioritization based on the three-bit priority field of the 802.1p VLAN tag. Each of the possible eight tag priority values are mapped into a four-level (2-bit) priority level. Refer to Table 7-7.
- DiffServ provides prioritization based on the six bits of the IP packet DiffServ or Type of Service byte. Each of the possible 63 levels are mapped into a four-level (2-bit) priority level. Refer to Table 7-7.
- 802.1p then DiffServ provides prioritization based first on the 802.1p VLAN tag, and then on the DiffServ or Type of Service byte.
- DiffServ then 802.1p provides prioritization based first on the IP packet DiffServ or Type of Service byte, then on the 802.1p VLAN tag.

Table 7-7. Priority Mapping table

Priority Level	VLAN 802.1p	DiffServ Value
High	6, 7	48 - 63
Medium high	4, 5	32 - 47
Medium low	2, 3	16 - 31
Low	0, 1	0 - 15

- To change mapping assignments, click and select on the relevant Internal Priority sub-menus.
- To return mapping to default, click Set Defaults.

10. To commit the configuration, click **Send**.

Next Step: Go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic, Volume IV, Chapter 9.

DAC GE Configuration

The DAC GE supports Gigabit Ethernet with three RJ-45 customer ports for 10/100/1000Base-T and one SFP (Small Form-factor Pluggable) port, which is installed with an optical transceiver for 1000Base-LX (LC connectors).

The DAC GE supports:

- Transparent (broadcast), mixed, or VLAN switch fabrics
- NxE1, NxDS1, or NxSTM1/OC3 transport channels
- Layer 2 link aggregation (802.3ad), and layer 1 link aggregation
- RWPR^{TM} enhanced RSTP (802.1d)
- VLAN tagging (VID and priority mapping)
- Port and QoS options
- Flow control (802.3x)
- Jumbo frames to 9600 bytes

With the DAC GE one 9500 MXC Node supports maximum Ethernet bandwidth assignments of:

- 204 Mbps with an NxE1 / 2.048 Mbps backplane
- 196 Mbps with and NxDS1 / 1.544 Mbps backplane
- 310 Mbps with an STM1 / 155 Mbps backplane

A DAC GE may be linked to a DAC ES or IDU ES when configured for NxE1 or NxDS1 operation.

DAC GE RSTP operation within a ring/mesh network is currently restricted to using only DAC GEs - all RSTP switches within the network must be DAC GE. (Interoperation with 3rd party L2 switches has not been tested, hence is currently not supported).

For information on link aggregation options and operation refer to Link Aggregation on page 7-66. For information on the associated Link Status Propagation feature, refer to Link Status Propagation Operational Characteristics on page 7-70.

DAC GE Configuration Screen

Figure 7-12 shows an example of a DAC GE Plug-ins screen, which apart from the Link Aggregation, Transport Channel Encoding, and RWPR options is similar in appearance to DAC ES.

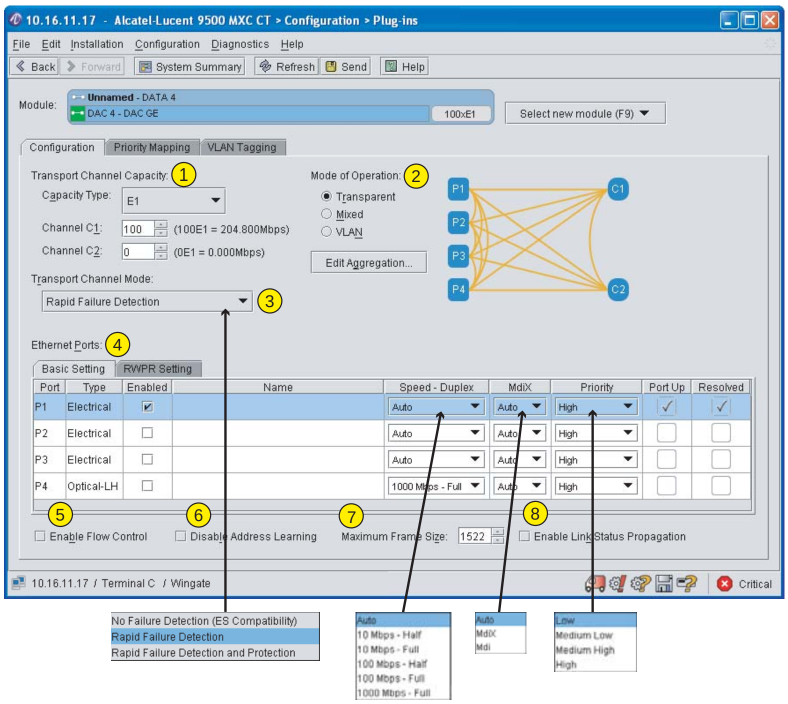
DAC GE card is operated with a 2 Mbps/E1, 1.5 Mbps/DS1, or 155 Mbps/STM1/OC3 backplane bus; Ethernet data is mapped to the backplane, then to a RAC or DAC 155oM for transport over a link or links.

For Nx2 Mbps or Nx1.5 Mbps mapping, the links can be RACs (radio) or

DAC 155oM (fiber).

For Nx155 Mbps mapping, only RAC links are supported.

Figure 7-17. Typical DAC GE Plug-ins Configuration Screen



Item	Description
1	Transport Channel Capacity: Enter a capacity in Mbps for C1 and/or C2. Capacity is entered in multiples of 2 Mbps, 1.5 Mbps or 155 Mbps, depending on the Backplane bus selection made in the Circuits screen. The equivalent TDM capacity is indicated in brackets. Capacity can be directly entered, or entered using the up-down tabs. Total capacity for C1 and C2 is shown in the Module field.
2	Select mode of operation; Transparent, Mixed or VLAN. Where layer 2 link aggregation is required, select from the Transparent mode options behind the Edit Aggregation tab.
3	Transport Channel Mode supports selection of the fast-link detection mechanism used to enable RWPR-enhanced RSTP, layer 2 link aggregation, and link status propagation. • Rapid Failure Detection and Protection should be selected when there is a DAC GE at both ends. Both DAC GEs must be with SW release 3.6 or later. • No Failure Detection (ES Compatibility) is for use where the DAC GE is linked to a DAC ES or IDU ES. • Rapid Failure Detection is only required when the far end DAC GE is operating with SW release 3.4 or 3.5.

Item	Description
4	Ethernet Ports - Basic Setting: • Ports. The ports P1 to P4 are individually configurable. • Type. Ports P1 to P3 are fixed as Electrical. Port P4 as optical. • Enabled. Click to enable required ports. A port must be enabled to allow traffic flow. • Name. Each port can be named/identified. Optional. • Duplex-Speed. Select auto-detect or a specific connection type from the drop-down menu. • MdiX. Select the required interface type, Auto-detect, Mdi or MdiX from the drop-down menu. For the DAC GE, the MdiX (cross-over) selection is tied to the Auto selection, which means that there are in effect only two user settings, Mdi (straight) or Auto, where Auto auto-sets for Mdi or MdiX. If the externally connected equipment is set for Auto, then the local port can be Mdi or MdiX. • Priority. Select the required port priorities from the drop-down menu. Port Priority only has application where two or more ports share a common channel*. Port Default must also be selected in the Priority Mapping screen. If any other selection is made in the Priority Mapping screen, the port priority selection is invalidated.* • Port Up. A tick indicates detection of a valid Ethernet connection. • Resolved. Tick indicates that a port has been auto-resolved for speed/duplex. The resolved tickbox is only applicable to Auto (all speeds) and to the 1000 Mbps Speed-Duplex selections.
5	Click to enable flow control (full duplex connections only).
6	Click Disable if the DAC GE link is used to provide a transparent Ethernet connection between external switches.
7	Set the maximum frame size. Setable range is 64 to 9600 bytes.
8	Click to enable link status propagation. Used to shut down a port upon a channel failure event. Applies where the connected equipment uses port status to determine the availability of an Ethernet connection.

Procedure for DAC GE Configuration

Figure 7-17 shows a typical configuration screen, which provides a view/change capability for operational mode, channel type, channel capacities, transport channel encoding, and Ethernet port settings.

Option tabs provide access to Priority Mapping and VLAN Tagging screens.

When you have completed the required configuration steps, go to the Circuits screen to configure circuit cross-connects. Refer to Procedure for Configuring Circuits - Traffic, Volume IV, Chapter 9.

When the configuration for a port or channel is changed there will be a momentary hit on all user traffic through the switch when Send is clicked to commit the change.

To configure the DAC GE:

1. From the Plug-ins screen, select the required module.
2. **Transport Channel Capacity**: Enter the capacity required per link channel using the scroll tabs, or use direct-entry.

   Channel capacity is entered in multiples of 2 Mbps, 1.5 Mbps, or 150 Mbps, depending on the setting of the backplane bus connection size. Equivalent E1, DS1 or STM1/OC3 capacity is indicated in brackets. To change the backplane bus, go to **Configuration** > **Circuits**, and reset the bus accordingly.

   The maximum configurable Ethernet capacity on one channel or on the total for both channels is:

   - 204 Mbps in 2 Mbps steps
   - 196 Mbps in 1.5 Mbps steps
   - 310 Mbps in 155 Mbps steps

   These maximum capacities also represent the backplane maximums.[4]

   Channel capacity is mapped to a RAC (radio) or to a DAC 155oM (fiber).

   - RAC 30 and RAC 40 support link capacities to 153 Mbps (Nx 2 Mbps) or to 154 Mbps (Nx 1.5 Mbps).
   - RAC 3X supports link capacities to 204 Mbps (Nx 2 Mbps), 154 Mbps (Nx 1.5 Mbps), or 310 Mbps (Nx 155 Mbps).
   - DAC 155oM supports fiber link capacities to 129 Mbps for both Nx 2 Mbps or Nx 1.5 Mbps selections.

RAC modulation/bandwidth and Node license must support the channel capacity selected within the DAC GE plug-ins screen.

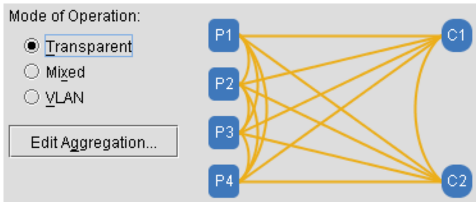
3. **Operational Mode**: Select Transparent, Mixed or VLAN mode for the Ethernet bridging-switching function. Transparent mode supports layer 2 (L2) link aggregation with options for channel and channel/port aggregation.

   For information on link aggregation options and operation refer to Link Aggregation on page 7-66.

   - **Transparent, Link Aggregation Disabled** is the default, broadcast mode; all ports and channels are interconnected. It supports four customer connections (Ports 1 to 4) with bridging to two link transport channels (C1and C2). For single link applications select only C1 (or C2) to avoid a traffic-loop, or use the VLAN tagging options to provide a dedicated port/channel association.

4 *Except for a 1.5 Mbps / DS1 selection, where the backplane bus max is 197.6 Mbps / 128xDS1.*

Figure 7-18. Transparent Mode



- **Transparent with Aggregation**. Click Edit Aggregation to view and set the aggregation options. The options provide selection of the channels and/or ports to be aggregated.

  A channel selection applies where C1 and C2 to are each to be mapped to a RAC or DAC 155oM in the same INU/INUe as the DAC GE.

  A port selection applies where the link or links to be aggregated are installed on one or more co-located INUs. A port-port Ethernet cable is used to interconnect the assigned DAC GE ports on the INUs.

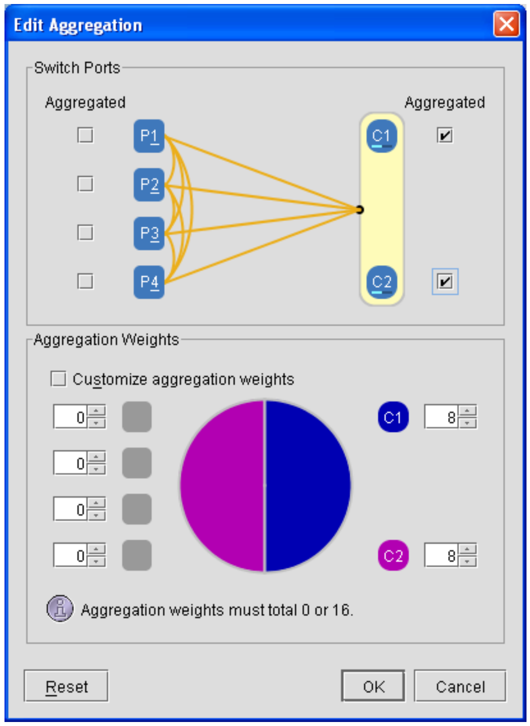
  Aggregation weighting refers to the way the aggregation keying process allocates traffic between the aggregated link grouping. 16 keys are provided and traffic is randomly assigned to a key. With two aggregated links of equal capacity the weighting (number of keys) should be split 8/8. With three aggregated links of equal capacity the split should be 5/5/6. The aggregation weights must be assigned such that they always total 16.

  Balanced aggregation weights are default applied, but where one of the aggregated links is of different capacity, such as a 300 Mbps link aggregated with a 150 Mbps link, the weighting on the 300 Mbps link should be set to 11, and to 5 on the 150 Mbps link.

  The maximum Ethernet capacity supported on one INU/INUe is 300 Mbps (311.04 Mbps). Using DAC GE link aggregation, two co-located INUs are used to provide a 600 Mbps user interface (600 Mbps virtual link); three are used to provide a 900 Mbps interface.

  Figure 7-19 illustrates C1 and C2 aggregation. The default weighting applied is 8/8. A typical application for this configuration is RAC 40 CCDP XPIC operation of two 150 Mbps links on one 28 MHz or 30 MHz radio channel.

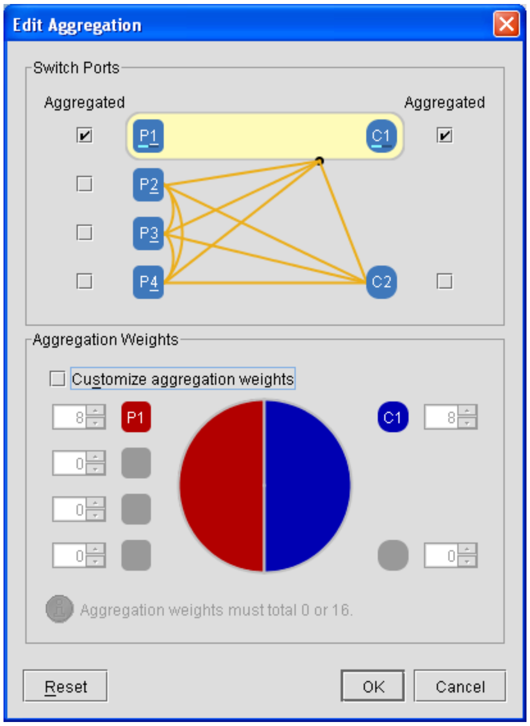
Figure 7-19. Transparent Mode with C1 and C2 Aggregation



TFigure 7-20 illustrates C1 and P1 aggregation. The default weighting applied is 8/8. A typical application for this configuration is same-path operation of two 300 Mbps links. Note that on the partner link, link aggregation is not configured, but Link Status Propagation should be enabled.

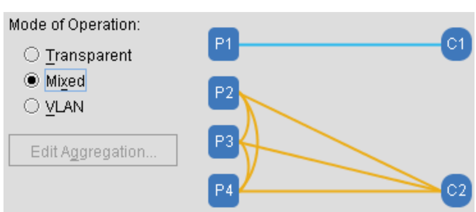
More information: See Link Aggregation on page 7-66, and Link Status Propagation Operational Characteristics on page 7-70.

Figure 7-20. Transparent Mode with C1, C2 and P1 Aggregation



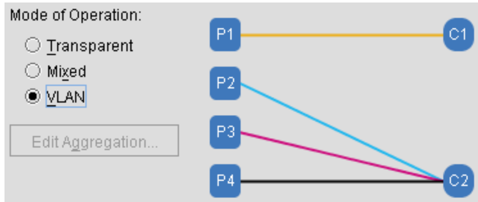
- **Mixed Mode** supports a two-channel LAN/broadcast solution where P1-C1 provides dedicated transport for port 1 traffic. A second transparent, broadcast mode connection is provided with ports 2, 3 and 4 and channel C2 interconnected. The two channels can be assigned on the same link or used to support separate links. Mixed Mode is particularly applicable to east and west links in an Ethernet ring/mesh network where path protection is provided by an *external* RSTP switch.

Figure 7-21. Mixed Mode



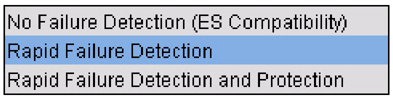
- **VLAN Mode** supports four separate LANs - each is held separate from the other. VLAN 1 is the same as for Mixed Mode, where dedicated transport is provided for port 1 traffic on channel C1. For Ports 2, 3 and 4, the LAN on each port is transported as a Virtual LAN (VLAN) over a common channel C2. Internal VLAN tagging of packets ensures correct end-to-end matching of ports P2 to P4 over the link. The two channels C1 and C2 would normally be assigned on the same link, but can be used to support separate links.

Figure 7-22. VLAN Mode



4. **Transport Channel Mode**: The options shown in Figure 7-23 are only supported in SW release 3.6 and later.

Figure 7-23. Transport Channel Mode Options



Select the mode required:

- **No Failure Detection (ES Compatibility)** is for use where the DAC GE is linked to a DAC ES or IDU ES. In this mode the rapid failure detection (RFD) is disabled.
- **Rapid Failure Detection** supports RWPR-enhanced RSTP, layer 2 link aggregation and link status propagation. Select this option where the DAC GE at the far end only displays a tick-box option for Rapid Transport Channel Failure Detection. (The far end DAC GE is operating with SW release 3.4 or 3.5).
- **Rapid Failure Detection and Protection** supports RWPR-enhanced RSTP, layer 2 link aggregation, link status propagation *and* physical (layer 1) link aggregation. Select this option where the DAC GE at the far end also displays this option.

Linked DAC GEs must have the same encoding option selected.

DAC GEs must be operating with SW release 3.6 or later to support compatibility with DAC ES/IDU ES.

DAC GEs must be operating with SW release 3.6 or later to support Rapid Failure Detection *and* Protection.

DAC GEs must be operating with SW release 3.4 or later to support Rapid Failure Detection.

DAC GEs operating with SW release 3.3 or earlier do not support Rapid Failure Detection, RWPR, or ES compatibility.

Where the DAC GEs at both ends of the link support (display) the option for Rapid failure Detection and Protection, use this in preference to Rapid Failure Detection.

5. **Basic Port Settings**:

5.1 **Enabled**: Click to enable or disable the required ports. A port must be enabled to allow traffic flow. This enabling/disabling function does not affect the Port Up and Resolved status indications.

5.2 **Name**: Enter the port name or other relevant port data (optional).

5.3 **Duplex - Speed**: Click to view and select auto-detect or a specified connection type and speed. Applies only to the electrical ports 1 to 3; optical port 4 is fixed for 1000 Mb and full duplex. For ports 1 to 3 the normal setting is Auto, where the auto negotiation feature senses and sets the speed (10, 100 or 1000Base-T) and connection for half or full duplex operation. The fixed options are used where auto negotiation fails to provide the expected result or where a fixed setting is preferred:

- Auto negotiation is not 100% reliable, particularly so where the connected equipment is using an older auto-sensing mechanism.
- Links with a duplex mismatch will operate, but will generate a large number of errors and will slow throughput.
- Generally, for auto negotiation to work, both interfaces must be set to auto for speed and duplex.
- *Full-duplex* can only be achieved if *both* interfaces are either set for auto-negotiation *or* are manually configured to use full duplex.
- Full duplex will not operate via a hub/repeater. These are half duplex devices.
- If auto-negotiation is enabled on only one side of the link, it will *always* default to half-duplex, regardless of what the other side of the link is forced to.
- If one side of a link is forced to full duplex and the other is set to auto-negotiation, a duplex mismatch will occur.
- You can force a new auto-negotiation by simply unplugging a host cable for 10 seconds.
- Most 10 Mb interfaces can run only in 10 Mb half-duplex mode.
- Most 10/100 Mb interfaces support auto-negotiation and most 10/100 Mb interfaces with RJ-45 twisted-pair can run in full-duplex mode.
- Any network connected via an AUI port (Attachment Unit Interface), such as with an external Ethernet transceiver, can run only in 10Mb half-duplex mode.

5.4 **Mdi/MdiX**: Sets a port connection to match the required send/receive cable terminations from the far-end port. Click to view and select from Auto, Mdi, or MdiX. Note however, that for the DAC GE the MdiX setting is tied to Auto; MdiX invokes an Auto setting.

The normal setting is Auto, where the auto negotiation protocol senses and sets the port connection to Mdi or MdiX (straight or cross-over respectively). Most RJ-45 Ethernet cables are Mdi. Note that if a port at the far end of the cable is set for Auto, the local end can be set for Auto, MdiX or Mdi, regardless of the cable type, straight or crossover. If the far end is set for Mdi, and a straight cable is used, Auto or MdiX must be selected on the local port. Similarly, if the far end port is set for MdiX and a straight cable is used, Mdi or Auto must be selected on the local terminal.

5.5 **Priority**: Sets the port priority. The options are high, medium high, medium low, and low. To change, view and select from the priority menu. Each port can be prioritized in this way.

•This prioritization only has relevance where two or more ports share a common channel.

•PPorts with a higher priority have their data packets accepted by the queue controller ahead of lower priority ports on a fair-weighted basis. This is to ensure that traffic on a low priority port gets some bandwidth. Refer to Step 12, Priority Mapping, for more information on port prioritization.

•*For port priority, Port Default must be selected in the Priority Mapping screen*. If any other selection is made in the Priority Mapping screen, port priority selections are invalidated.

5.6 **Port Up**: An arrow indicates detection of valid Ethernet framing at the local port connection. Unconnected ports, ports with invalid framing, or ports with an incorrec**Resolved**: A tick in a resolved box indicates that the DAC GE has auto-resolved the port connection for Speed-Duplex. By default (industry standard) 1000Base-T uses auto-negotiation, so the resolved tickbox display is valid for an Auto or 1000 Mbps setting.

•If Speed-Duplex is set to Auto or 1000 Mbps, the resolved tickbox will be ticked when speed/duplex has been resolved.

•If Speed-Duplex is set for 10 or 100 Mbps fixed, the resolved tickbox is not applicable, so will never be ticked. Port Up is the primary indication of port status.

To further confirm port operational status, check the connection and activity LEDs of the RJ-45 connectors, or check port status using the System/Controls or Performance diagnostic screens. For LEDs, refer to Volume II, DAC GE Front Panel Layout. For System/Controls and Performance screens, refer to Diagnostics, Volume IV.

6. **Maximum Frame Size** sets the maximum frame size that can be accepted at the switch interface. In turn it determines the Maximum Transmission Unit (MTU), which determines the largest datagram than can be transmitted without it being broken down into smaller units (fragmented). The MTU should be larger than the largest datagram you wish to transmit unfragmented[5].
   - The setable frame-size range is 64 to 9600 bytes, however it should not be set above 7500 bytes for bi-directional traffic. 9600 can be used for uni-directional requirements; frame sizes to 9600 bytes in one direction, and normal frame sizes in the other direction. In practice frame sizes above 4000 bytes are seldom used.
   - When operating with a DAC ES / IDU ES at the far end bear in mind that their maximum frame size setting is 1536 bytes.
7. **Enable Flow Control**: Flow control is an option for full-duplex links only. It is implemented by the of IEEE 802.3x pause frame mechanism, which tells the remote node to stop or restart transmission to ensure that the amount of data in the ingress queue does not exceed a ‘high water mark’.
   - The receiver will signal to the transmitter to stop transmitting until sufficient data has been read from the queue, triggered by a ‘low water mark’, at which point the receiver signals to the transmitter to resume transmission.
   - To be effective, flow control must be established from the originating source through to the end point, and vice versa, which means the equipment connected to DAC GE ports and beyond must also be enabled for flow control.
8. **Disable Address Learning**: Address Learning is default implemented to support efficient management of Ethernet traffic in multi-host situations. The

[5] *The setting only supports this interface. Some other link/interface in the path may have a smaller MTU, at which point the datagram will be fragmented if its size is greater.*

option to disable Address Learning is for use in a ring/mesh network where protection is provided by an *external* RSTP switch. To avoid conflict between the self-learning function within DAC GE and the external RSTP switch during path failure situations, the DAC GE capability must be disabled. Failure to do so means that in the event of a path failure, and subsequent re-direction of Ethernet traffic by the external switch to the alternate path, the DAC GE will inhibit re-direction of current/recent traffic until its address register matures and deletes unused/un-responsive destination addresses, which may take several minutes.

9. **Enable Link Status Propagation**: Link Status Propagation (LSP) is used to enhance rapid detection by externally-connected equipment of the status of a DAC GE channel. It does so by capturing the channel status (up/down) on the DAC GE ports to force a port shutdown in the event of a channel failure. A port shutdown is immediately detected by the connected equipment so that it can act on applicable alarm/failure options, such as the initiation of protection switching provided in RSTP or link aggregation configurations.

   The Transport Channel Mode must be selected for Rapid Failure Detection and Protection, or Rapid Failure Protection, for correct LSP operation. Both ends of the DAC GE link must be set for the same Transport Channel Mode and have LSP enabled.

   Specifically, LSP supports:

   - Shut-down of the DAC GE user ports at both ends of a DAC GE link when a transport channel is down due to a radio link failure, or similar. When the transport channel is restored, the user ports are automatically restored at both ends.
   - Shut-down of the transport channel in the event of an Ethernet cable disconnection or external device failure on the relevant DAC GE port. The channel shut-down automatically propagates the failed condition to the far-end DAC GE. When traffic is restored on the port, the transport channel is restored, and subsequently the far-end DAC GE port.

   Applications that will require LSP include:

   - Operation with external switches running RSTP or other protocols that only use Ethernet link status (down/up) to trigger a topology change when a path failure occurs, and is subsequently restored. When LSP is enabled, a failure on a DAC GE transport channel (radio link for example) is reflected directly to the external user device through a port shut-down. This should improve link failure detection times for these devices, compared to the times needed for conventional hello time-out or polling time-out using control frames.

10. L2 link aggregation, when *co-located* INUs are installed to provide the physical links. Link aggregation functionality depends directly on the aggregated port status to confirm the operational status of the aggregated link, and is selected only on the *partner* L2 switch or switches - not on the switch that is *hosting* the link aggregation function). For example, where two DAC GE links are link aggregated, the DAC GE that is hosting the aggregation (is providing the aggregated interface) is not configured for LSP. LSP is only configured on the partner DAC GE link.

    For more information on the Link Status Propagation, refer to Link Status Propagation Operational Characteristics on page 7-70.

11. **RWPR Port Settings**: Click the RWPR Setting tab.

    The settings available are used to configure the DAC GE for RWPR (RSTP) operation, specifically:

    - Enabling RSTP operation on required channels/ports.

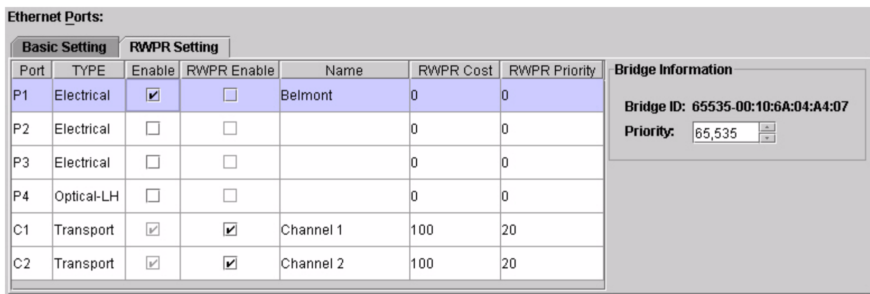
- Supporting selection of a root switch (in conjunction with other DAC GEs in the RSTP network.
- Supporting selection the most efficient path (shortest/fastest/preferred) to/from the root switch.

RWPR™ enables fast-switched RSTP within a 9500 MXC DAC GE ring/ mesh network.

RWPR cost is the same as RSTP path cost.

RWPR priority is the same as RSTP port priority or port cost.

Figure 7-24. RWPR Setting Window



11.1 **Port, Type and Enable** columns mirror the function provided in the Basic Port settings except that transport channels C1 and C2 are included. A port must be enabled to allow traffic flow. Channels are auto enabled based on the Channel C1 and/or Channel C2 capacity selection.

11.2 **RWPR Enable**. Click to select the channels or channels and ports to be included in the RSTP-protected ring/mesh network.

- For a site where one DAC GE is installed to support both east and west ring paths only enable C1 and C2.
- For a site where DAC GEs are back-to-back connected via a port, only enable the relevant channel (C1 or C2) and the port used.
- At a meshed site (three or more RSTP link connections) select all channels and ports used to support the RSTP network connections.
- Local traffic ports (port or ports supporting the local LAN connection) must not be RWPR enabled.

11.3 **Name**. Enter a name for ports used (optional).

11.4 **RWPR Cost** is set to represent data bandwidth (speed) available on the port/ path, and is assigned a value such that the higher the available speed, the lower the cost.

- A lower cost path is always elected over a path with a higher cost. Highest priority is given to highest speed = lowest value cost. The setable range is 0 to 1,000,000.

- Costs are added through the network. If the path from a DAC GE has a cost of 100, and the path from it to the next DAC GE towards the root DAC GE (root switch) is also 100, the combined cost up to the second DAC GE is 200.

11.5 **RWPR Priority** sets the port/channel priority and is set to represent how well a port/channel is located within a network to pass traffic back to the root DAC GE (root switch). The setable range is 0 to 255.

RWPR priority comes into play when RWPR cost on its own cannot assist RSTP to decide the preferred route from the root DAC GE. This occurs where RWPR costs from the root DAC GE to a remote DAC GE are equal. RWPR priority is then used to determine which port on the equi-cost DAC GE is to be set as forwarding and which is to be blocked, and hence sets the preferred route to the route switch.

- Port priority is contained within a Port ID, which comprises the port priority setting, and the port number.
- Where RWPR priority settings are such that they cannot assist RSTP to decide port states on a DAC GE (priority is the same or not set), port numbers are used. Spanning tree selects the port with the lowest port number as the forwarding port.

RWPR Cost (RSTP path cost) and RWPR Priority (RSTP port priority) settings are used by spanning-tree to elect the network topology beneath the root switch. The spanning-tree algorithm uses data from both to determine an optimum network tree (optimum paths to/from root switch), with contesting ports set for forwarding or blocking.

On a simple ring network *where all paths are configured for the same Ethernet capacity*, Cost and Priority settings should be set such that traffic flows both ways around the ring from the root DAC GE (root switch), to a DAC GE that is equi-distant from the root, at which point RSTP will set one of the channels (ports) on this equi-distant DAC GE to forwarding, and the other to blocking.

By convention, RWPR Cost should be set the same (e.g. 500) on all DAC GEs where data bandwidth is equal on all ring paths. Doing so will ensure costs are set equally (they total equally) in both directions around the network from the root DAC GE to the equi-distant DAC GE.

Similarly RWPR Priority can be set the same (e.g. 50) on all DAC GE channels (ports). In this case RSTP will use the port IDs on the equi-distant DAC GE to set the preferred route to this DAC GE. The lowest value port, for example C1, will be preferred over C2, and C2 will be blocked.

However, if one route, clockwise or anti-clockwise, is preferred from the route DAC GE to the equi-distant DAC GE, RWPR priority values on the equi-distant switch should be set to favor the preferred route.

The value ranges available for RWPR cost allow selection of a wide range of values. The actual value selected is not important on its own - what is important are the values selected in conjunction with other DAC GEs (other paths) on the network.

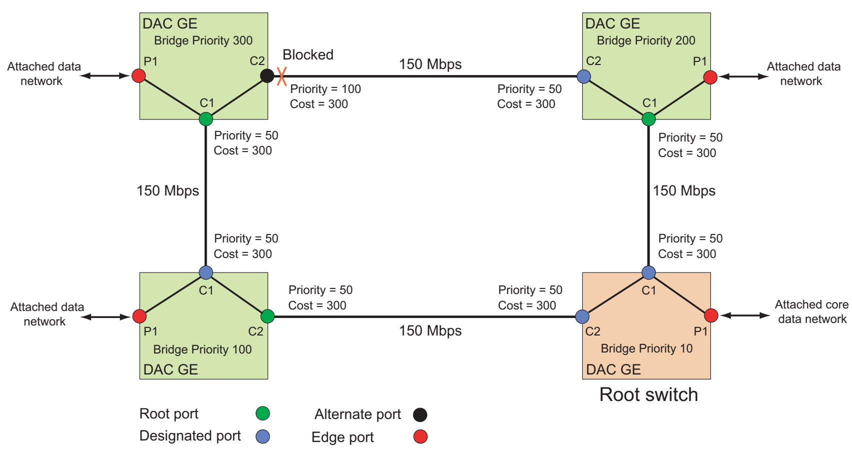
In summary, path costs (RWPR costs) are used first to determine a preferred route towards a blocking switch, then port priorities (RWPR priorities) are used on the blocking switch to determine which port is forwarding and which is blocked. If port priorities are the same, the port numbers are used.

See Figure 7-25 for an example network.

11.6 **Bridge ID**[6] **and Bridge Priority** are used to establish the root DAC GE (root switch) in an RSTP network.

- The root switch is the logical center of the network. For a typical single gateway ring (all traffic on the ring is sourced and sunk at one 'gateway' site) the gateway DAC GE must be elected as the root switch.
- The DAC GE with the *lowest* bridge priority number is elected as the root switch. In the event this DAC GE fails or is withdrawn, the DAC GE with the next lowest-value bridge priority is elected as the root switch. The setable range is 0 to 65,535 - set each DAC GE in the network such that the root DAC GE has the lowest number, with the next highest number assigned to the DAC GE best positioned to act as the root switch in the event of a failure of the gateway Node/DAC GE.
- If DAC GEs are configured for the same priority value, or left as default, the DAC GE with the lowest MAC address becomes the root switch.

Figure 7-25. Example Ring with RWPR Settings



In this example network:

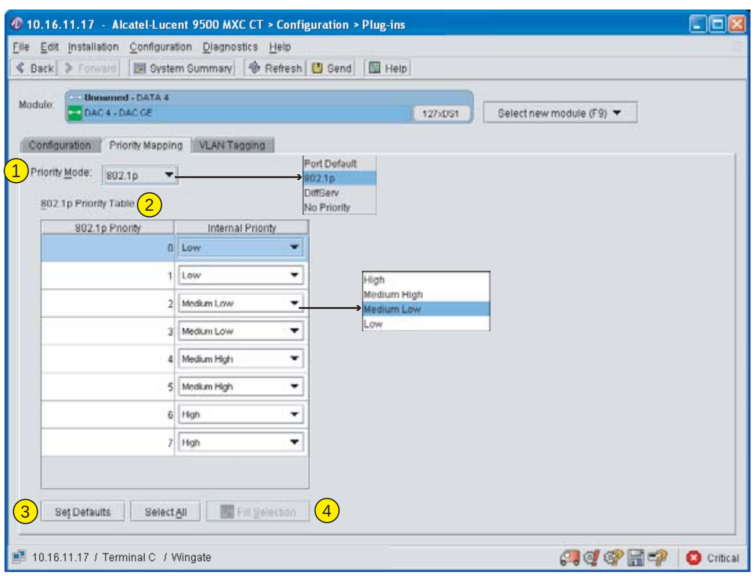
- The root switch is configured with the lowest bridge priority value. (Lowest value = highest priority). If the root switch fails, the lower-left switch would become the root switch.

[6] *Bridge ID is a unique identifier for the DAC GE switch function. The most significant bits are occupied by the bridge priority setting, the remainder by the switch MAC address.*

- Data bandwidths are equal (150 Mbps) on all ring links. DAC GE RWPR costs (path costs) have been set to 300 on channels C1 and C2 on all DAC GEs. This means that from the root switch, RWPR costs are equal (1200) to the top-left switch. So RWPR costs alone do not help to elect a preferred route, clockwise or anti-clockwise, to the top-left switch.
- RSTP next looks at the port priority (RWPR priority) settings on the top-left equal-path-cost switch to determine channel port status; fowarding (root) or blocked. As the preferred route is clockwise, C2 has been configured with a lower RWPR priority (higher value number). So C2 becomes the blocked port and all traffic to this switch travels clockwise to/from the root switch via C1.
- If C1 and C2 on the top-left switch were configured with the same RWPR priority, RSTP would next examine the port numbers involved, to assist the election of a preferred route. In this case, C1 has the lowest port number so C1 would be confirmed as the forwarding (root) port, and C2 as the blocked port.

12. **Module Name**. Enter a name (optional - recommended) for the module by right-clicking in the relevant DATA module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.
13. **Priority Mapping**: Click the Priority Mapping tag to view and select the priority mode and associated mapping. Refer to Figure 7-26. DAC GE has a four level (two bit) priority field, meaning the 8 priority levels of 802.1p tagging or the 63 levels of DiffServ are mapped into 4 levels over a DAC GE link.

Figure 7-26. DAC GE Priority Mapping Screen



Item	Description
1	Priority Mode. Select from the drop-down menu.
2	Priority Table. Presents the priority mapping used to convert the 8 priority levels of 802.1p and the 63 levels of DiffServ to the 4 levels supported by the DAC GE priority stack: high, medium high, medium low, and low. The mapping shown is default mapping for 802.1p. To change mapping, click and select from the Internal priority sub-menus.

Item	Description
3	Set Defaults returns priority mapping to its default settings.
4	Select All selects (highlights) all rows. Fill Selection sets all selected (highlighted) rows to the mapping set in the top-most row.

Procedure

- Click the Priority Mode box to display and select from mode menu. A selection applies to all ports.
  - Port Default sets the queue controller priority on a port basis - it ignores any 802.1p VLAN priority tags or IP DiffServ priority values. Port priority settings are made per-port in the Priority column in the Configuration > Basic Setting window. Refer to Step 5.5.
  - 802.1p provides prioritization based on the three-bit priority field of the 802.1p VLAN tag. DAC GE maps each of the possible eight priority tag values into a four-level (2-bit) priority field. Refer to Table 7-8 for default mapping assignments.
  - DiffServ provides prioritization based on the six bits of the IP packet DiffServ or Type of Service byte. DAC GE maps each of the possible 63 levels into a four-level (2-bit) priority field. Refer to Table 7-8 for default mapping assignments.
  - If No Priority is selected DAC GE will pass packets transparently; it will not assign a priority on incoming untagged or tagged packets.(Any port priority setting made in the Basic Setting window is ignored/over-ridden).
  - Data is forwarded on a fair-weighted basis to ensure low priority packets are given some bandwidth.
  - The same four-level low to high prioritization mechanism is used to prioritize ingressing VLAN tagged traffic against untagged traffic that is subject to port priority. If ingressing VLAN tagged frames are to be accorded priority over untagged traffic on all ports, then the mapping used to assign a priority to the VLAN tagged frames must be set to a higher level than that for port priority in the DAC GE Configuration screen.

Table 7-8. DAC GE Priority Mapping Table

DAC GE Priority Level	802.1p Priority	DiffServ Priority
High	6, 7	48 - 63
Medium High	4, 5	32 - 47
Medium Low	2, 3	16 - 31
Low	0, 1	0 - 15

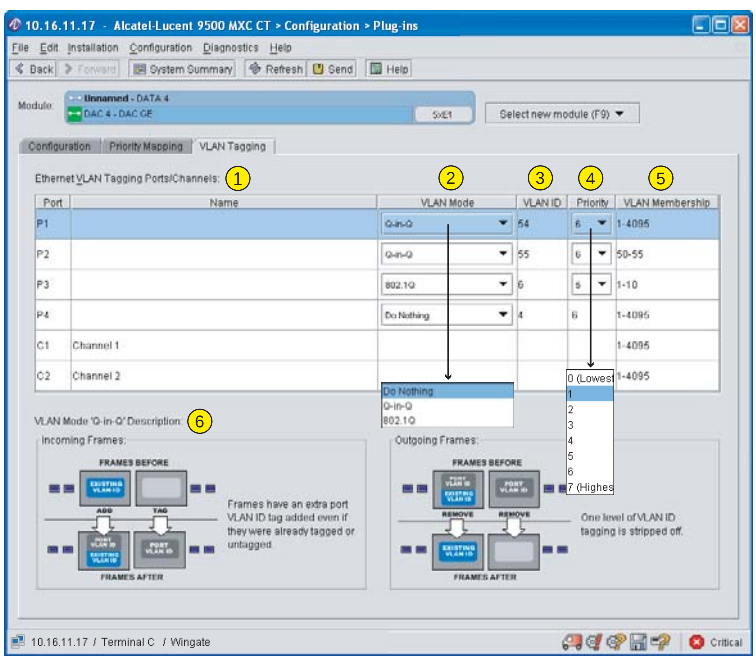
- To change mapping assignments, click and select on the relevant Internal Priority sub-menus.
- To return mapping to default, click Set Defaults.

14. **VLAN Tagging**: Click the VLAN Tagging tab to view the options.

    DAC GE supports 802.1q tagging with menus for selection of VLAN tagging modes, and priority settings for tagged-traffic. Diagrams assist understanding of the tagging action for each mode; refer to Figure 7-27 and to Figure 7-28.

- The tagging options are Do Nothing, Q-in-Q, or 802.1q.
- Selections are made on a per-port basis.
- With 802.1Q, untagged frames are tagged.
- With Q-in-Q, all frames are tagged. Frames with existing tags are double tagged.
- The tagging options of Q-in-Q and 802.1q are only available for Transparent mode and on ports P2 to P4 for Mixed mode. Do Nothing is fixed for VLAN mode and for P1 of Mixed mode.
- A VLAN ID can be entered (range 0 to 4095) or left as default. At each end of the VLAN the IDs must be matching (have the same ID number).
- A VLAN membership filter can also be selected. Only VLAN IDs within the membership range are allowed to transit the relevant port/channel.
- With this capability DAC GE can tag, 802.1p prioritize, and aggregate LAN traffic from two, three or four ports onto a common trunk/channel. At the far end of the DAC GE trunk, which may be over multiple hops, options are provided to remove the VLAN tags applied by DAC GE, or allow them to be retained intact for VLAN traffic management at downstream devices.
- VLAN tagging is typically used at the edge of a network to tag traffic on a LAN or VLAN and to assign a priority on its traffic. In this way up to four separate LANs (ports 1 to 4) can be carried as virtual LANs (VLANs) on a single 9500 MXC link; 9500 MXC acts both as an edge switch and as the radio trunk link to the core network.
- Each virtual LAN (VLAN) is held separate on the trunk and accorded the priority set within the 802.1p priority stack at all intermediary 802.1p devices. This allows network providers to discriminate on the service priority accorded over its network for each VLAN.

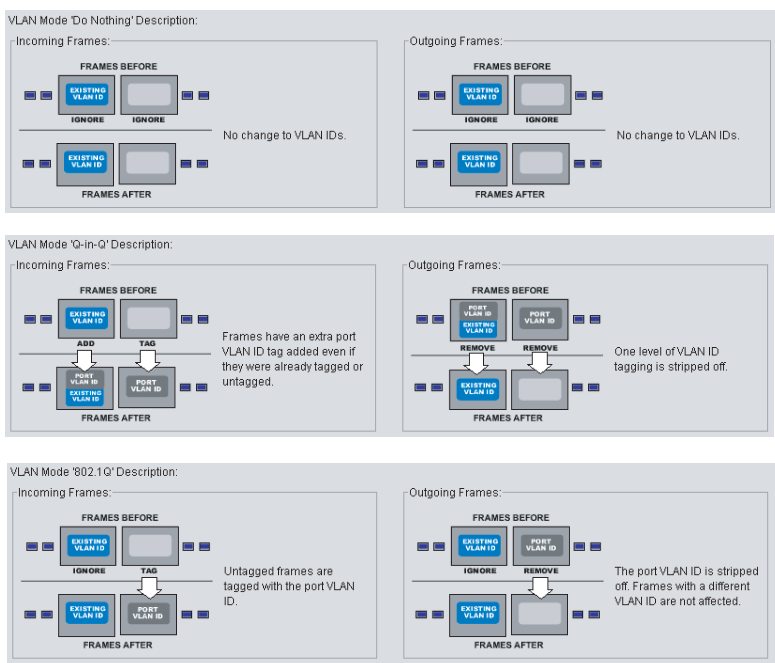
Figure 7-27. DAC GE VLAN Tagging Screen



Item	Description
1	A name (if required) is entered in the DAC GE *Configuration* screen.
2	VLAN Mode. Select a mode from the drop-down menu. A description for each selection is provided at the bottom of the screen.
3	A VLAN ID can be entered (range 0 to 4095) or left as default[1]. At each end of the VLAN the IDs must be matching.
4	Priority[1]. Select from the 8-level drop-down menu. This sets a VLAN priority with respect to other VLANs. When available bandwidth is exceeded, VLAN traffic with a higher priority is forwarded on a strict priority basis ahead of lower priority VLAN traffic.
	For Do Nothing, the VLAN ID and Priority fields are not editable; the existing entries are not acted on (have no relevance).
5	VLAN Membership. Applies a filter to the Port and/or Channel so that only the selected range of IDs is allowed to transit.
6	VLAN mode description. Illustrates the action on incoming and outgoing frames.

1. Only applies to *tagging* options.

Figure 7-28. DAC GE VLAN Modes



Link Aggregation

Link aggregation aggregates two or more data links so they appear as a single, higher-bandwidth logical link. The resultant traffic capacity is the sum of the individual link capacities.

Aggregated links also provide redundancy. Should one of the physical links fail, affected traffic is redirected onto the remaining link, or links:

- In the event the remaining link or links do not have the capacity needed to avoid a traffic bottleneck, appropriate QoS settings can be used to prioritize traffic such that all high priority traffic continues to get through.
- To provide a similar level of redundancy without aggregation, hot-standby or diversity protection is required, but with such protection the standby equipment is not used to pass traffic.

Two modes of link aggregation are supported by DAC GE, layer 2 and layer 1.

- Layer 2 (L2) link aggregation uses source and/or destination MAC address data in the Ethernet frame MAC/LLC header. It provides excellent load balancing between the physical links under normal LAN traffic densities i.e. where there are multiple concurrent sessions between different MAC source and destination addresses.
- Layer 1 (L1, physical layer) aggregation acts on the byte-level data stream; data is split between the physical links on a byte-by-byte basis. It should be used where there is just one source and destination MAC address session in play, such as between two routers, or where there are just a few sessions in play, particularly so if one session dominates the available bandwidth.

The same rapid-transport-channel failure detection mechanism (RFD) used with RWPR operation is also used to sense a physical link failure, to result in traffic re-assignment times of typically less than 50 ms.

Note that two aggregated links (physical links) may be operated on the same frequency channel (CCDP) using RAC 40s.

For applications where two physical links *from one INU/INUe* are to be aggregated, L1 aggregation is recommended as it supports equitable loading (load balancing) regardless of the number of data sessions in play. It also supports higher burst speeds compared to L2 aggregation.

Layer 2 Link Aggregation

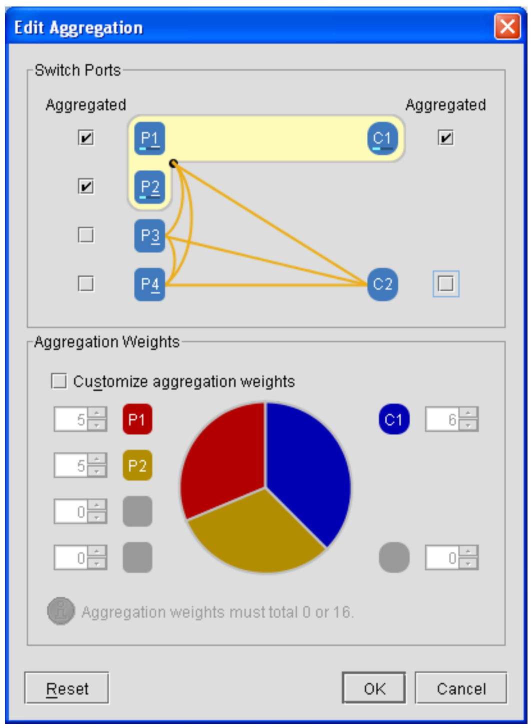
Traffic streams transiting the virtual link are split between the physical links based on their source and destination MAC addresses and the 'aggregation key' allocated to each of the physical links, the aggregation group[7]. This splitting prevents the occurrence of an IP loop, even though all traffic is sent and received on a common LAN interface at each end of the virtual link.

- The aggregation key process sets the weighting (load balancing) of traffic between the links in the aggregated group. For the DAC GE there are 16 keys, and traffic (source / destination MAC address based) is allocated between the keys on a random basis.
- Keys are only assigned to the channels and ports used to connect to the links in the aggregated link group.

7 *For L2 aggregation a session is established between source and destination MAC addresses. Once established all traffic will use the established link, which will be over one link, or the other - it cannot be split over both.*

- The number of keys assigned to the channels / ports is based on the split of capacity between the links. For example, if the aggregated group comprises two links of equal capacity, the keys are assigned as 8/8. But for a 300 Mbps link aggregated with a 150 Mbps link, the former should be allocated 11 keys, and the latter 5 keys. The number of keys applied must always total 16.
- The default assignment of keys is balanced; the 16 keys are split evenly, or near-even for an odd-number split. This assignment can be edited to support instances where the links are not of equal capacity.
- Figure 7-29 shows the Edit Aggregation window for a C1, P1, P2 aggregated grouping. Such a configuration would be used where three co-located INUs are used to support separate physical links, for example three 300 Mbps links to provide a single 900 Mbps virtual link at ports P3 and P4.

Figure 7-29. C1, P1, P2 Link Aggregation



Where there is only a single MAC addresses in play, such as a connection between two routers, L2 link aggregation is not effective. All traffic goes via one link - the other link or links in the aggregation group carry no traffic.

Where there are just a handful of MAC source and destination addresses in play (less than 16) link load balancing may be less than optimum, particularly so where just one or a few of the sessions have very high throughput demands.

With normal LAN traffic densities (20+ concurrent sessions), layer 2 aggregation keying generally ensures equitable balancing of traffic between the links.

When a link fails, all traffic from the failed link is recovered over the remaining link, or links. If it is to more than one link, aggregation keying applies an equitable split between the links.

When a failed link is returned to service, aggregation keying restores load sharing across all links.

Figure 7-30 illustrates a 300 Mbps LAN connection over two aggregated 150 Mbps links.

- The aggregation process ensures that any one traffic stream is only transported over one link.
- Load sharing generally ensures an equitable traffic split
- Each link provides redundancy for the other.
- The aggregation option is selected in the Plug-ins screen.

Figure 7-30. Basic 300 Mbps L2 Link Aggregation: Two 150 Mbps Links

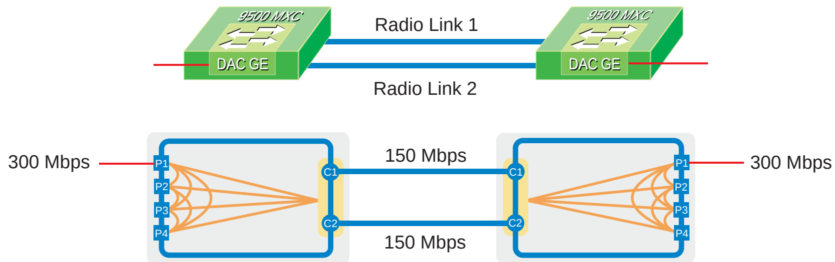
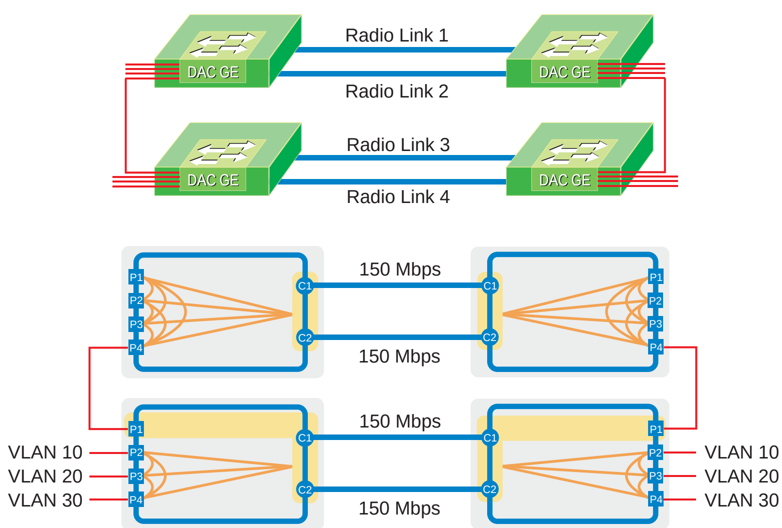


Figure 7-31 illustrates aggregation of four 150 Mbps links. In the top link, C1/C2 link aggregation is selected. In the lower link C1/C2/P1 aggregation is selected.

Link Status Propagation should be enabled for the *top* link. See Link Status Propagation Operational Characteristics on page 7-70.

The diagram also illustrates DAC GE VLAN tagging. Three company VLANs are DAC GE VLAN tagged (double tagged) and carried as a trunked VLAN on the aggregated links. VLAN tagging is selected in the VLAN Tagging screen.

Figure 7-31. 600 Mbps L2 Link Aggregation: Four 150 Mbps Links



Layer 1 Link Aggregation

With L1 link aggregation a maximum of two links can be aggregated per DAC GE transport channel, with the aggregation applied on the backplane bus using circuit cross-connects (CT Circuits screen).

- One DAC GE transport channel comprising NxE1, NxDS1, or NxSTM1 circuits is split across two separate links by assigning the individual circuits across two separate links.
- The links do not need to be configured for equal capacity.
- The circuits must be assigned in correct sequence, for example circuits 1 to 8 over one link, and 9 to 20 over the other.

Ethernet traffic is split equally between the link timeslots on a byte basis (parallel bus) meaning data within an Ethernet frame is transported across both links.

Compared to L2 aggregation it provides optimum payload balance regardless of the throughput demands of individual user connections. Whether there is one, a few or many concurrent sessions, traffic is always split between the links based on the configured capacity of the links.

In the event a link is lost, its traffic is assigned to the remaining link.

Figure 7-32. 300 Mbps L1 Link Aggregation: Two 150 Mbps STNM1 Links

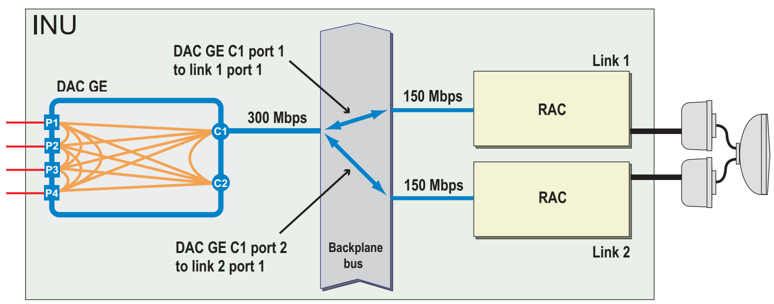


Figure 7-32 illustrates L1 link aggregation. A 300 Mbps assignment on DAC GE C1 is split between two 150 Mbps links, which may be operated (as shown) on the same frequency channel using RAC 40s for CCDP XPIC operation.

L1 link aggregation for Nx2 Mbps, Nx1.5 Mbps, or Nx150 Mbps rates requires SW release 3.6 or later.

Rapid Failure Detection *and* Protection must be selected as the Transport Channel Mode on the DAC GEs.

Link Status Propagation Operational Characteristics

This section describes the operational characteristics of Link Status Propagation (LSP), and its application to DAC GE L2 link aggregation when the aggregated links are supported on different DAC GEs / INUs.

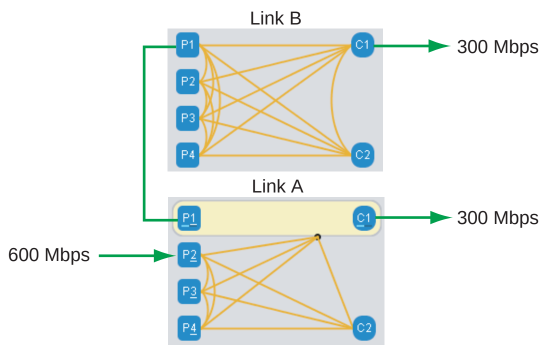
Link Aggregation Applications

DAC GE link aggregation functionality uses port status to confirm the operational status of the aggregated link. Refer to Figure 7-33.

- Link A, which hosts the aggregation function, requires knowledge of Link B port status to confirm the operational status of Link B, the aggregated link.

- With LSP enabled on Link B, its operational status reflects automatically via its port P1, to P1 on Link A.
- LSP *should not be enabled on Link A*.
  - Do not enable where you wish to retain service on one link if either link fails.
  - If enabled, P2 on link A will shutdown if either link fails.

Figure 7-33. Link Aggregation Example



Operational Characteristics

Within a DAC GE, port status propagation can only by executed without ambiguity if there is a one-on-one (unique) relationship between related ports.

- Do not enable for many-to-many or one-to-many port/channel (non-unique) relationships. Non-uniquely related ports do not execute status propagation even if enabled in the configuration.
- When establishing port relationships, the DAC GE only considers user ports and transport channels that are activated (enabled user ports, or traffic-configured transport channels).
- Aggregated ports are considered as one virtual port, which means status propagation can be enabled in this instance. If one of the aggregated ports is down, the DAC-GE will automatically shutdown the uniquely related user port. Similarly, if the uniquely related user port is down, it will automatically shutdown the aggregated ports.
- Current implementation of LSP is not designed for double failures. In order to avoid oscillation under such conditions, the DAC-GE incorporates a delay of 20 seconds after port restoration.
  - When a DAC-GE restores a port (port is forced up as a consequence of link status propagation), a delay of 20 seconds occurs before port status is re-verified.

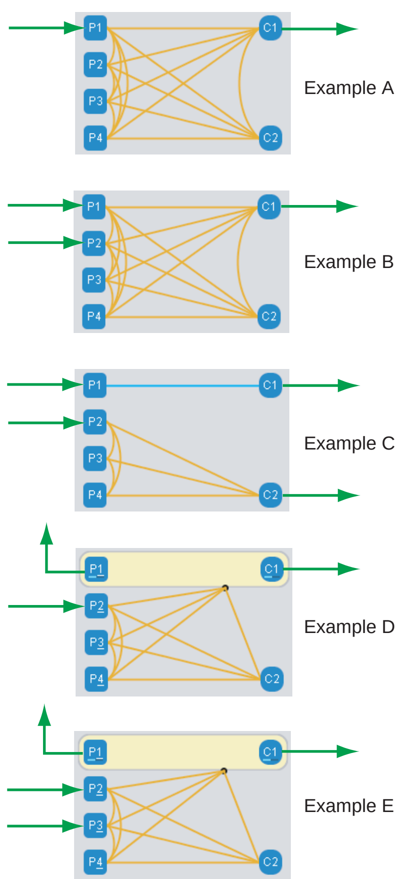
The following examples in Figure 7-34 illustrate these operational characteristics. The green arrows indicate that a port/channel is activate, otherwise it is inactive. Remember that:

- LSP should only be enabled on the link or links that are to be aggregated - it should not be enabled on the DAC GE that is hosting the aggregation function.
- Rapid Failure Detection and Protection, or Rapid Failure Detection, must be selected as the Transport Channel Mode.
- Identical configurations must be set at both ends of the link(s).

Example A:	P1 & C1 are uniquely related, so link status propagation can be enabled.

Example B:	P1, P2 & C1 are not uniquely related, so link status propagation is not applicable.
Example C:	P1 & C1 are uniquely related. P2 & C2 are uniquely related. Link status propagation is applicable and operates simultaneously and independently.
Example D:	Aggregated P1 & C1 channels and P2 are uniquely related, so link status propagation can be applied.
Example E:	Aggregated P1 & C1 channels and P2 & P3 are not uniquely related. Link status propagation is not applicable.

Figure 7-34. Example Configurations



AUX Configuration

AUX configuration applies to 9500 MXC Node and Terminal.

9500 MXC Node supports:

- Three auxiliary data interfaces. Each may be configured for synchronous 64 Kbps, or up to 19.2 kbps asynchronous data.
- Alarm I/O for up to six TTL alarm inputs and up to four Form C relay outputs.

For more information on the AUX plug-in and its applications, refer to AUX on page 3-54, Volume II, Chapter 3.

9500 MXC Terminal supports:

- One auxiliary data interface, configurable for synchronous 64 Kbps, or up to 19.2 kbps asynchronous data.
- Alarm I/O for two TTL alarm inputs and four Form C relay outputs.

Configuration of the data interface and alarm I/O is considered separately.

Refer to:

- Auxiliary Data and NMS Functions on page 7-73
- AUX Configuration on page 7-77
- Alarm I/O Configuration on page 7-78

9500 MXC Terminal does not support an *NMS* option, otherwise configuration of AUX is as for 9500 MXC Node.

Auxiliary Data and NMS Functions

Auxiliary configuration is provided for two functions, Data and NMS:

- The **Data option** supports transport of 3rd party synchronous and asynchronous data over a 9500 MXC network.
- The **NMS option** allows 9500 MXC NMS to be ported to a 3rd party network for transport to a remote 9500 MXC node or network. This feature is not supported by 9500 MXC Terminals.

Refer to:

- Data Option Overview on page 7-74
- NMS Option Overview on page 7-75
- AUX Transport on Link Overhead and Operating Rules on page 7-75

Data Option Overview

Each port is configured for asynchronous V.24/RS-232, or synchronous V.11/RS-422 data and cross-connected to one of up to six overhead ports (channels) on each link (RAC or DAC 155oM)[8].

These channels share the same overhead as the NMS and radio-radio internal communication.

At intermediate sites, each configured channel must be re-directed to the next RAC, or DAC 155oM. (An AUX is not required at intermediate sites).

At the destination site, each channel is directed to the required port on the AUX plug-in.

The configuration flow is outlined in Figure 7-35.

AUX Plug-in configuration is described in AUX Configuration on page 7-77.

AUX Circuits configuration is described in Circuits Configuration - Auxiliary on page 9-14.

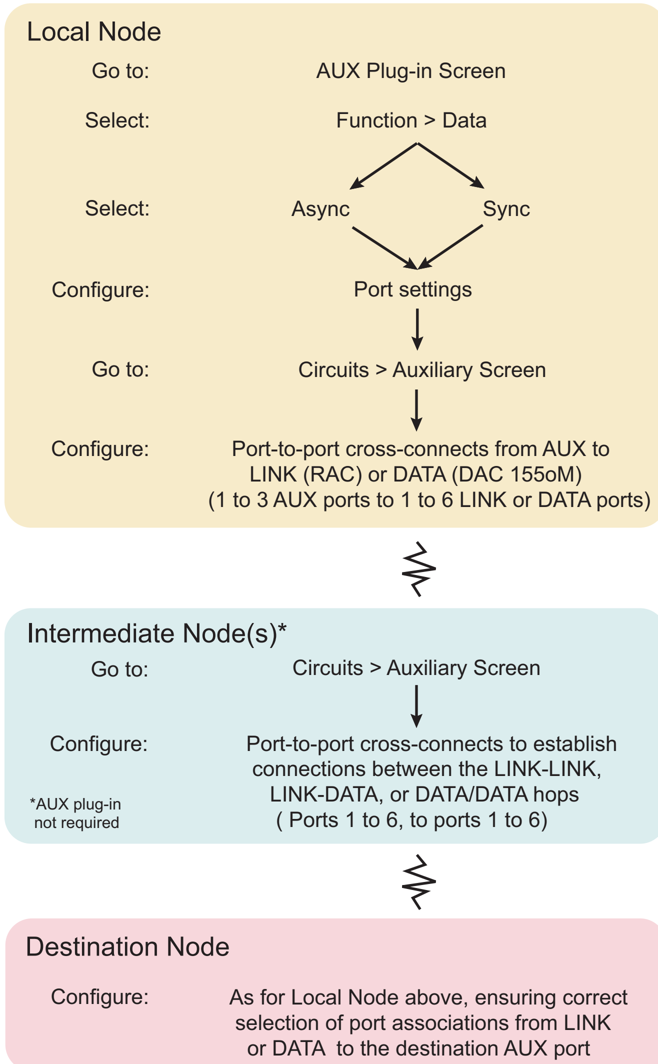
Within a protected ring, Auxiliary Data circuits will be interrupted beyond a break-point, and will not be restored until the ring unwraps.

Configuration Flow

The flow for AUX Data configuration for local, intermediate and destination Nodes is shown in Figure 7-35 on page 7-75.

[8] *6 channels are available within the normal 512 kbps overhead. Refer to AUX Transport on Link Overhead and Operating Rules on page 7-75.*

Figure 7-35. AUX Data Configuration Flow



NMS Option Overview

The data type for NMS connectivity is fixed for synchronous V.11/RS-422, 64 kbps.

For an INUe, the AUX plug-in must be inserted in slots 1 to 6 as NMS access is only provided on these slots on its backplane. Where the NMS data function is not selected, the AUX plug-in may also be inserted in slots 7 to 9.

The NMS option is not supported by the 9500 MXC Terminals.

AUX Transport on Link Overhead and Operating Rules

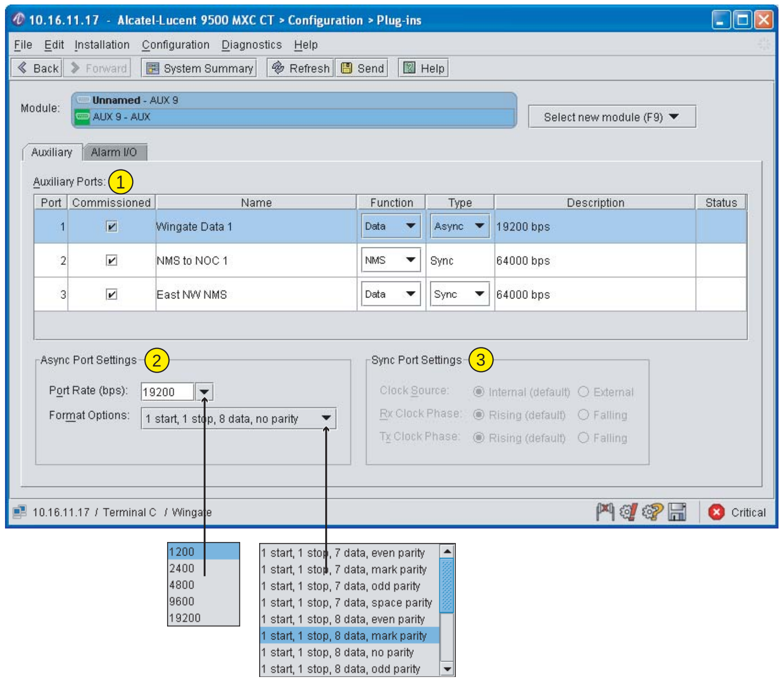
- The link overhead supports 9500 MXC NMS, radio-radio handshaking (such as ATPC), and auxiliary data.
  - Auxiliary data is allocated to individual 64 kbps circuits (up to six for the INU/INUe, one for the IDUs) in the overhead. 64 kbps channeling is used regardless of the async/sync selection.

  - When auxiliary data is not being transported, the full overhead capacity is available for NMS to get best possible NMS throughput speed.
- The overhead is provided on RAC (radio) and DAC 155oM (fiber) plug-ins (the two types which can be used to provide linking), and on the IDUs.
- The overhead supports a capacity of 512 kbps, with two exceptions:
  - DAC 155oM has two NMS transport options: RSOH (Radio Section Overhead) and MSOH (Multiplexer Section Overhead). RSOH limits the overhead to 192 kbps. MSOH provides 512 kbps.
  - For 4xDS1, QPSK, the overhead is limited to 256 kbps.
- Rules governing the use of the overhead for an INU/INUe *link* are:
  - 9500 MXC NMS transport requires a minimum 128 kbps.
  - Overhead capacity is reduced in 64 kbps steps (down to the 128 kbps minimum) for each data channel configured.
  - For a 512 kbps overhead this means up to six, 64 kbps auxiliary data circuits can be accommodated above the NMS minimum of 128 kbps (512 less 128 kbps).
  - For a 192 kbps overhead (DAC 155oM with RSOH) just one 64 kbps data circuit can be accommodated. Similarly, for a 4xDS1, QPSK configuration only two 64 kbps data circuits are possible within the 256 kbps overhead.
  - The 64 kbps data circuit allocation *must start at port 1* to avoid unnecessary overhead capacity reduction for NMS transport. Allocation is configured in the Auxiliary Circuits screen. Refer to Circuits Configuration - Auxiliary on page 9-14.

AUX Configuration

Figure 7-36 shows a typical screen for auxiliary data configuration.

Figure 7-36. Typical AUX Plug-ins Screen



Item	Description

1	Auxiliary Ports:
	• Commissioned. When ticked a warning alarm is raised in the event no clocking is detected on the port. Only applies to a Sync setting.
	• Name. Enter a name/ID (optional).
	• Function. Select Data or NMS.
	  • The NMS option is not available on 9500 MXC IDUs.
	  • The NMS option forces a Sync setting.
	• Type. Select Sync or Async.
	• Description. Confirms the data rate selected.
	• Status. Displays a problem icon in the event of a configuration or operational problem.

2	Async Port Settings. Configure for rate and format options.
3	Sync Port Settings. Configure for clock source and clock phasing.

To configure the AUX:

1. From the Plug-Ins screen, select the required module.
2. Click on a Port row to enable its configuration options.
3. Select Function, Data or NMS. (NMS is not a 9500 MXC Terminal option)

4. Select Type, Async or Sync. This option is only provided for a Function > Data. When NMS is selected, the Type is fixed to Sync.
   - Selecting Async highlights the Async Port Settings window. Configure for Rate and Format options. A sub-menu is provided for standard rate settings, but non-standard settings can be direct-entered up to 19.2 kbps.
   - Selecting Sync highlights the Sync Port Settings window. Configure for clock source and clock phasing.
5. The Description column confirms the data rate. Synchronous operation is fixed at 64 kbps.
6. The Status column displays a problem icon in the event of a configuration or operational problem.
7. Tick the Commissioned box for a configured port:
   - For a Sync setting, an AUX alarm is raised in the event no clocking is detected on the port. (If the box is not ticked, no alarm action is raised).
   - For an Async setting, no alarm action is provided.
8. Enter a name (optional) for each commissioned port.
9. For a Function > Data selection, proceed to Configuration > Circuits > Auxiliary Circuits, to configure the port cross-connects. Refer to Procedure for Configuring Auxiliary Circuits on page 9-15.

Before AUX *circuits* are configured, the plug-ins to be used to transport the AUX circuits (RAC/ DAC 155oM) must first be configured.

10. For a Function > NMS selection, no further AUX-specific configuration is required.
11. Enter a name (optional - recommended) for the module by right-clicking in the relevant AUX module in the **System Summary** screen, selecting **Rename**, and typing. The default name is ‘unnamed’.
    - The AUX name entered will appear in all CT screens where AUX is identified. Includes Plug-ins, Circuits, System Summary, System/Controls.
12. To commit the configuration, click **Send**.

Alarm I/O Configuration

The Alarm I/O screen supports AUX configuration of alarm input and output *conditions*. It does not support mapping of alarm actions; what to do with an alarm input, and where to source the event(s) to activate an alarm output. For *alarm action* mapping, refer to 9500 MXC Node and Terminal Alarm Actions on page 11-1.

9500 MXC Alarm I/O screen supports:

- Configuration options of:

9500 MXC Node	9500 MXC Terminal
• 2 TTL alarm inputs and 4 Form C relay outputs, OR • 4 TTL alarm inputs and 2 Form C relay outputs, OR • 6 TTL inputs only (default)	• 2 TTL alarm inputs and 4 Form C relay outputs.

- Inputs may be configured to sense for a high or low voltage to trigger an alarm.
  - Active Condition Low requires a ground or a TTL 0v on the input to trigger an alarm.
  - Active Condition High requires an open circuit or a nominal +5V TTL (> +2V) input to trigger an alarm.
- The output relays may be configured to be energized or de-energized on receipt of an alarm event.
  - Active Condition De-energized requires an alarm event to release the relay.
  - Active Condition Energized requires an alarm event to energize the relay.
  - On the relay, both normally closed and normally open contacts are available on the I/O connector. Refer to Appendix C.

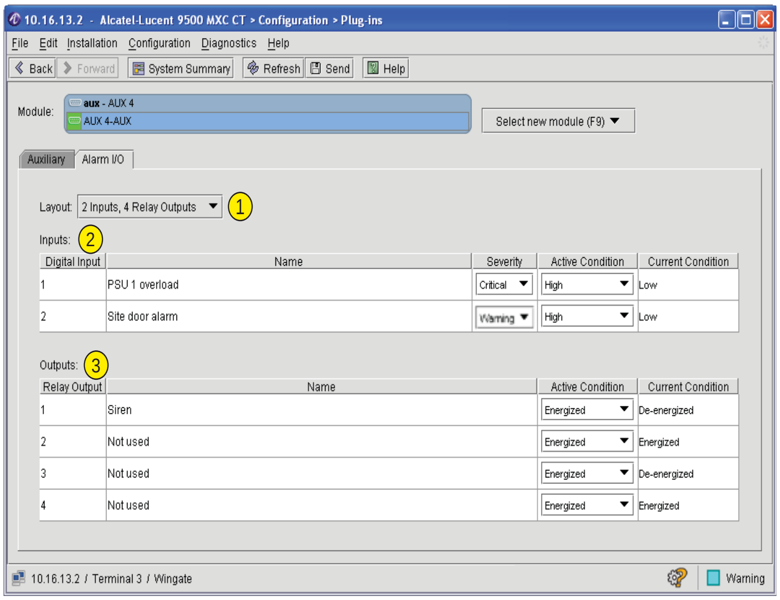
For output relay contact specifications refer to Alarm Outputs on page 3-57, Volume II, Chapter 3.

Directing alarm inputs to local or remote outputs, or internal alarms to local or remote outputs, is achieved in the Alarm Actions screen. Refer to 9500 MXC Node and Terminal Alarm Actions on page 12-1.

AUX Alarm I/O Screen

Figure 7-37 shows a typical AUX Alarm I/O screen for 9500 MXC Node. For 9500 MXC Terminal four Alarm I/O ports are displayed.

Figure 7-37. Alarm I/O Screen



Item	Description
1	For an INU/INUe select an input/output port combination. IDUs have one fixed combination.
2	Alarm I/O Ports: • Name. Enter an alarm name/description (optional). • Enter a severity. • Active Condition. Select high or low as the active (alarm-on) condition. • Current Condition. Current condition, high or low, for each alarm input. Relay Outputs: • Name. Enter an alarm relay name/description (optional). • Active Condition. Select relay energized or de-energized for the active condition. • Current Condition. Current condition, energized or de-energized, for each alarm output.

Procedure for Alarm I/O Configuration

1. From the Plug-Ins screen, select the required module.
2. Select the Alarm I/O tab.
3. Select the Port Layout required:
   - The Node supports three options for input and output combinations.
   - The Terminal supports one option.
4. For alarm inputs, select the severity: warning, minor, major, or critical. Alarm input status and severity is reported in the Alarms screen, and the time/date of a status change is captured in the Events Browser screen. Alarm inputs may be mapped to a relay output on any 9500 MXC radio in the network.
5. For each input and output select the Active Condition:
   - For an input this sets the condition required to trigger an alarm event. Active - Low indicates an alarm will be triggered with a change from a high (internal +5V source) when the input is grounded. Active - High will trigger an alarm when a nominal +5V input is applied (> +2V).
   - For a relay output this sets the active (alarm received) condition of the relay to energized or de-energized.
6. Current Condition indicates the present *alarm* state of each input or output.
   - If an input is set to active high, and no input is applied (open circuit) or a +5V TTL voltage is applied, the current condition is high, and an alarm is reported against that input. Similarly, if an input is set as active low and no ground is applied to that input (or no 0V TTL), the current condition is reported as high so no alarm is indicated.

     Where an *active* condition and *current* condition are the same, low/low or high/high, an alarm is reported.
   - If an output is set to active de-energized and no alarm event(s) mapped to it, its current condition is energized. Note also that both normally open and normally closed contacts are available on the alarm I/O connector.
7. To commit the configuration, click **Send**.

Next Step

To configure alarm actions (mapping), go to 9500 MXC Node and Terminal Alarm Actions on page 11-1.

For information on connector pinouts and I/O cable options, refer Appendix C.

Chapter 8. Protection

Node and Terminal protection are considered separately. Refer to:

- Node Protection on page 8-1
- Terminal Protection on page 8-15

Most screens support context sensitive help. To view, click on Help in the tool bar, or select Context Help under Help in the menu bar.

For protected links the licensed capacity of an INU must support both RACs - each must be separately 'licensed'.

Similarly, each IDU of a protected pairing requires its own license.

Node Protection

Link and Tributary protection mechanisms are supported.

Standard Link Protection configurations are:

- Hot-standby with two RACs
- Space diversity with two RACs
- Frequency diversity with two RACs
- Ring with two RACs or with a RAC/DAC 155oM pairing

For hot standby and diversity, the payload, auxiliary data, and remote alarm I/O connections are protected.

For ring, the payload and remote alarm I/O connections are protected; auxiliary data is not protected.

Dual Link Protection configurations provide master protection over two protected link pairs. Options are:

- Frequency diversity over hot-standby
- Frequency diversity over space diversity

Table 8-1 summarizes the dual link protection options; two protected subordinate links are in turn protected by a higher, master protection option. All RACs (RAC 30 or RAC 3X) must be located in the same INUe.

Table 8-1. Dual Protection Options

Master Protection	Subordinate Protected Link Pairings	
	Link A	**Link B**
Frequency Diversity	Hot Standby	Hot Standby
	Hot Standby	Non-protected
	Space Diversity	Space Diversity
	Space Diversity	Non-protected

1+1 Ring Link Protection

A 9500 MXC Super-PDH ring protected network can be enhanced with one or more 1+1 protected links.

- 1+1 protection of a ring-protected link is normally implemented to provide path protection as distinct from equipment protection. Therefore space diversity (SD) is the required/recommended 1+1 protection mode.
- 1+1 protection may be applied to co-channel ring links. Using RAC 40s two concentric, autonomous rings of equal capacity/bandwidth can be configured to operate on the same frequency using the V and H polarizations.

For more information on RAC 40 ring operation, with and without 1+1 protection, refer to Co-channel Operation on page 3-84, Volume II, Chapter 3.

Tributary protection provides redundancy for trib circuits in the event of a DAC failure.

Protected DAC operation is supported for:

- DAC 3xE3/DS3M
- DAC 1x155o
- DAC 2x155o
- DAC 2x155e
- DAC 155oM

For Node protection topics refer to:

- Node Protection Configuration on page 8-3
- Node Protection Operation and Rules on page 8-3
- Link and Data Protection Configuration Screen on page 8-9

More Information:

For **Node protection options**, refer to Protected Operation on page 3-60, Volume II, Chapter 3. Includes information on hot-standby, diversity, ring, and dual protection.

For **protection switching criteria**, refer to Protection Switching Criteria on page 3-77, Volume II, Chapter 3.

For a **description of Node protection operation**, refer to Appendix F.

Node Protection Configuration

For Link hot-standby and diversity configurations, two RAC plug-ins of the same type are required to provide protection, with one assigned as the primary, and the other secondary.

For Link dual protection configurations four RACs are required for subordinated protected/protected links, or three RACs for protected/non-protected installations. Each of the subordinated protected links are configured as standard hot-standby or diversity links, but while both must be configured for the same capacity each can be on different channel bandwidths and/or frequency bands. Similarly for a subordinated protected/non-protected link pairing.

For Ring the east west pairings may be RAC/RAC, RAC/DAC 155oM, or DAC 155oM/DAC 155oM. DAC 155oMs are used where fiber linking is required to close a ring.

For Tributary protection, two DAC plug-ins of the same type are required to provide protection, with one assigned as the primary, and the other the secondary.

From one Node/Terminal you can launch CT screens for its immediate remote partner(s) by right-clicking on the relevant RAC or DAC 155oM within a LINK, RING or DATA module (applies to all module-based screens such as System Summary and Plug-ins), and selecting the Launch Remote option (requires an operational connection to the remote end).

Node Protection Operation and Rules

This section provides data on the basic 9500 MXC link and data protection options. For additional data on dual protection and 1+1 ring protection refer to:

- Additional Rules for Dual Protection on page 8-6.
- Additional Rules for 1+1 Ring Protection on page 8-7

Protected Operation and Rules:

1. Two partner plug-ins must be installed in the Node; it is not possible to configure a protected link without both.
   - For a protected Link, two RACs of the same type must be installed.
   - For a Ring, two RACs, or a RAC and a DAC 155oM, must be installed. The two RACs may be different types, such as a RAC 30 in one direction, and a RAC 3X in the other.
   - For a protected Tributary, two DACs of the same type must be installed.
2. The licensed capacity of an INU must support both RACs - each must be separately 'licensed'.
3. The RAC protection function switches Tx and Rx paths independently.
4. Within the Protection screen, a RAC or protected RACs are identified as LINK. A DAC or protected DACs are identified as DATA.
5. Partner plug-ins will only be permitted within the slot conventions for the INU and

INUe. Refer to 9500 MXC Node Slot Numbering Conventions on page 1-5 of this Volume.

6. Where protected co-channel operation (protected RAC 40s) is required, hot-standby or diversity can be selected.
   - The *protection partner* RAC 40s must be installed in the same INU/INUe. Normal 9500 MXC hot-standby or diversity operation and rules apply.
   - The *co-channel partner* RAC 40s must be installed in a co-located partner INU, with one INU used on vertical polarization, the other horizontal. To avoid confusion, the vertical and horizontal assignments should be entered in the Polarization Settings panel in the Plug-ins screen.
   - An equal-loss coupler must be used with the protected ODU pairings.
   - Support is provided from SW release 4.3, for mixed ODU 300hp and ODU 300ep operation. Mixed hp/ep operation in protected RAC 40 configurations prior to this release is not recommended.
7. Once a protected pairing is configured, one or both RACs or DACs may be withdrawn without affecting the configuration and the protection screen representation.
8. A protected pairing will be returned to non-protected on selection of Non-Protected in the Partners column, or if one of the protected plug-ins is replaced by an incompatible plug-in type (such as a DAC 16x), *and* the incompatible plug-in is installed as the *accepted* plug-in the System Summary screen.
9. When two non-protected LINKs (2xRAC) are selected for hot-standby or diversity, the protected link will assume the circuit connections (traffic and auxiliary) of the primary RAC. Similarly, for hot-standby DATA (DACs) the protected DATA will assume the circuit connections of the primary DAC. Any circuit connections previously assigned to the secondary RAC/DAC will be dropped.
   - To ensure that circuit connections of what will be the primary link are retained, the selection of the primary RAC must be made by first highlighting the RAC which is to become the primary, and then selecting its secondary partner from the Partners sub-menu.
   - When a protected hot-standby or diversity link is returned to two non-protected links, the circuit connections established for the protected link will stay with what was the primary RAC. There will be no circuit connections assigned to what was the secondary RAC. Similarly, for protected DACs the circuit connections established will stay with what was the primary DAC. There will be no circuit connections assigned to what was the secondary DAC.
10. When two non-protected links (2xRAC, RAC with DAC 155oM, or 2xDAC 155oM) are selected for RING protection, the ring will assume the circuit connections (traffic and auxiliary) of the east RAC or DAC.
    - To ensure that circuit connections of what will be the east link are retained, the selection of the east RAC or DAC must be made by first highlighting the RAC/DAC which is to become east, and then selecting its secondary partner from the Partners sub-menu.
    - When a ring is returned to two non-protected RACs and/or DACs, the circuit connections established for east will stay with what was the east RAC/DAC. There will be no circuit connections assigned to what was west.
11. Ring protection provides options for wrap and unwrap actions.

- Wrap and unwrap criteria may be separately selected for Standard and Sensitive. Refer to Ring Protection Switching Criteria on page 3-92, Volume II, Chapter 3.
- An Error-free Timer supports selection of 10 seconds, or 1, 5, or 10 minutes. An unwrap will occur once all wrap criteria have been cleared for the selected period.
- A Delay Ring Unwrap timer supports setting of a time of day for an unwrap (providing all wrap criteria have been cleared).

12. For a wrapped ring link the RAC Online LEDs remain unlit until the unwrap error-free timer and, if set, the time of day timer times out[1].
13. For a hot standby or space diversity link, the primary RAC is default online transmitting, and the secondary RAC is controlling online receiving (both RACs are receiving data but the assigned secondary RAC controls the hitless switching between each stream and sends data to the TDM bus).
14. For a frequency diversity link, both primary and secondary RACs are online transmitting, and the secondary RAC is default controlling online receiving (both RACs are receiving data but the secondary RAC controls the hitless switching between each stream and sends data to the TDM bus).
15. For protected DACs, primary and secondary DAC operation is determined by the protection type selected:
    - For a Tributary Protected option (TT selection), the primary DAC is default online transmitting (Tx to customer equipment) *and* sending Rx data to the TDM bus.
    - For Tributary Always-On option (TA selection), both primary and secondary DACs are default online transmitting to customer equipment (the customer equipment switches between these two always-on tributaries), but only the primary DAC is sending Rx data to the TDM bus.
    - For a TT selection, “Y” cable sets must be used on the tributaries.
    - For a TA selection, separate cable sets are used on the tribs to each DAC.
16. LOS on any trib interface is a switching condition. Ensure all traffic-carrying tribs are commissioned (commissioned tick-box for relevant trib(s) in Plug-ins screen is ticked). Equally, ensure tribs not used are not commissioned (not ticked).
17. When a failed hot-standby or diversity RAC/ODU, or failed DAC is repaired or replaced it immediately becomes available for protection service, but it will *not* automatically return to its default configuration for primary and secondary online operation. Return to default (or other user-configured setup) requires use of the lock function in the System Controls screen to first force a manual change, and to then restore Auto/Lock-off.
18. When a failed *ring* link node is repaired or replaced it is automatically returned to service after completion of the Error-free Timer period (default 5 minutes) and, if set, the optional Delay Ring Unwrap Timer.
19. A protection guard timer mechanism prevents protection switching oscillation. Refer to Switching Guard Times on page 3-77, Volume II, Chapter 3.

[1] *Even when RAC/RAC communication is restored on the wrapped link, the RAC Online LEDs remain unlit until the unwrap timers time out.*

Additional Rules for Dual Protection

1. All RACs must be installed in one INUe.
   - Four RACs for a protected-with-protected link pairing.
   - Three RACs for a protected-with-non-protected link pairing.
2. Subordinated links may use different RACs, for example one link may use RAC 30s, the other RAC 3Xs. Similarly if a protected link is paired with a non-protected link, the RAC used in the non-protected link does not need to be of the same type used in the protected link.
3. Both subordinated links must be configured for the same capacity.
4. Each of the subordinated links are first configured for the protection option required. Refer to Dual Protection Options on page 8-2. Once configured the option to protect is applied to one of the protected links, whereupon all valid protection partners are presented for selection.
5. Each subordinated link may operate on different channel bandwidths, and/or different frequency bands.
6. Each of the subordinated links operates as a normal link of that configuration.
7. Under dual protection only one link of the two subordinated links is sending received data to the Node bus at one time.
8. With frequency diversity master protection both of the subordinated links are online transmitting. Subordinated links (hot-standby / space diversity / non-protected) must be configured on different frequency channels.
9. Dual protection switching is not hitless. Each of the two subordinated protected links incorporate hitless (errorless) Rx switching in the normal way, but the master switch between the two subordinated links is not hitless. Refer to Dual Protection on page 3-63, Volume II Chapter 3, and to Service Restoration Times for Dual Protection on page 3-81, Volume II, Chapter 3.
10. With a frequency diversity master switch it is possible to operate with Rx from one protected link, and Tx to the other.
11. The frequency diversity master switch only controls the Rx:
    - There is no Tx switch event (no muting of transmitters). Each of the two subordinated links (hot-standby / space diversity / non-protected) remain free to transmit (they cannot therefore share a frequency channel).
    - The receive data stream is switched to what was its offline link to bring it online sending to the backplane bus.
12. When two protected links are selected for dual protection (or protected with non-protected) the secondary link will assume the circuit connections of the primary link. Any circuit connections previously assigned to the secondary link will be dropped.
13. When a dual protected link is returned to two separate protected links (or protected link and a non-protected link), the circuit connections established will stay with what was the primary link. There will be no circuit connections assigned to what was the secondary link.

Additional Rules for 1+1 Ring Protection

1. 1+1 protection of a ring-protected link is normally implemented to provide path protection as distinct from equipment protection. Therefore space diversity (SD) is the required/recommended 1+1 protection mode[2].
2. One, some or all links on the ring may be 1+1 protected.
   - A 9500 MXC ring Node may have one or both (east and/or west) ring links configured for 1+1 protection.
3. 1+1 protection may be applied to co-channel ring links.
   - Using RAC 40s two concentric, autonomous rings of equal capacity/bandwidth can be configured to operate on the same frequency using the V and H polarizations.
   - Where co-channel links are to be 1+1 protected, both links (V and H) must protected.
   - For more information on RAC 40 ring operation, with and without 1+1 protection, refer to Co-channel Operation on page 3-84, Volume II, Chapter 3.
4. A ring-wrap will occur when:
   - The path supported by a 1+1 link exhibits a path fail condition. The path failure switching criteria are the standard ring path failure criteria, with the exception of the 10^{-6} BER option[3]. Refer to Radio Wrap Conditions on page 3-82, Volume II, Chapter 3.
   - The 1+1 link triggers an online Rx and/or Tx switch event. Refer to Hot-standby and Diversity Switching Criteria on page 3-77, Volume II, Chapter 3.
   - The 1+1 link triggers a demodulator not locked alarm on both RACs.

- The decision to unwrap is made when the ring error-free timer times out and, if set, the time of day timer. Refer to Unwrap Timers on page 3-83, Volume II, Chapter 3.
- Ring wrap and unwrap times for 1+1 ring links are identical to 1+0 ring links. Refer to Wrap and Unwrap Times on page 3-82, Volume II, Chapter 3.
- The protection guard timer mechanism prevents switching oscillation at the ring level. Refer to Switching Guard Times on page 3-77, Volume II, Chapter 3.
- Event Browser entries are created for switch events on the ring and subordinate space diversity link(s).

Figure 8-1 illustrates the protection management hierarchy where both east and west links on a Node are space diversity.

Figure 8-2 illustrates the heirachy where one ring link is space diversity, and the other 1+0.

- Space diversity protection is subordinated to ring protection.
- A subordinate space diversity link operates as a standard link according to standard ring requirements.
- A subordinate space diversity link operates independently of the ring operation. Specifically, a wrapped ring link does not inhibit normal 1+1 operation of the space diversity link.

2 Hot-standby can be configured, but unlike space diversity offers no protection against path fade events. However, should ring 1+1 operation with hot-standby links be required, its CT configuration is identical to space diversity.

3 For 1+1 ring links the 10^{-6} BER ring wrap/unwrap option is not supported.

Figure 8-1. Switch Management Heirachy: SD + SD Subordinated Links

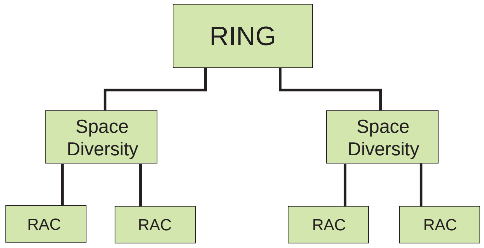
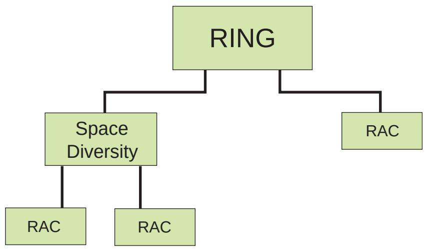


Figure 8-2. Switch Management Heirachy: SD + 1+0 Link



A ring wrap occurs when the path provided by the space diversity link fails, or a Tx or Rx online switch event occurs on the space diversity link, or both space diversity receivers trigger a demodulator not locked alarm.

- Normal space diversity online Tx and/or Rx switching remains enabled when the ring is wrapped.
- A silent transmitter switch[4] is initiated when both far-end receivers are in path-fail alarm, and the link has been wrapped for not less than 5 seconds.
  - If the link failure is due to a path fade, the silent transmitter command from the far-end(s) will not be received at the local end(s), meaning no Tx switch will occur.
  - If the link failure is due to a Tx failure, the silent transmitter command from the far end will initiate a switch to the standby Tx at the local end (the secondary RAC is the default standby Tx).
- Auxiliary data circuits and any payload circuits configured for point-to-point operation are not protected in the event of a ring wrap (as for a ring operation using 1+0 links).
- NMS is supported on the 1+1 ring links (as for ring operation using 1+0 links).
- Standard ring diagnostics are supported at the ring level, and operate independently of the 1+1 diagnostics.
- Standard 1+1 link diagnostics are supported on the 1+1 ring links.
- For 1+1 ring links the RAC Online LED indications are governed by the ring state:

[4] *A silent transmitter switch is designed to prevent an undetected transmit failure from causing a link to go down indefinitely.*

- For an *unwrapped* 1+1 (space diversity) link the RAC Online LEDs are governed by normal SD link operation; for the default situation of primary RAC online transmitting and secondary RAC online receiving (controlling the receive diversity bus) both RACs at each end of the link indicate green Online.
- For a *wrapped* 1+1 link the RAC Online LED indications are governed by the ring. All RAC Online LEDs are unlit if the 1+1 link has been restored but waiting for the error-free timer and, if set, the time of day timer to time out (as for ring operation using 1+0 links).

Link and Data Protection Configuration Screen

The Protection Configuration screen provides:

- Identification of *protectable* and/or *protected* Link (RAC) and Data (DAC) entities
- Slot location of associated installed RAC and DAC plug-ins
- Identification of protected and non-protected pairings
- Selection of plug-in pairs for a protected configuration
- Selection of the protection type
- Selection of the primary and secondary, or east and west partners.

Figure 8-3 on page 8-10 shows a typical Protection screen for an INUe.

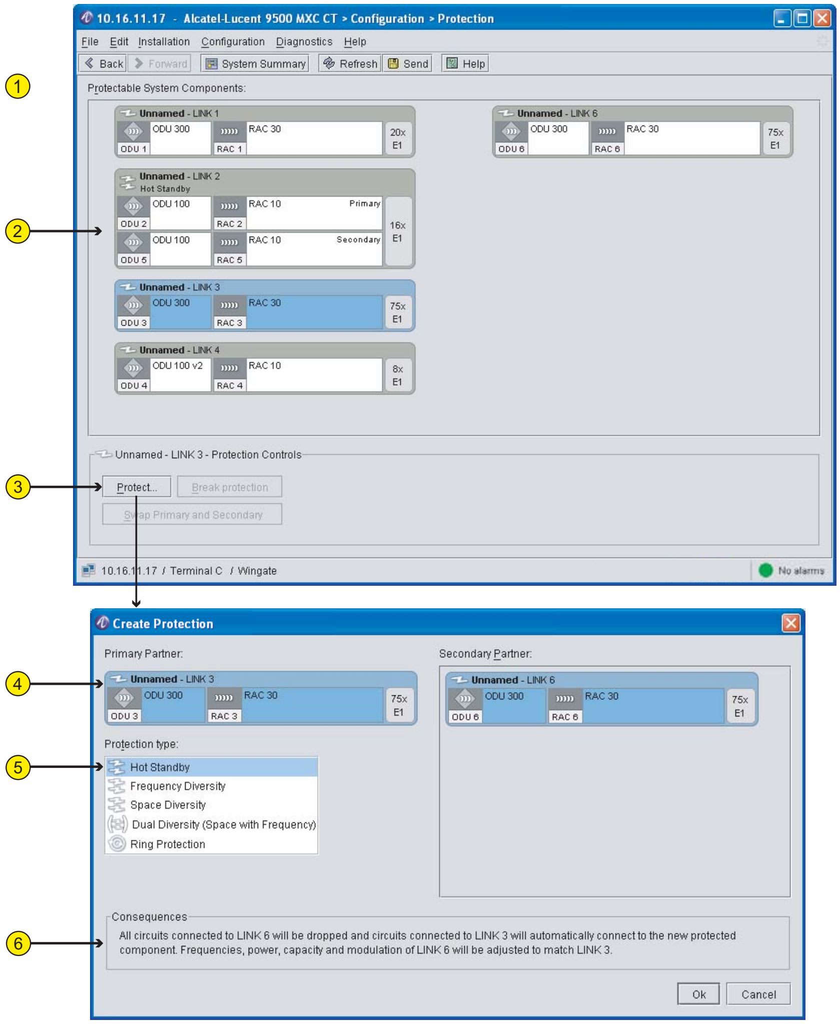
Figure 8-4 on page 8-11 shows a typical Protection screen for a ring selection.

Figure 8-5 on page 8-12 shows a Protection Selection Window for a DATA/DAC selection.

For configuration procedures refer to:

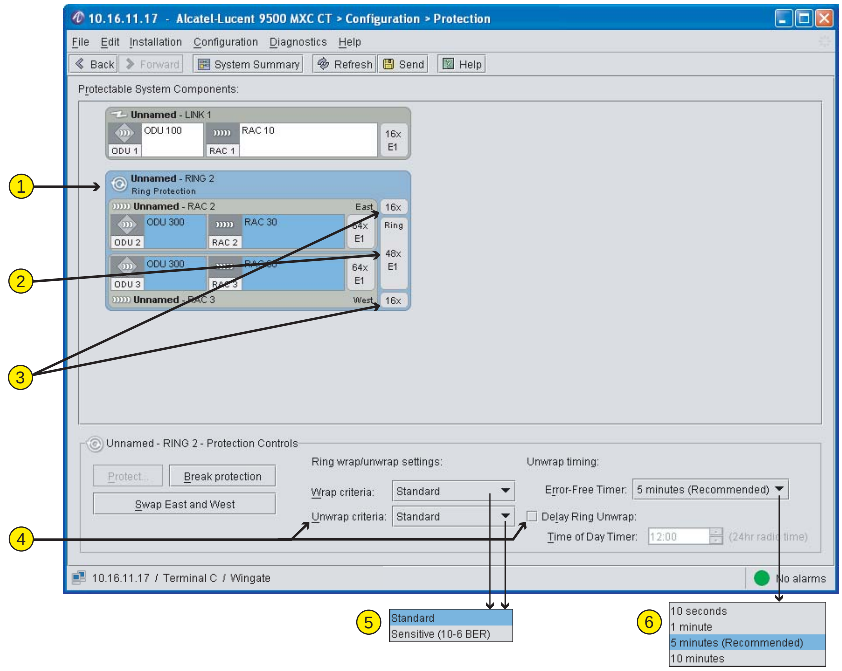
- Description of Node Protection Configuration Screen on page 8-12
- Configuring Node Protection Options on page 8-13

Figure 8-3. Typical INUe Protection Screen



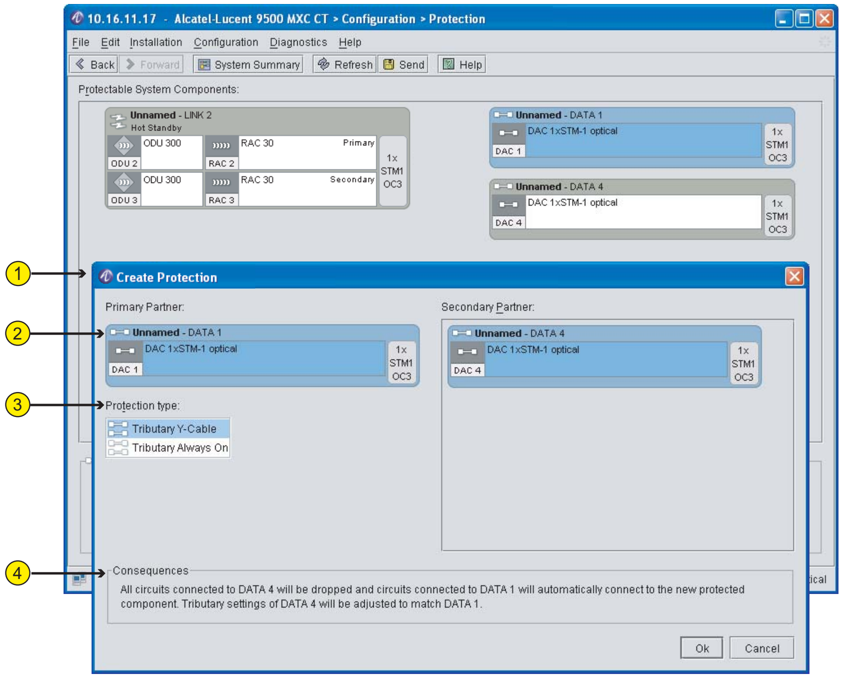
Item	Description
1	The Protection screen identifies all *protectable* plug-ins and all plug-ins that have been configured for *protected* operation. Once a link is protected, the options are to break protection or to swap primary with secondary.
2	Link 2 shows a hot-standby pairing, its primary/secondary status, and its configured capacity.
3	The example screen shows that Link 3 (RAC in slot 3) has been selected (highlighted). Click **Protect** to select a protection partner.
4	The example shows that only Link 6 is available/valid for protection pairing with Link 3.
5	Select a protection type.
6	The note indicates the consequences of protection action for each protection type.

Figure 8-4. Typical Ring Protection Screen



Item	Description
1	Shows a ring pairing with its configured ring capacity and balance of available LINK capacities.
2	In this example the east and west RACs have been configured for a capacity of 64xE1, but with a ring capacity of 48xE1. (Note that a 1xE1/DS1 capacity is auto-configured when ring protection is first set).
3	Shows balance of circuits available (16xE1) for use as additional ring-protected circuits, or as point-to-point circuits.
4	Ring wrap and unwrap settings. If Delay Ring Unwrap is selected, both wrap and unwrap criteria default to standard.
5	Select standard or 10^{-6} BER wrap and unwrap criteria.
6	Select an unwrap timer option. An unwrap will occur upon error-free completion of the selected period.

Figure 8-5. Protection Window for DATA/DAC protection



Item	Description
1	The Protect tab has been clicked to open the Create Protection window for a DAC 1xSTM1 (DATA 1) selection.
2	Select partner and protection type. For this example the only available/valid protection partner for DATA 1 is DATA 4.
3	Select TA or TT trib protection type.
4	The note indicates the consequences for the selected protection action.

Description of Node Protection Configuration Screen

The configuration screen identifies:

- All installed RACs (all RACs are protectable)
- All *installed and protectable* DACs (E1/DS1 and Ethernet DACs are not protectable)
- Current protection status, and which LINK or DATA of a protected pairing is primary or secondary, or east and west for a ring.
- Link type, RAC location and configured link capacity.
- For ring protection, identification of E1/DS1 circuits assigned to the ring and the balance of circuits available to assign to the ring or as point-to-point circuits.

The Protection Screen enables:

- Selection of a component to protect. The selected component will automatically become the primary component of a protected pairing.
- Selection of the protection partner and protection type.

- Identification of configuration consequences when applying protection to existing components.
- Selection of some protection specific options, such as 10^{-6} BER wrap and unwrap criteria for a ring selection, and selection of tributary protection type for a protected DATA/DAC pairing.
- Swapping of primary and secondary, or east and west.
- The breaking of a protection pairing.

Configuring Node Protection Options

If your are configuring Dual Protection or 1+1 Ring Protection options, refer to their additional rules before commencing configuration. See:

- Additional Rules for Dual Protection on page 8-6.
- Additional Rules for 1+1 Ring Protection on page 8-7.

If you are configuring protection on co-channel XPIC links, refer to the guidelines provided in Co-channel Operation on page 3-84, Volume II, Chapter 3.

To view and configure protection options:

1. Identify the LINK, DATA, or LINK/DATA pairings you wish to convert to protected operation.
2. For LINK or DATA protection, identify which is to become primary. This is important where you wish to maintain any existing circuit connections; the LINK or DATA assigned as primary will retain its existing connections, and circuit assignments for the secondary will automatically be configured to match the primary. (Any prior circuit connections for the secondary will be dropped - view ‘Consequences’ for on-screen advice).
   - Click first on the component *which is to become primary* then click Protect to view the Protection Selection window. Only valid partners are shown.
   - For a LINK select the partner and the protection type required, then click OK to confirm.
   - For a DATA select the partner and the tributary protection type required, then click OK to confirm.
3. For a dual protection of protected links or protected with non-protected, identify which is to become primary. The protected LINK assigned as primary will retain its existing connections; circuit assignments for the secondary will automatically be configured to match the primary.
   - Click first on the LINK which is to become primary then click Protect to view the Protection Selection window.
   - For a protected link only dual protection options are shown. Select the partner and the protection type, then click OK to confirm.
4. For RING protection, identify which is to become east and west. The LINK or DATA (DAC 155oM) assigned as east will retain any existing connections, and circuit assignments for the west will automatically be assigned to match the east. (Any prior circuit connections for the west will be dropped - view ‘Consequences’ for on-screen advice).
   - Click first on the component *which is to become east* then click Protect to view the Protection Selection window. Only valid partners are shown.

- Select ring-wrap and unwrap criteria. See Figure 8-4. Options are provided for Standard and Sensitive, with additional unwrap selections of an Error-free Timer, and a Delayed Ring Unwrap timer:
  - Standard is default for wrap and unwrap. For information on ring wrap and unwrap criteria, refer to Ring Protection Switching Criteria on page 3-81, Volume II, Chapter 3.
  - Sensitive *adds* a 10^{-6} BER event to the wrap and/or unwrap criteria. A *wrap* will occur on occurrence of a standard wrap event and/or a 10^{-6} BER event. Similarly an *unwrap* will not occur until after completion of an error-free period that is clear of any standard or 10^{-6} BER events.
  - The Error-free Timer sets the period of error-free operation needed prior to initiation of an unwrap. (When a wrap has occurred the timer counts down towards an unwrap as soon as all wrap conditions are cleared. The count begins anew should a wrap condition re-occur during the countdown). Default is 5 minutes (recommended).
  - The Delay Ring Unwrap option allows setting of a time of day when an unwrap will occur providing all wrap conditions have been cleared for a period not less than that set in the Error-free Timer.
    - With this option selected the Wrap and Unwrap criteria default to Standard.
    - The Delay Ring Unwrap has a 1-hour window. If the conditions which caused the wrap are not cleared by the Error-free Timer during this window, then Delay Ring Unwrap resets for the same time the following day.
  - The System/Controls screen provides a countdown timer to indicate the time to go before the ring will unwrap. Applies to both the Error-free Timer and Delay Ring Unwrap Timer. (Counts down to zero).

5. Should you wish to reverse primary and secondary, or east and west roles, click on the ‘Swap primary and secondary’ or ‘Swap east and west’ tab.
6. To commit the selection, click **Send**.

To return a protected link/ring to two non-protected links, click on the Break Protection tab. Existing circuit connections will transfer to what was the primary/east link. There will be no circuit connections assigned to what was the secondary/west link.

Changing the protection type or changing the primary and secondary selection may cause existing circuits to be disconnected. When making a change, always check any existing circuit connections to/from the affected plug-ins and reconfigure as necessary.

Terminal Protection

The protectable Terminals are:

IDU	Protection Options
IDU 20x	Hot-standby, Space Diversity
IDU 155o	Hot-standby, Space Diversity

Tx protection switching is not hitless. Rx path switching (voting) is hitless (errorless) between the two receive data streams on hot-standby and space diversity.

Tributaries must be configured for either Tributary Protected or Tributary Always On.

Refer to:

- Terminal Protection Operation and Rules on page 8-15
- IDU Protection Configuration on page 8-17

Terminal Protection Operation and Rules

Note that when an IDU 20x is configured for protected operation above 20xE1 or 16xDS1, the standard trib and PSU protection functions are not supported.

- For capacities to 20xE1 / 16xDS1 standard IDU equipment and path protection applies, with Y cables normally used on the tribs.
- For higher capacities, traffic from the standby IDU is routed to the online IDU to support termination of up to 40xE1 or 32xDS1 tribs. In this configuration trib and PSU protection is not supported, however RAC/ODU and path protection functions are retained, though unlike operation at 20xE1 / 16xDS1 there is no Rx voting on the two receive streams; each Rx default sources its data form its directly-connected ODU. In the event of a path/ODU failure the affected IDU switches to source its data from its partner IDU, which is not hitless.

Operation and Rules:

1. The IDU partners must be of the same type and configured for the same capacity, modulation, frequency and Tx power.
2. Each partner must be separately configured; there is currently no ability to configure one, and copy its configuration to the other.
3. A *protected* IDU pairing does not support protected operation to an INU. A protected IDU link requires like IDUs at both ends.
4. The IDU partners must be loaded with the same release of operating (embedded) software.
5. The IDU designated as primary is default online for Tx and Rx providing the primary and secondary IDUs are powered on at the same time[5].
6. In the event of a Tx switch (hot-standby and space diversity) the online Rx, which controls the hitless Rx operation (diversity bus), is also switched to be with the online Tx IDU. The reverse does not occur i.e. if the an online Rx switch occurs, the

[5] *Providing the primary IDU is powered on before the secondary IDU, or within 10 seconds of the secondary IDU, the primary IDU will be default online. If the primary IDU is powered on later than 10 seconds after the secondary, the secondary IDU will be established as the online IDU.*

Tx does not switch.

7. Tx switching is not hitless. Rx path switching (voting) is hitless (the least errored Rx data stream from the two receivers is selected by the online Rx on a block-by-block basis).
8. When a switch does occur, the link will stay with the online Tx and Rx until forced to change by a subsequent alarm condition or a CT command.
9. Protection applies only to the payload and alarm I/O[6]; auxiliary data is not protected.

   If auxiliary data is required it should be configured for the primary IDU at each end of the link, which is the default online IDU. In the event of a protection switch (to secondary IDU Tx or Rx), the link must be returned to primary online to restore auxiliary data.
10. Alarm I/O is configured separately for each partner.
11. The two IDU partners must be interconnected with a protection cable and Ethernet NMS cable before commencement of protection configuration, and must stay in place subsequently to support protection switching and NMS access.For the IDU 20x the interconnecting protection cable/ports are labelled as 'Expansion'.
12. Providing the protection cable is installed, only one IDU can be transmitting (partner is Tx muted). This applies regardless of whether or not 'Enable IDU Protection' has been selected in the IDU protection screens.
13. If the IDU which is acting as the hub[7] for NMS interconnection is switched off (-48 VDC supply removed), next-hop NMS connectivity will be lost.
    - Before disconnecting the supply to one IDU of a protected pair, ensure next-hop NMS connectivity is maintained by, if necessary, re-locating the next-hop NMS cable to its partner IDU.
14. When installed with a single antenna, an equal loss coupler is recommended. If an unequal loss coupler is used, bear in mind that one IDU has both its Tx and Rx connected to the low-loss side, and the other IDU the high-loss side.
15. A unique IP address must be entered for the IDU partners (each must be seen as a separate device on the management network).
    - The network portion of the IP address must be common. The host portion must be unique (both IDUs are on the same LAN).
    - OSPF or RIP should be selected. Static routing can be used but care must be exercised within a network of two or more hops of protected IDUs in the event the IDU providing the cabled Ethernet NMS connection to the next hop is powered-down/withdrawn and it is necessary to transfer the cable to its partner IDU.
16. For IDUI 155o, and for IDU 20x with protected capacities to 20xE1 or 16xDS1, two tributary protection options are provided; Tributary Protection (TT), and Tributary Always On (TA). Tributary Protection is normally used. For the IDU 20x a third option is provided on capacities above 20xE1 or 16xDS1: Hot Standby: Non-protected Tributary.
    - For a Tributary Protected selection, "Y" split/merge trib cable assemblies must be used. Trib-in (from customer) is connected to both IDUs, but only the online Tx IDU transmits. Trib-out (to customer) connects data from the online receiver only; the standby trib-out function is muted.

[6] *Alarm I/O remote actions are transported via the NMS.*
[7] *Connects its partner IDU and a co-located link or other NMS port for next-hop NMS.*

- For Tributary Always-On option (TA selection), standard trib cable assemblies are used to connect each IDU to the customer equipment. Trib-in (from customer) is connected to both IDUs, but only the online Tx IDU transmits (as for a TT selection). Trib-out (to customer) connects received data from both the online and standby IDUs; the customer equipment provides selection of the receive stream.
- For IDU 20x, Hot Standby: Non-protected Tributary, must be selected where the IDUs are used for capacities above 20xE1 or 16xDS1.

17. LOS on any trib interface is a switching condition. Ensure all traffic-carrying tribs are commissioned (commissioned tick-box for relevant trib(s) in Plug-ins screen is ticked). Equally, ensure all tribs not carrying traffic are not commissioned (not ticked). Except that LOS is not a switching condition for IDU 20x when configured for capacities above 20xE1 / 16xDS1.
18. Once a protected pairing is configured, one IDU may be withdrawn from service (power off) without affecting their protection configuration.
19. When a failed IDU is repaired or replaced it immediately becomes *available* (after start-up) for protection service, providing the original CompactFlash card is installed.
20. A protection guard timer mechanism prevents protection switching oscillation. Refer to Switching Guard Times on page 3-77, Volume II, Chapter 3.

IDU Protection Configuration

Before commencing configuration of a protected IDU pairing:

- Ensure the Protection and Ethernet interconnection cables are installed between the IDU partners.

Providing the protection cable is installed only one IDU can be transmitting.

- Determine which of the partner IDUs is to be configured as primary.

Configuration Procedure

This procedure applies to standard protected IDU operation. For the **IDU 20x,** refer to Additional Procedures for IDU 20x on page 8-20, which applies to operation at capacities greater than 20xE1 or 16xDS1.

A summary of the protection procedure for a new installation is provided below. For more complete IDU information refer to Procedure Overview for a New Installation on page 3-7, in Volume IV.

At the outset each IDU must be separately logged into with CT to configure a network IP address and protection settings (V.24 or Ethernet DHCP login, depending on the IDU). Once configured, CT screens for both IDUs can be displayed using an *Ethernet* NMS connection to just one of the IDU partners.

Configure in turn:

1. **Information** (terminal and site names).

2. **Plug-ins** (link, tributary, auxiliary, alarm I/O).

   Link and tributary settings must be identical for the partner IDUs.

   Auxiliary data functions are not switch-protected.

3. **Networking** (IP addressing and routing). Configure each IDU partner with a unique IP address. The network address octets (that which is set with the network mask) should be common but the host address must be unique.

   OSPF or RIP routing is recommended. Static routing can be used but care must be exercised in networks of two or more hops. See Terminal Protection Operation and Rules, pt 15.

4. **Protection**. Select Enable Unit Protection and configure for primary or secondary[8], and tributary protection type. Refer to Figure 8-6.

   At this point, once configurations have been confirmed by clicking Send, CT screens for both IDUs can be opened using a CT connection to one of the IDUs[9]. Log into one IDU and select its partner by selecting File > New CT > Partner IDU.

5. **Alarm Actions** (if required)

6. **Date/Time**.

7. **Software Management** (both partners must be loaded with the same software release)

8. To commit the configurations click Send.

9. Check the partner configurations.

   The Configuration > Protection screen confirms the IP address for the viewed IDU and partner IDU, and whether set for primary or secondary.

   The Diagnostics > System/Controls > Unit Protection screen for the Link Module confirms the protection settings and which of the IDUs is online for Tx and for Rx.

10. During antenna alignment apply a Tx lock at each end of the link.

11. Exercise protection switching using the Tx Mute control in Diagnostics > System/Controls. IDU Protection Configuration Screen

The Protection Configuration screens shown in Figure 8-6 provide:

- Enabling Terminal protection.
- Confirmation of an IDU protection pairing; partner unit IP addresses are automatically set/shown when the protection cable is plugged in.
- Selection of primary and secondary IDU.
- Selection of tributary protection type.

More information:

- For protection switching criteria, refer to IDU Protection on page 2-23 in Volume II, Chapter 2.
- For online/offline locks, loopbacks and Tx mute, refer to System/Controls on page 15-35, Volume IV, Chapter 15.

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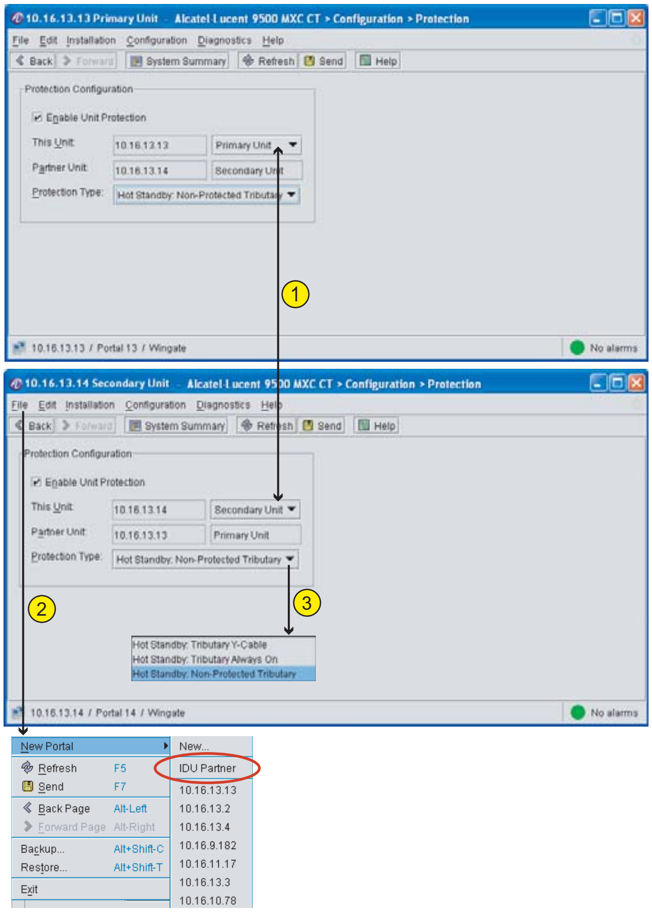
8 *If both IDUs are configured as primary, or secondary, a configuration not supported alarm will appear.*

9 *For protected IDUs two screens can be launched, one for the primary IDU and one for secondary, and the two screens positioned to sit side-by-side or above-and-below. CT memorizes the most recent size/position settings for primary and secondary and automatically applies these in all future protected IDU sessions.*

Figure 8-6. IDU Primary and Secondary Protection Screens



Item	Description
1	Ensure that one IDU is configured as Primary and the other as Secondary. Example screens show an IDU 20x pairing.
2	To easily open a CT session with a protection partner click File > New CT > IDU Partner.
3	Select the tributary protection type.

Additional Procedures for IDU 20x

The IDU 20x supports normal terminal protection for capacities to 20xE1 or 16xDS1 using the Hot Standby: Tributary Y-cable, or Hot Standby: Tributary Always-On options. Follow the standard IDU protection configuration procedures.

It also supports Hot Standby: Non-protected Tributary, which provides for termination of 40xE1 or 32xDS1 tribs using separate 20xE1 or 16xDS1 connections *to each IDU*. In this configuration trib and PSU protection is not supported, however RAC/ODU and path protection functions are retained, though such protection is not hitless for traffic on the failed path/ODU.

- For 40xE1 or 32xDS1 operation, traffic from the standby IDU is routed to the online IDU to support termination of 40xE1 or 32xDS1 tribs; 20/16 tribs from each IDU. Figure 8-7 illustrates normal data flows for the two sets of trib traffic.
  - Protection is provided for all 40/32 tribs for a path / ODU failure. Each IDU can take Rx data from its directly connected ODU (default), or from the partner ODU/IDU via the IDU-IDU expansion cable.

    Switching on a *failed path* is not hitless; the 20/16 tribs assigned on the failed path are restored from the remaining path (via the IDU-IDU expansion cable) within 200 ms, the 20/16 tribs assigned on remaining path are not affected. Figure 8-8 illustrates data flows for the two sets of trib traffic for an offline ODU failure.
  - Protection is not provided for all 40/32 tribs for a *tributary module or PSU equipment failure*. Tribs terminated on the failed IDU (20/16 tribs) will be lost; tribs terminated on the partner IDU will not be affected, providing the recommended (default) protection configuration is used where each IDU is taking Rx data from its directly connected ODU.

Configuration is identical to the standard IDU protection procedure except that:

- The IDUs are configured for 40xE1 or 32xDS1 link capacities in the Plug-ins screen. These capacities must be supported by the appropriate license. Refer to Volume IV, Chapter 4.
- Hot Standby: Non-protected Tributary must be selected in the Protection screen.
- Ensure the default protection configuration has been applied. Use the System/Controls screen to check that the following status is confirmed. If not, use the Tx Online and Rx Source locks to force a change, then restore locks to Auto.
  - Tx online is Primary.
  - Primary Controls > RX Source is Primary (Primary IDU is taking its traffic from its directly-connected ODU).
  - Secondary Controls > RX Source is Secondary. (Secondary IDU is taking its traffic from its directly-connected ODU).
- As the tribs are not protected for Hot Standby: Non-protected Tributary operation, each IDU is separately trib-cabled (cross-over or straight cables) to its user interface. Y cables are not used.

For easy simultaneous viewing of multiple screens, move and resize the screens. Once the screen positions are set, the same positions for primary and secondary IDUs appear each time a protected IDU pairing is opened.

Figure 8-7. IDU 20x: Normal Data Flow

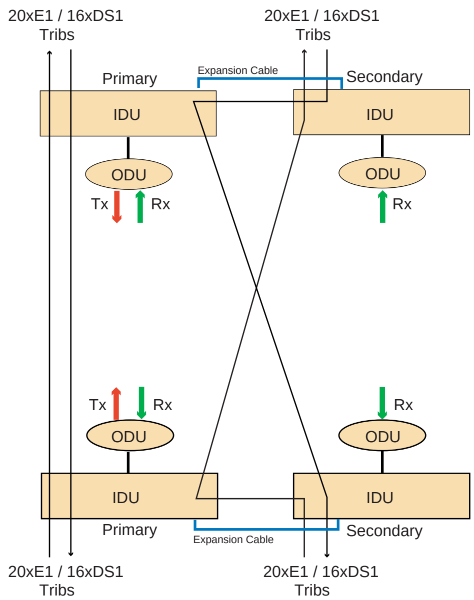
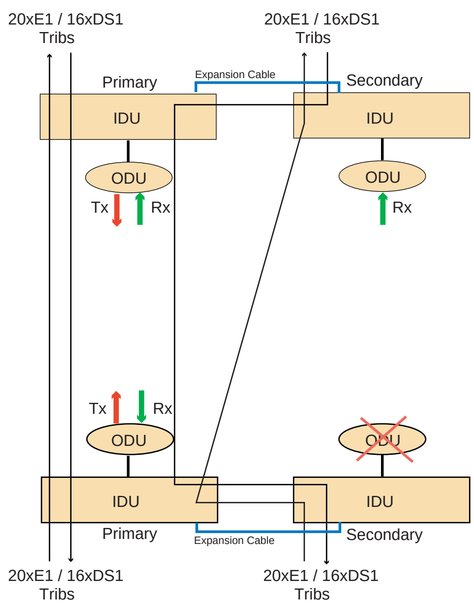


Figure 8-8. IDU 20x: Data Flow with Offline Rx ODU Failure



Chapter 9. Circuits

The Circuits configuration screen supports separate windows for traffic and auxiliary connections:

- Traffic circuits are carried in the payload.
- Auxiliary circuits are carried in the LINK (RAC or DAC 155oM) overhead, together with the NMS.

Circuits are routed between plug-ins via the TDM bus.

Before circuits are configured you should have at hand a listing of all circuits to be configured, including circuit names.

The circuits screen applies to 9500 MXC INU/INUe, and to IDU ES.

IDU ES circuits functionality for Ethernet, E1/DS1 tributaries, and AUX is similar to an INU/INUe fitted with 1xRAC, 1xDAC 16x, and 1xAUX plug-ins.

Refer to:

- Circuits Configuration - Traffic on page 9-2
- Circuits Configuration - Auxiliary on page 9-14

Circuits Configuration - Traffic

Circuits are cross-connected using a common setting for the backplane bus. One of the following options must be selected:

- 2.048 Mbps (E1 capable)
- 34.368 Mbps (E3 capable)
- 1.544 Mbps (DS1 capable)
- 44.736 Mbps (DS3 capable)
- 155.52 Mbps (STM1/OC3 capable)

The framing used by the modem accepts Ethernet and/or TDM data to support one or both formats over a link, or links.

Where support for multiple rates is required, such as E1 and STM1, a DAC 155oM is used to multiplex an STM1/OC3 stream to NxE1 or DS1, to permit a common E1 or DS1 backplane setting.

Similarly, the DAC 3xE3/DS3M with its E13 or M13 mux function provides support for E3 or DS3 using an E1/DS1 backplane:

- The E13 mux multiplexes a maximum of two E3 interfaces; each is multiplexed to 16xE1.
- The M13 mux multiplexes a maximum of two DS3 interfaces; each is multiplexed to 28xDS1.

For protected hot-standby and diversity configurations circuit connections are synchronized for both RACs; circuit assignments are LINK based.

Within the Circuits configuration screen, a common look and feel is supported:

- For non-protected, hot standby, and diversity links, screen operation is identical.
- For ring protection, operation is identical except that different terminology is used to address ring drop-insert and pass-through circuit connections.

Refer to the following to view typical configuration screens:

- Typical Circuits Configuration Screen on page 9-3
- Expanded Circuits Configuration Screen on page 9-4
- Circuits Configuration on page 9-5
- DAC ES/GE Circuit Configuration Screen on page 9-6.This also applies to the IDU ES.
- Ring-Node Circuit Configuration Screen on page 9-7

Refer to Procedure for Configuring Circuits - Traffic on page 9-10 for the configuration process.

Typical Circuits Configuration Screen

Figure 9-1shows a circuits screen for a typical aggregation node comprising a 40xE1 link interconnecting with a 16xE1 link, a 20xE1 link and a DAC 16x:

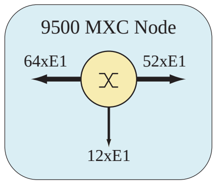
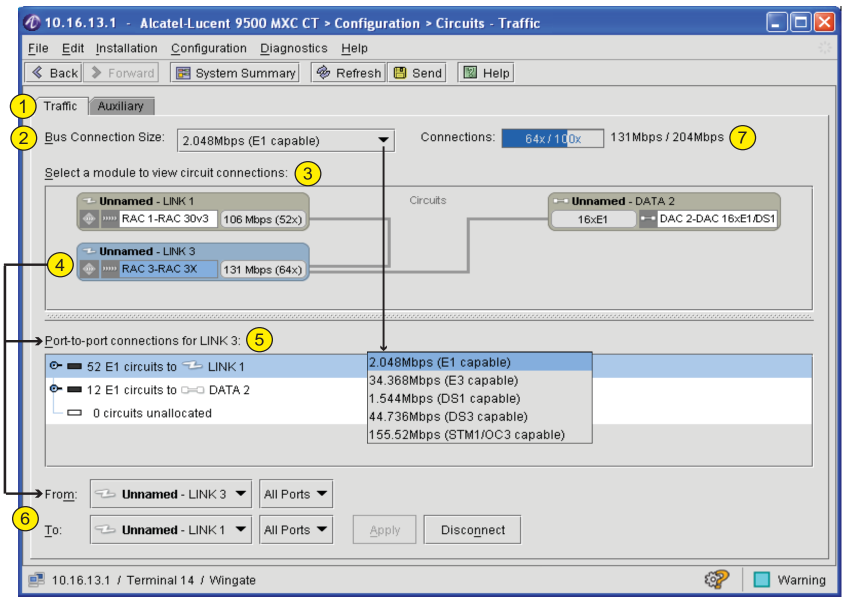


Figure 9-1. Typical Circuits Screen



Item	Description
1	Tabs provide access to Traffic or Auxiliary circuits configuration.
2	Select the Bus Connection Size from the drop-down menu.
3	All circuit-configurable modules are shown in this frame, together with any existing circuit paths. RACs display their configured link capacity. DACs display their native capacity. Modules can be named in the System Summary screen.
4	Click on a module to view its Port-to-Port connections, and to populate the From tab.
5	Shows the port-to-port connections for the selected module. Connections are default shown in summary form. To view each connection, click the circular toggle.
6	The From and To tabs are used to assign circuit connections between modules.

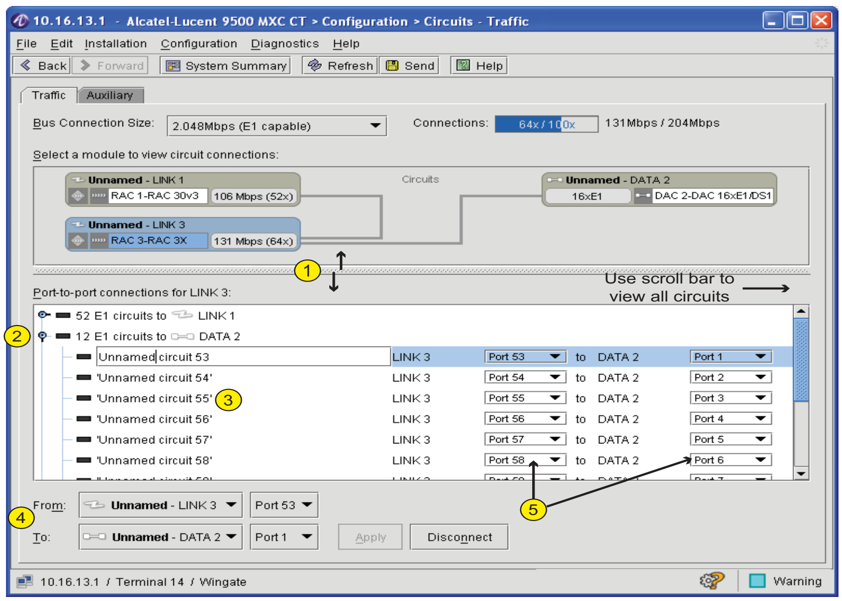
Item	Description
7	The Connections bar shows the number of circuits configured, against the maximum capacity for the selected bus size. In this example, 64xE1 / 131 Mbps has been configured on the Bus, which has a maximum capacity of 100xE1 / 204 Mbps.

Expanded Circuits Configuration Screen

Figure shows the port-to-port connections for Link 2 to Data 4 for the configuration shown in Figure 9-1:

Typical Expanded Circuits Screen Showing Port-By-Port Connections

Figure 9-2. Expanded Circuits Screen Showing Port-By-Port Connections



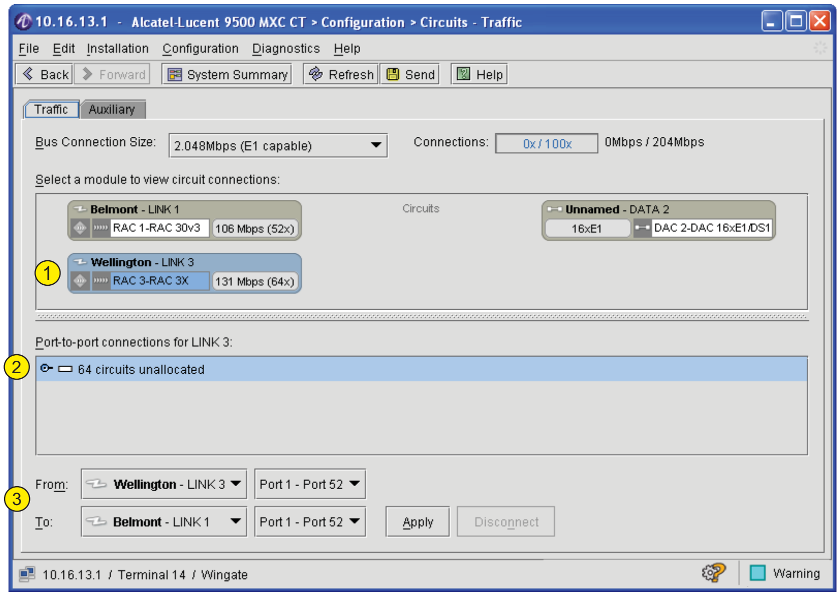
Item	Description
1	Click and drag the bar to adjust the frame heights.
2	With toggles in the down position, circuit connections are displayed port-to-port.
3	Circuit names can be user-defined.
4	From, To and Port tabs are used to set circuit connections for unallocated tribs, or to disconnect tribs. The disconnect option supports bulk Link or Data disconnection with the toggle up, or circuit-by-circuit disconnection with the toggle down.
5	A port refers to the circuit timeslot to/from the backplane bus. In this example, each timeslot is an E1. This field is used to view, check, and where preferred, to edit port-to-port connections.

Circuits Configuration

Figure 9-3illustrates on-screen functionality for new circuit connections, based on the configuration illustrated in Figure 9-1 and Figure 9-2.

The Procedure for Configuring Circuits - Traffic on page 9-10 describes the configuration process.

Figure 9-3. Establishing New Circuit Connections

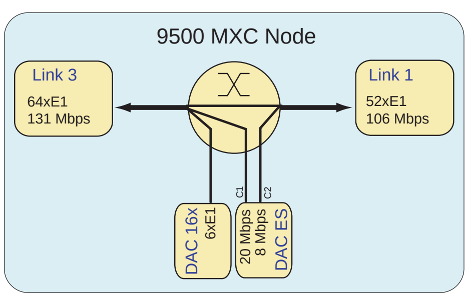


Item	Description
1	Click on a module to set the **From** selection.
2	The Point-to-Point panel shows all 64 circuits configured on RAC 3 as unallocated.

Item	Description
3	Click the **To** tab to view set the **To** selection. In this example the Link to Belmont is selected. To establish new connections, use the Port and Apply tabs. • For a new node (no circuits allocated) bulk port connection options are presented on initial selection. • Where only some of the capacity (number of ports) is to be connected, click and select from the Port menu buttons, which provide a port-by-port selection. Click **Apply** to set the first connection, and continue to click **Apply** to establish subsequent connections. • Similarly, where a new set of connections is to be established, from a Link or Data that has already had ports allocated, use the Port - Port menus to set the start of the port numbering for **From** and **To**, and click, and continue to click Apply to complete the connection assignment. • To view an check individual port-to-port connections, click the relevant toggle down. • Red text indicates a port is allocated. Black indicates it is unallocated. • Existing port-to-port connections (red) can be changed by selecting and re-connecting in the expanded (toggle-down) view. • Mouse-over for advice.

DAC ES / GE Circuit Configuration Screen

Figure 9-4 shows a 9500 MXC Node configured to provide the following connections.



- Link 3 has circuits mapped to Link 1, the DAC ES (C1), and the DAC 16x.
- Link 1 circuits are mapped to Link3 and the DAC ES (C2).

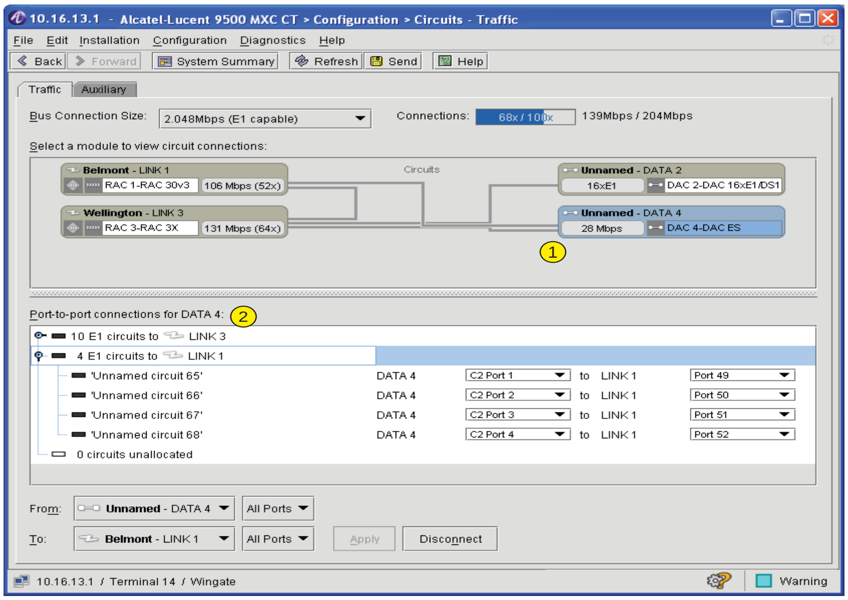
Circuits screen operation for a DAC GE is identical to a DAC ES.

Before circuit connections for the DAC ES or DAC GE can be configured, the channel capacities must first be set in their Plug-ins screen.

For DAC ES/GE, refer to Additional Rules for DAC ES and DAC GE on page 9-13.

The IDU ES Ethernet function mirrors the DAC ES. Its 8x E1/DS1 function mirrors the DAC 16x.

Figure 9-4. Example Circuit Connections with a DAC ES



Item	Description
1	The DAC ES is selected in the module view.
2	DAC ES connections populate the Port-to-Port connections frame. It has 10 circuits (20 Mbps) connected to Link 3, Wellington, and 4 circuits (8 Mbps) connected to Link 1, Belmont. • DAC ES channel 1, ports 1 to 10, are connected to Link 3. • DAC ES channel 2, ports 1 to 4, are connected to Link 1. The toggle-down view of the connections to Link 1 show DAC ES C2 ports 1 to 4 connected to Link 1 ports 49 to 52.

Ring-Node Circuit Configuration Screen

This applies to MXC 9500 Super-PDH ring protection.

Figure 9-5 hows an example of a ring-node with point-to-point circuit overlay. The essential information can be summarized as:

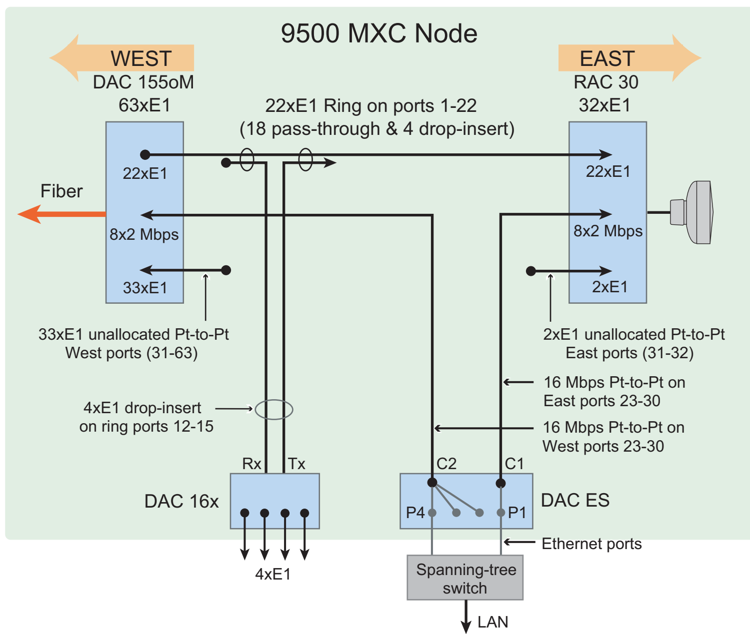
- Link 3 / RAC 3X, is configured for a capacity of 64xE1 / 131 Mbps.
- Link 1 / RAC 30, is configured for a capacity of 32xE1 / 65 Mbps).

- The maximum possible ring-protected capacity on the node is therefore 32xE1 / 65 Mbps (the lesser of the two capacities).
- Actual ring-protection capacity required is 22xE1 (18xE1 pass-through and 4xE1 drop-insert). This leaves 42xE1 point-to-point (non-ring-protected) capacity towards the east, and 10xE1 towards the west.
- The DAC 16x is configured for 4xE1 drop-insert circuits from the ring.
- The DAC ES is configured to support a 16 Mbps (8x 2.048 Mbps / E1) RSTP network connection; 16 Mbps point-to-point towards the east, and 16 Mbps west.

This leaves spare point-to-point capacity of 34xE1 towards the east, and 2xE1 east.

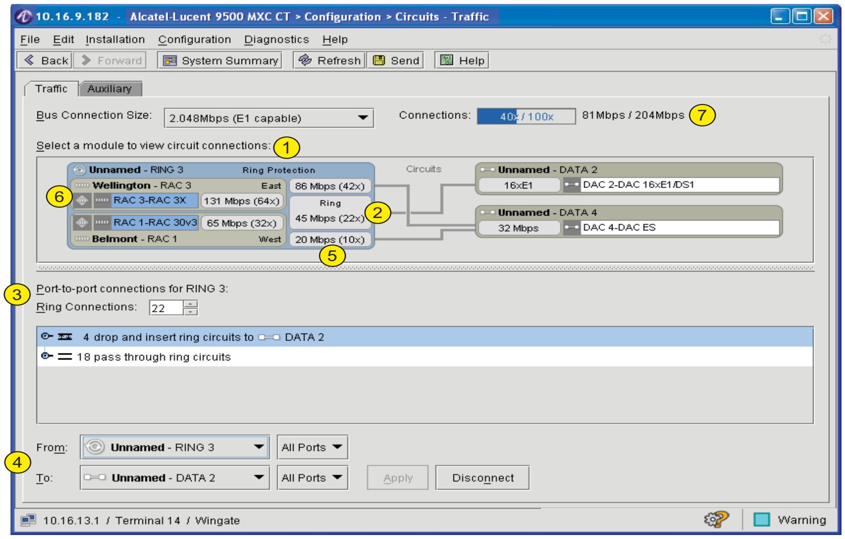
The circuits screen for this example is shown in Figure 9-6.

Figure 9-5. Example Circuit Requirements for a Ring



To map/plan circuits to be configured on a ring use the planning sheets in Planning a Ring Network, Appendix A.

Figure 9-6. Example Circuits Screen for Figure 9-5 Requirements



Item	Description
1	The Module frame summarizes the module protection, configured link and ring capacities, configured DAC ES capacity (C1 + C2), and default DAC 16x capacity.
2	The Ring box shows the configured ring capacity. Click in the RING module header or click within the Ring box to open the Port-to-Port Connections frame for the ring (RING 3).
3	Use the up-down counter to set the ring capacity (or direct-enter). Pass-through and drop-insert connections are shown. If there are no drop-insert circuits, all circuits are shown as pass-through. To view the port-port connections for drop-insert circuits, click its toggle to down.
4	The From and To options are used to select and configure the drop-insert circuits from the ring.
5	The boxes above and below the Ring box show the *link* capacity that is available for point-to-point connections. Point-to-point connections (where required) are established by clicking on the relevant east RAC or west RAC, to populate the Port-to-Port Connections frame and the From button, for the selected RAC. For setting new point-to-point connections, refer to Figure 9-3. The Connections bar shows the number of backplane bus slots used (40xE1 / 86 Mbps) against the available maximum (100xE1 / 204 Mbps).

Procedure for Configuring Circuits - Traffic

Before You Begin

- Before configuring circuits for an **east-west ring**, refer to Additional Rules for an East-West PDH Ring on page 9-12, and to the Ring Network Planning and Implementation Guide in Appendix A.
- Before configuring circuits to/from a **DAC ES, IDU ES, or DAC GE**, refer to the Additional Rules for DAC ES and DAC GE on page 9-13.
- Before configuring circuits to/from a **DAC 3xE3/DS3M**, refer to Additional Rules for DAC 3xE3/DS3M on page 9-13.

To view and configure traffic circuits:

1. Open the Traffic Circuits screen from **Configuration > Circuits**.
2. **Bus Configuration**. Click Bus Connection Size to view a submenu of bus options:

   2.048 Mbps (E1 capable)
   34.368 Mbps (E3 capable)
   1.544 Mbps (DS1 capable)
   44.736 Mbps (DS3 capable)
   155.52 Mbps (STM1/OC3 capable)

   This must be set to match the capacity type required within the Plug-ins screen for the relevant RACs/DACs. If incorrectly set, a warning icon (red cross) is displayed in the Plug-ins and Circuits screens. Mouse-over for tooltip advice.
3. **For existing circuit connections**, click on the relevant LINK, RING or DAC, to view its connection details in the Port-to-Port connections frame. Refer to Figure 9-1. With the toggle up, connections are shown in summary form. Click the toggle down to view port details.

For a new/non-configured module the connections box will show all circuits as unallocated.

For a configured module the connections box will summarize the circuit connections as well as any unallocated circuits.

4. **To set up new connections**, use the *From* and *To* buttons, and the *circuits unallocated* line in the Port-to-Port connections frame. The toggle(s) in this frame should be kept in the up (horizontal) position for easy viewing. Refer to Figure 9-3.
   - Populate the **From** tab by clicking on the module you wish to connect **from** in the module selection frame.
   - Use the **From** > **Port** tab to set (in numerical order) the first From port connection.
   - Populate the **To** tab by selecting the required module from its drop-down menu (menu only applies where there are two or more possible **To** options).
   - Use the **To** > **Port** tab to set (in numerical order) the first To port connection.

If there are *no* allocated circuits, the From and To buttons will prompt for bulk allocation of circuits between the first pair of modules, with the number of connections based on the lowest capacity end of the selected pair. For instance, if a 32xE1 link has been selected as the From module and a 16xE1 DAC selected as the To module, the From and To port buttons will prompt for a 16xE1 bulk allocation. If such a bulk allocation is not intended, then select the 1st port-to-port circuit using the Port drop-down menus, and proceed as above.

5. Click **Apply**.

   The newly connected circuit is shown in the port-to-port connections frame, and the number of circuits unallocated is reduced accordingly.

   - Continue to click **Apply** to establish subsequent new circuit connections *between the same modules*. This connection is made in ascending numerical order from the port number first established.
   - To establish new connections between a *different* pair of modules, use the **From** and **To** module and port settings to define the first connection, and then click Apply. Continue to click **Apply** to advance the connections.

6. **To view and name individual circuits**, click on the relevant line toggle in the Port-to-port connections frame. This turns the toggle tail from horizontal to vertical (toggle down) and brings up connection details, or in the case of unallocated circuits the ports available for connection. Refer to Figure 9-2 on page 9-4. The circuit name is user defined, simply highlight the existing entry and type over to replace.

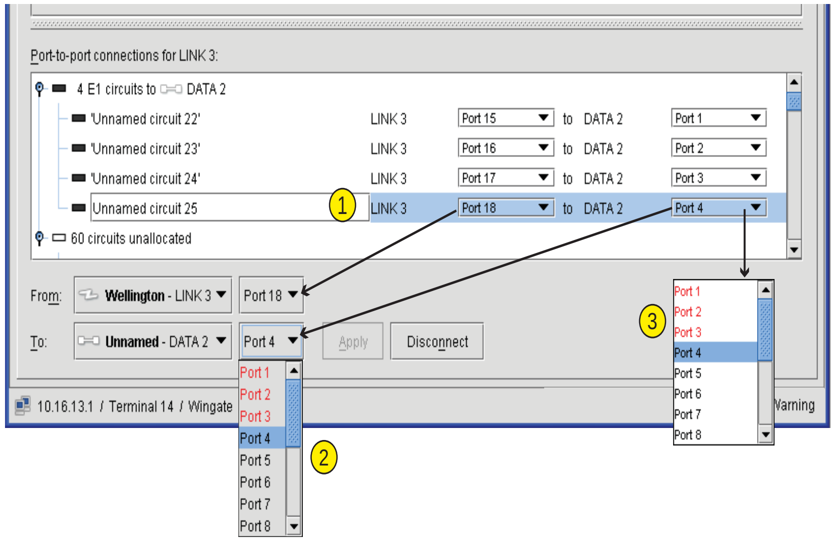
Each circuit in a network should have a unique name, and that name should be entered at all Nodes that carry that circuit. A trib name should also relate to its circuit name to permit easy association of a trib with circuit when setting a DAC BER test using the circuit loopback feature.

7. **o view and change existing circuits,** click on the relevant line toggle (toggle down) in the Port-to-port connections frame. This brings up the connection details for that item. To change connections for an existing circuit, click to highlight the relevant circuit line. This populates the From and To buttons with the port connections for that circuit. Use the selections provided under the button submenus to set a changed connection. Red lettering for an item in a submenu means that the port is allocated; black means that it is unallocated. You can also use the sub-menus under the Port buttons in the Circuit row/line. When you are done making changes, click **Apply**. This screen is shown in Figure 9-7.

   - Existing port connections are in red. Unallocated ports are in black.

     If an existing port connection is changed, then its partner port will be returned to Circuits Unallocated, and its original circuit connection line will disappear.

Figure 9-7. Changing Existing Circuit Connections



Item	Description
1	Highlighting a circuit line displays the relevant module and port numbers in the From and To buttons.
2	The From and To sub-menus are used to effect a port-port change. Red lettering denotes an allocated port. Black denotes it is unallocated. If a connection is made to a red port, its partner port is returned to circuits unallocated.
3	Circuit editing can also be achieved using the sub-menus under the Port buttons in the circuit line, but note that any change is effected immediately, there is no apply button required to confirm a change.

8. **To disconnect existing circuits**, highlight groups of circuits (toggle up) or individual circuits (toggle down), and click *disconnect*.
9. To commit the new configuration, click **Send**.

Additional Rules for an East-West PDH Ring

1. The backplane bus must be set to E1 or DS1. 9500 MXC ring circuit protection is only valid for NxE1 or NxDS1 configurations.
2. The ring capacity must be set before drop-insert circuits are configured.
3. When the ring capacity is set, all circuits are default connected as pass-through. The minimum configurable capacity on a ring is 1xE1 or 1xDS1.

To assist your planning of circuits on a ring refer to Planning a Ring Network, Appendix A.

Additional Rules for DAC ES and DAC GE

The following applies to DAC ES (plug-in card and IDU ES module) and DAC GE when configured for a 2 Mbps (ETSI) or 1.5 Mbps (ANSI) bus connection size.

1. Ethernet data is transported on Nx2 Mbps (2.048 Mbps) or Nx1.5 Mbps (1.544 Mbps) circuits.
2. When assigning circuits to Channel C1 and/or Channel C2, they must be linked in order of port number, that is, the lowest number port of the transport channel at the local end must be linked to the lowest numbered port of the transport channel at the remote DAC ES, the next lowest numbered port to the next lowest numbered port, and so on; the circuits used must be in contiguous/adjoining.
3. The linked transport channels must be configured with the same bandwidth at each end of the radio path. For example if C1 of a DAC ES is configured for 20xE1 / 2Mbps, the DAC ES/GE at the remote end of the circuit (over one hop or multiple hops) must also have C1 configured for 20xE1 / 2 Mbps. But they can be displaced in port order, for example the 20 ports at one end could range from 1 to 20, and at the other, from 11 to 30.
4. The DAC ES or DAC GE plug-ins must be circuit-configured directly to a Link (RAC or DAC 155oM) at each end of the radio path. Ethernet data on channels C1 and/or C2 carrying cannot be mapped to DAC E1 or DS1 *tribs*. This is to ensure that the *byte* boundaries are maintained on the circuits between DAC ES/GE modules - bytes sent on each Nx2 Mbps or Nx1.5 Mbps channel must arrive intact and unshifted at the corresponding channel at the remote DAC ES/GE[1].
5. With one DAC ES up to 96x2 Mbps or 112x1.5 Mbps circuits (using both channels) can be configured for Ethernet transport, or a mix of Ethernet and TDM E1 or DS1 circuits can be configured up to the maximum of the backplane bus; 100xE1 or 128xDS1.
6. With a DAC GE a total of 100xE1 or 127xDS1 circuits can be configured on one channel, or over both channels, or a mix of Ethernet and TDM E1 or DS1 circuits can be transported up to the maximum of the bus; 100xE1 or 128xDS1.
7. A DAC ES can be installed at one end of the link and a DAC GE at the other.
8. When used with an *external spanning-tree switch*, a DAC ES/GE should be configured for Mixed mode. Doing so allows C1 at one node to be connected to C1 *or* C2 at the next node, thereby supporting an odd or even number of Nodes in a ring. Address learning must also be disabled.

Additional Rules for DAC 3xE3/DS3M

1. For 3xE3/DS3 mode the Bus Configuration must be set for E3 or DS3.
2. For E13/M13 mode the Bus Configuration must be set for E1 or DS1.
3. For E13/M13 mode the two E3 or DS3 tribs are presented as:
   - E3 front-panel Tx/Rx 1 to E1 ports 1 to16
   - E3 front-panel Tx/Rx 2 to E1 ports 17 to 32
   - DS3 front-panel Tx/Rx 1 to DS1 ports 1 to 28
   - DS3 front-panel Tx/Rx 2 to DS1 ports 29 to 56
4. For E13/M13 mode, where the E1/DS1 streams are to be transported end-to-end over a 9500 MXC link or links, the E1 or DS1 circuits should, for ease of

[1] *When Ethernet traffic is to be sent over a DAC 155oM, the E1/DS1 circuits used must be configured in the DAC 155oM plug-ins screen for TVT.*

identification, be in contiguous blocks of 16xE1 or 28xDS1 respectively.

5. Where the E13/M13 mode is used to demultiplex an incoming E3 or DS3 trib (from a 3rd party E13/M13 mux or from another DAC 3xE3/DS3M), the individual E1 or DS1 circuits may be port-port connected via the bus to a DAC 16x or multiple DAC 4x plug-ins, which may be on the same INU/INUe and/or at a remote INU/INUe via LINKs (RACs).

6. For E3 Transparent node the E1 circuits should, for ease of identification, be in contiguous blocks of 17xE1.

Circuits Configuration - Auxiliary

Unlike traffic circuits, which are carried as main payload, Auxiliary circuits are carried within the LINK or DATA (DAC 155oM) overhead, along with NMS and proprietary link signalling.

Before AUX circuits are configured, the plug-ins to be used to *transport* the AUX circuits (RAC/ DAC 155oM) must be configured.

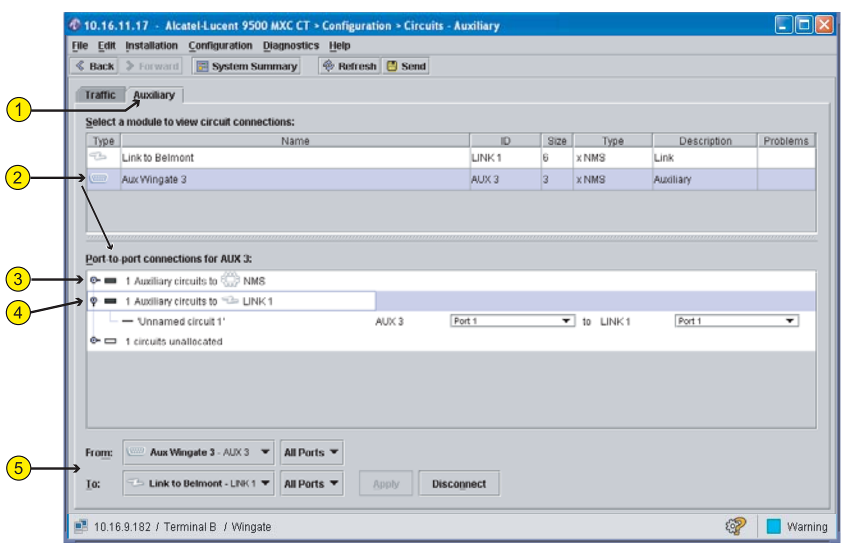
Similarly, AUX circuits to be connected must first be established within the AUX plug-ins screen. Refer to Procedure for Configuring Auxiliary Circuits on page 9-15

Auxiliary Circuits Screen

Figure 9-8 is an example of an auxiliary screen showing AUX ports 1 and 3 configured for DATA transport, and port 2 configured for NMS.

Only Data circuits can be configured in this screen. NMS ports are shown only to provide a complete picture of all AUX ports.

Figure 9-8. Auxiliary Circuits Screen



Item	Description
1	The Auxiliary circuits tab is selected.
2	The AUX plug-in (AUX in slot 3) is selected (highlighted), which populates the port-to-port connections box and the From tab.
3	This AUX circuit has been configured for NMS in the AUX plug-ins screen. No action is required or possible from this screen.
4	This AUX circuit has been configured for data in the AUX Plug-ins screen. Click the toggle down to view its circuit connections. The example shows one auxiliary data circuit has been established between AUX 3 and Link 1 using the Auxiliary circuits screen. The example also shows the remaining circuit is unallocated; one AUX Plug-in supports a maximum of three circuits.
5	Auxiliary circuit connection and disconnection action is identical to Traffic circuit connection and disconnection.

Procedure for Configuring Auxiliary Circuits

To view and configure auxiliary circuits:

1. Open the Auxiliary Circuits window from **Configuration** > **Circuits**.
2. Click on a module row to view existing circuit connections, or to initiate new connections.

   Only installed plug-ins capable of transporting auxiliary traffic are displayed: AUX, LINK (RACs), and DATA (DAC 155oM).

   For a new/non-configured AUX plug-in, the connections box shows all circuits unallocated.

   For a configured AUX, the box shows existing circuit connections as well as any unallocated circuits.

   Toggle up connection details are displayed in summary form in the port-to-port connections box.

   • Click toggle down to view port-to-port details.
3. Circuit connection, disconnection and naming procedures are identical to Traffic Circuit connections. Refer to Procedure for Configuring Circuits - Traffic on page 9-10.
4. When allocating ports from AUX to LINK or DATA, the *LINK or DATA port allocations must start at port 1* to avoid unnecessary overhead capacity reduction for NMS transport[2]
5. To commit the configuration, click **Send**.

[2] *If, for example, just one AUX data channel is required and is configured for port 6 in the link overhead, then NMS capacity within the overhead will be reduced to its 128 kbps minimum. If on the other hand the AUX data channel is configured for port 1, then available NMS capacity will be 448 kbps (512 less 64 kbps).*

AUX port allocation to LINK or DATA must be in numerical order beginning at LINK/DATA port 1.

Chapter 10. Networking Configuration

The Networking configuration screen provides view and change settings for NMS IP addressing and routing, trap destinations, and a DHCP server option. Refer to:

- Static or Dynamic Routing on page 10-1.
- Networking Screens on page 10-4.
- DHCP Server Function on page 10-12

For detailed information and guidance on NMS addressing and routing options, refer to Appendix D.

Most screens support context sensitive help. To view, click on Help in the tool bar, or select Context Help under Help in the menu bar.

Static or Dynamic Routing

Each 9500 MXC Node or Terminal functions as a router to manage the NMS IP routing between nodes, and from nodes to other management connected devices, such as other Alcatel-Lucent radios, or other vendor products or management networks.

Static routing requires manual configuration of the routing table and any subsequent reconfiguration. It is suitable for simple networks and for networks where no significant change in routing is expected. A default gateway option is provided.

Dynamic routing makes use of a routing protocol such as **RIP** (Routing Internet Protocol) and **OSPF** (Open Shortest Path First), which dynamically updates the routing tables held within each router through a mutual exchange of messages. In most instances it should only be necessary to enter the IP address for the terminal and select RIP or OSPF. For 9500 MXC, the dynamic routing options are **RIP1**, **RIP2**, or **OSPF**. Compared to static routing, dynamic requires much less configuration management by a network administrator.

For large networks using OSPF with **segmented OSPF areas**, the OSPF area (network group) for the Node/Terminal must be enabled along with entry of the OSPF area number.

Dynamic routing must be used in 9500 MXC **ring-network** configurations.

Refer to 9500 MXC Address and Routing Options on page 10-2.

Interfacing OSPF to RIP

Where an OSPF-routed network is interfaced to a RIP-routed network, OSPF *and* RIP must only be enabled on the interfacing router (9500 MXC terminal).

- Where a 9500 MXC OSPF-routed terminal interfaces with a co-located RIP-routed terminal, set RIP on the 9500 MXC Ethernet interface and OSPF on the 9500 MXC link/radio interface(s).
- Where a 9500 MXC OSPF-routed terminal is required to interface with one or more co-located 9500 MXC OSPF-routed terminals *and* a RIP-routed terminal, set RIP *and* OSPF on each 9500 MXC Ethernet interface, and OSPF on the their link/radio interface(s).

Note that:

- Simultaneous RIP and OSPF is only ever enabled on a 9500 MXC Ethernet NMS interface.
- The 9500 MXC radio link interfaces are set for OSPF *or* RIP - set to match the dynamic routing option selected for the 9500 MXC network.
- This partitioning of routing selection is enabled in the Interface Addressing screen.

Within a 9500 MXC network that is using dynamic routing, select OSPF *or* RIP; never both.

Where a 9500 MXC network must interface with a network that is using a different dynamic routing protocol, only select both (OSPF *and* RIP) on the Ethernet interface.

9500 MXC Address and Routing Options

At the outset, a decision must be made to use single or interface IP addressing, and static or dynamic routing. The screen-based configuration options are:

1. Single IP addressing and static routing:
   - Use of a single IP address and subnet mask. This specifies the Ethernet port address, and all other interfaces (links, V.24) assume this address.
   - Requires manual configuration and maintenance of the routing table for all devices within the network.
2. Single IP addressing with a combination of static routing and routing via default gateways:
   - Use of a single IP address and subnet mask (as for 1).
   - A default gateway is configured *towards* the NOC (network operating Center), and static routes are configured for all Nodes/Terminals pointing *away*.
   - Requires manual configuration and maintenance of the routing table for all devices within the network.
3. Single IP addressing and dynamic routing:
   - Use of a single IP address and subnet mask. This specifies the Ethernet port address, and all other interfaces (links, V.24) assume this address (as above).

- Requires selection of OSPF and/or RIP, whereupon the routing is established and maintained without manual intervention.
- If the NMS network into which the Node/Terminal is to be installed has been OSPF segmented, Enable OSPF Area must be selected and the number for the area entered, which will be a number determined by area-boundary routers installed in the network.
- Does not require manual configuration of routing tables. Generally devices can be added to or removed from the network without impacting NMS connectivity.

4. Interface (advanced) IP addressing and static or dynamic routing:
   - Use of a separate IP address for each 9500 MXC NMS interface: Ethernet, Link(s), V.24.
   - Selection of static or dynamic routing options, as above.

Refer to Rules for Single and Interface Addressing Modes on page 10-3.

Option 3 would normally be used within a 9500 MXC network.

Rules for Single and Interface Addressing Modes

For extended rules, hints and tips, and network examples, refer to Appendix D.

Single IP Address

- All interfaces assume the Ethernet port address.
- Where OSPF and/or RIP are enabled/disabled, it applies on all interfaces except V.24. (Dynamic options can only be selected for the V.24 interface within interface addressing).
- The Single IP address mode is only active if all single mode conditions are met when the screen is refreshed. If conditions are not met then the interface address mode is selected. As an example, if the radio is configured with a single IP address and OSPF, and subsequently the network management system or SNMP command is used to turn off OSPF on *one* interface, the single IP address mode is no longer valid.

Interface (Advanced) Address

- All interfaces can be uniquely numbered, with entries for IP address, subnet mask, interface, and next hop. Each interface can set for static or dynamic routing. The dynamic routing options are OSPF, RIP1, RIP2.
- If new interfaces are added to the node, such as a new link, they must be separately configured (any new interface is displayed with a default 1.0.0.1 IP address).

Networking Screens

The Networking screens provide configuration for IP addressing, dynamic or static routing, and trap destinations. A DHCP server option can also be configured.

For addressing and routing functions refer to:

- Configuring Single IP Addressing and Dynamic Routing on page 10-6
- Configuring Single IP Addressing and Static Routing on page 10-6
- Configuring Interface IP Addressing and Routing on page 10-9
- Configuring Trap Destinations on page 10-11

For the DHCP server option refer to DHCP Server Function on page 10-12.

Opening Screen

Networking opens to an IP addressing screen, which supports:

- Single IP addressing
- Selection of dynamic routing options of OSPF, RIP1 or RIP2.
- Enable DHCP server.

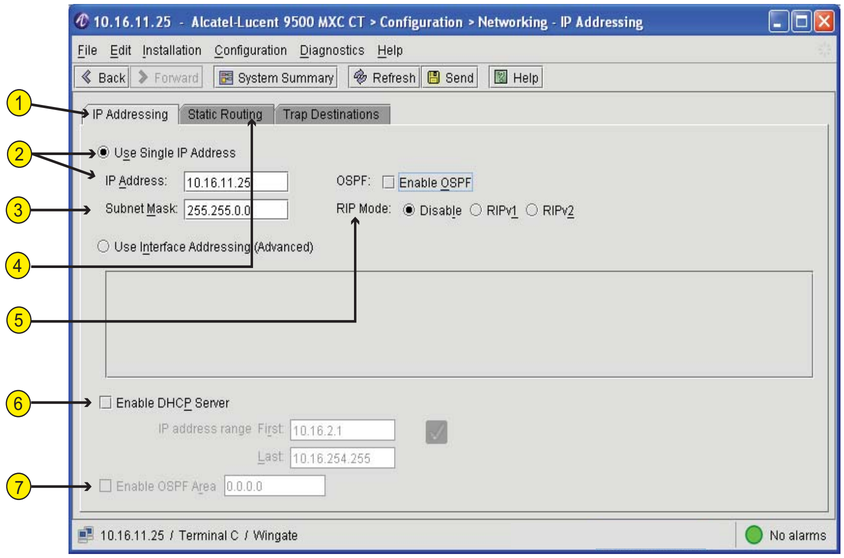
Tabs provide access to Interface Addressing, and to Static Routing or Trap Destination screens.

On selection of OSPF routing, the option to Enable OSPF Area is un-greyed. If the NMS network into which the Node/Terminal is to be installed has been segmented for OSPF area operation, its area number must be entered. Otherwise leave unchecked.

Figure 10-1 shows a typical IP Addressing screen. The example shows entry of a single IP address, and no selection of dynamic routing, indicating static routing has been chosen. To view other screen selections refer to:

- Figure 10-2 on page 10-7 for a Static Routing screen.
- Figure 10-3 on page 10-10 for an Interface Addressing screen.

Figure 10-1. Single IP Address Screen



Item	Description
1	The single IP address option is selected.
2	User defined fields for the IP addresses, and mask.
3	Click to select the Interface addressing (advanced addressing) option.
4	Tabs provide access Static Routing and Trap Destination screens.
5	Click to enable dynamic routing, OSPF or RIP.
6	Click to enable the DHCP Server option for CT PC connection.
7	An OSPF area can be defined upon selection of the OSPF routing option.

Configuring Single IP Addressing and Dynamic Routing

1. In the opening screen enter an IP Address and Subnet mask for the 9500 MXC Node or Terminal. This is the address for the Ethernet interface on the 9500 MXC router; all other interfaces on the router assumes this Ethernet address.
2. Select a dynamic routing mode: OSPF, RIP1 or RIP2.

   If RIP1 or RIP2 is selected it limits the number of IP hops in the NMS network to 15, meaning (for dynamic routing) the limiting number of sequential 9500 MXC links is 15. This 15 hop limitation does not apply to OSPF.

   If OSPF is selected and the NMS network into which the Node/Terminal is to be installed *has been OSPF segmented*, Enable OSPF Area must be selected and the number for area the entered, which will be a number determined by area-boundary routers installed in the network. If the network has not been segmented, do not select Enable OSPF Area (it will be default entered as the backbone network with an area number of 0.0.0.0).

Configuring Single IP Addressing and Static Routing

The static routing screen provides user defined fields for the destination IP address, subnet mask, and the interface by which it is directed, such as a link (radio path) or Ethernet port. Refer to Figure 10-2 on page 10-7.

The entry in the static routing table lets the local 9500 MXC Node or Terminal know that another remote network connection exists (the destination), and the Interface defines the path/port connection used to get there.

If the Interface is via one of the Ethernet NMS ports (or V.24), then the IP address for the device connected to this interface must also be entered under ‘Next Hop’. This situation may arise where a network management connection is to be established with other Alcatel-Lucent products or with 3rd party equipment. A Next Hop entry is not required if the Interface is a Link.

Default Gateway

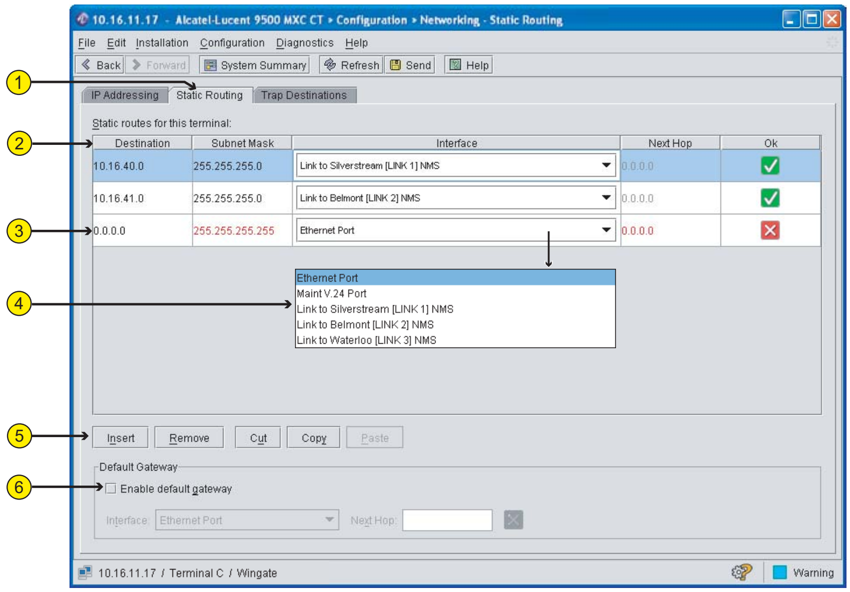
A default gateway option is available, which can be used in conjunction with static routing to reduce data entry requirements and support flexible adding/changing of PC connections at a NOC LAN[1]:

- *Towards* the NOC a single default gateway is entered on each Node/Terminal instead of static routes.
- *Away* from the NOC static entries are required in the normal way - each Node/Terminal must have an entry for all other Nodes/Terminals that are on its *away side only*.
- No static routes are required from Nodes/Terminals to address NOC host devices (PCs, Server), meaning NMS PCs (9500 MXC CT) can be added/removed from the NOC LAN without affecting network visibility.
- At the NOC, each of the LAN hosts (PCs, Server) are also configured with a default gateway in their TCP/IP properties. (Just as an Ethernet connected 9500 MXC CT PC is configured to use its directly-connected Node/Terminal as its default gateway). Entry of static routes to Nodes/Terminals is not required.

1 *Assumes a single NOC site. Where multiple NOCs are deployed, default gateways can be established on individual branches of the network, but at branching sites specific route entries will be required to the NOCs.*

For information on static routing, default gateway application and example networks, refer to Appendix D.

Figure 10-2. Static Routing Screen



Item	Description
1	Static Routing selected.
2	User-defined fields for destination, mask, interface, and next hop.
3	Shows a new (still to be defined) route line added.
4	Interface selection sub-menu.
5	Use these tabs to insert a new route, remove a route, or cut or copy a route.
6	Click to enable a default getaway selection. (The default gateway defines routing towards the NOC, meaning static routes need only to be defined for IP addressable devices that point away from the NOC).

Procedure

1. In the *IP Addressing* screen enter a single IP Address and Subnet mask for the 9500 MXC Node or Terminal. This defines the Ethernet port address for the Node/Terminal, and all other interfaces assume this address.

If you are using an Ethernet connection for your CT PC and you re-configure the IP address of the radio to put it on a different subnet, a new CT session will be needed to log back in after the Send button is clicked.

For a normal TCP/IP connection, a new LAN compatible IP address must first be entered on your PC.

For a DHCP connection (DHCP server enabled) it will only be necessary to re-start CT. (With some versions of Windows, DHCP connection may be retained automatically).

2. Click on the *Static Routing* tab. Static routing or static routing with a default gateway must be defined for all configured 9500 MXC network management interfaces. Options are only presented for valid NMS interfaces; those through which network management interconnection can be established. The options are:
   - Ethernet Port (default)
   - Maint. V.24 (default)
   - Link. Link applies to each installed link, non-protected or protected.
   - Data. Data applies to each installed DAC 155oM, or DAC 3xE3/DS3M in E13 or M13 mode.
3. To add a route line, click the **Insert** button.
   - Enter a destination IP address and subnet mask.
   - Select **Interface** from Interface submenu. Submenu displays all valid interfaces.
   - Enter a Next Hop IP address only when an Ethernet or V.24 port is selected as an interface, in which case the IP address for the device connected to the Ethernet port must be entered.

Until a valid route is entered its OK status will display a cross, and the causative Destination, Subnet Mask and/or Next Hop entries will indicate red.

The parameters checked by CT to declare a route valid include destination address bytes, and incorrect subnet mask and/or next hop settings.

CT will not commit configuration changes for an invalid route entry.

4. Continue to add and define route lines on all *used* interfaces:
   - Where simple static routing is used (default gateway not enabled) specific routes[2] are established from this Node/Terminal to all IP addressable devices on the network (9500 MXC Nodes/Terminals, legacy terminals, 3rd party terminals).
   - Where the default gateway is enabled static routes are only defined for IP addressable devices that point away from the NOC. The default gateway defines routing towards the NOC.
   - If the Ethernet NMS or V.24 ports are not being used to connect to other devices, do not enter a route line for them.

[2] *A non-specific route may be entered as a pseudo default gateway using an address of 0.0.0.0 and a mask of 0.0.0.0, but only under guidance of your network administrator. The default gateway option should be used.*

The V.24 port is only to be configured when used for connection to a router, or similar device. For V.24 connection to a 9500 MXC CT PC, no configuration is required.

- **Remove** deletes the selected route line.
- **Cut** removes the selected route line but with a paste attribute (cut and past).
- **Copy** provides copy-from the selected route line.

5. To commit the configuration, click **Send**.

Configuring Interface IP Addressing and Routing

The Interface Addressing screen allows each interface to have its own IP address to support route partitioning across a node, or to assist network planning and management diagnostics in larger networks.

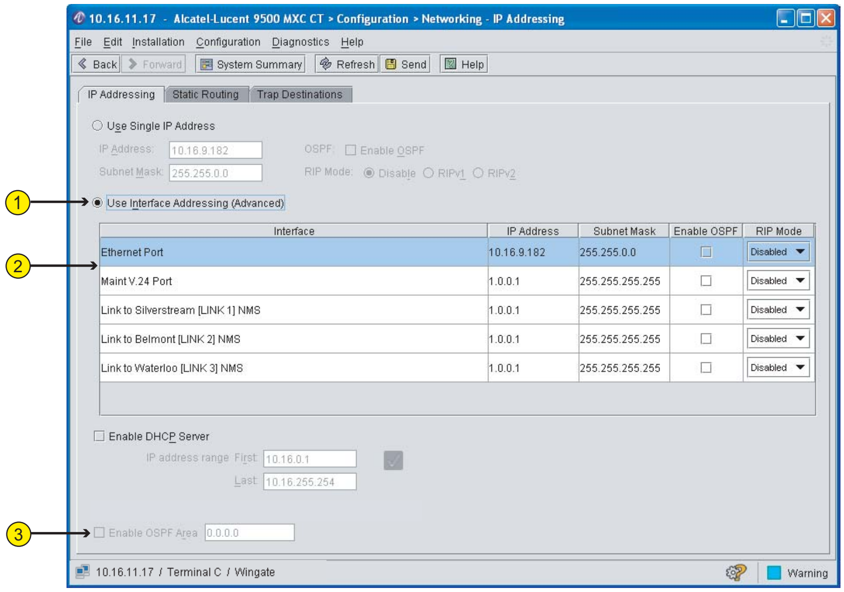
Interface IP addressing may be used with dynamic or static routing, with the selection enabled on a per-interface basis.

Interface IP addressing and routing options should only be used under guidance from the network administrator.

The screen opens with line entries for the Ethernet port, the Link(s), and the V.24 maintenance port. For the 9500 MXC Node the number of Link lines match the number of links installed (non-protected and protected each count as one link). For a ring configuration both links are shown, with the Link lines replaced by reference to RING 1:RAC 1 NMS, and RING 2:RAC 2 NMS.

Figure 10-3 shows an example IP addressing screen for a 9500 MXC Node.

Figure 10-3. Interface Addressing Screen



Item	Description
1	The Interface Addressing option has been selected.
2	User-defined fields are provided for IP address, mask, OSPF and RIP. The example shows the V.24 interface and links with default settings (not configured).
3	Use with an OSPF routing selection to define the OSPF area.

Interface Addressing Screen Description

- The Interface Addressing screen opens with line entries for the Ethernet port, the Link(s), and the V.24 maintenance port.
- If single IP addressing has previously been set, then the Ethernet line is populated with its details, as above. The Link and V.24 lines show default IP address and Subnet mask settings of 1.0.0.1 and 255.255.255.255 respectively.
- All interfaces should be configured. Link NMS ports can be left unnumbered (default), as a proprietary connection is established over the radio path for NMS transport. However, to conform with established IP network practice, link ports which are to be left unnumbered, should be set for an IP address of 0.0.0.0, and a subnet mask of 255.255.255.255, whereupon such interfaces are shown to assume the address of the router/Ethernet port.

For guidance on IP addressing and routing, refer to Appendix D.

Where unique IP addressing is wanted on each interface (such as on links) the address would normally be set to identify them as separate network elements (unique network address).

- If dynamic routing is to be used on one or more interfaces, enable by clicking on the RIP or OSPF selections. Follow the guidelines under Configuring Single IP Addressing and Dynamic Routing on page 10-6.
- If static routing is to be used, follow the Static Routing procedures under Configuring Single IP Addressing and Static Routing on page 10-6.

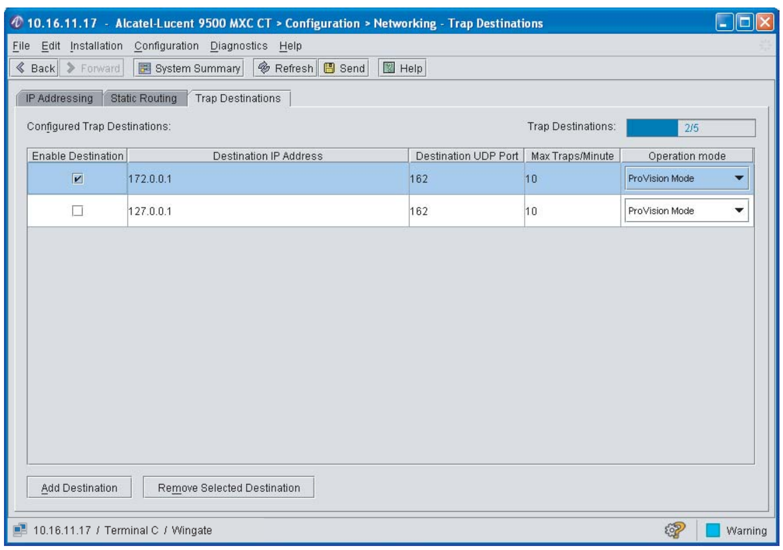
Configuring Trap Destinations

The Trap Destinations screen supports identification of a network management server to which traps can be sent from 9500 MXC via its network management network. Two modes are supported, ProVision or Third Party:

- **ProVision Mode** sends a common trap for all alarms, alerting the ProVision element manager to break its polling cycle and go straight to the alarmed 9500 MXC.
- **Third Party Mode** sends traps specific to each alarm, providing a description of the event and it severity.

Figure 10-4 shows an example Trap Destinations screen.

Figure 10-4. Trap Destinations Screen



Procedure

1. Click **Add Destination** to open a destination line.
2. In **Destination IP Address** enter the address of the network management server.
3. In **Destination UDP Port**, enter the UDP port number of the server. For a ProVision server, the port is 162.
4. In **Max Traps/Min** enter the maximum number of traps to be forwarded per minute. This should be set at a level balancing the need to acknowledge events and the requirement to continue to monitor the rest of the network. Default is 10, maximum 120, minimum 1.
5. In **Operation Mode**, select Provision or Third Party.
6. Click **Enable Destination**.
7. Click **Send** to commit the configuration.

DHCP Server Function

The IP addressing screens include an option to enable a DHCP server (Dynamic Host Communications Protocol) on a 9500 MXC Node/Terminal.

The DHCP server function is used to support Ethernet NMS access for your CT PC whereby 9500 MXC-to-PC connection is established under DHCP; the DHCP server on 9500 MXC assigns an IP address for your CT PC, which is configured to obtain and IP address automatically.

For information on the DHCP option and CT PC laptop setup, refer to 9500 MXC CT to 9500 MXC Connection Options on page 2-2 of Volume IV.

Refer to:

- Rules, Hints and Tips for a DHCP Server on page 10-12
- Configuring The DHCP Server on page 10-13

Rules, Hints and Tips for a DHCP Server

This information should be read in conjunction with data provided under 9500 MXC CT to 9500 MXC Connection Options on page 2-2 of Volume IV.

- DHCP is *not* default enabled.
- The primary benefit of the DHCP server is that it enables Ethernet access without needing to know the IP address of the target radio. Under DHCP, your PC is configured in the TCP/IP properties window to obtain an IP address automatically, and the radio provides a LAN compatible address to your CT PC.
  - The IP address assigned by the server has a 'lease time' of 30 seconds, meaning the IP address remains assigned for this minimum period. On expiry of the lease, such as at CT disconnection, the address goes back in the address pool, ready for re-assignment.
  - If you disconnect your CT PC and then reconnect while the lease is valid, your PC will reconnect using the same IP address - the address assigned under the lease. Conversely, if you reconnect after 30 seconds, your PC will be re-assigned an IP address, which may or may not be the same as before. From a CT user's perspective this operation is transparent.
- If you change the IP address of the radio you are DHCP connected to, when you click Send to confirm the change, the CT session will be interrupted for between 30 to 50 seconds, during which time the lease time for the original lease expires and a new DHCP lease is assigned (This interruption time is a Windows-imposed limitation; Windows 98, 2000 and XP).
- When the DHCP server has been enabled it does not prevent CT PC access by using a specific IP address set in the TCP/IP properties window of your CT PC; both DHCP and direct IP addressing are available, although DHCP provides a much more straightforward connection process.
- For protected 9500 MXC Terminals (two co-located IDUs), or where there are other local 9500 MXC devices (INU, INUe, IDU) on the same NMS LAN (NMS 10/100Base-T ports interconnected), all devices may be configured as DHCP servers, *except* at sites such as a NOC (Network Operations Center).

  - Where two or more devices are configured as DHCP servers all will respond to the broadcast message provided by your CT PC when first connected to the NMS LAN, however only one of the servers will get to provide the IP address for your PC. The CT Start-up window will indicate all 9500 MXC radios on the NMS LAN, from which point you can select the radio to log into.
  - When two or more DHCP servers are on a LAN, good practice requires each to have a different (non-overlapping) address range (the range of addresses available for assigning to your PC). For 9500 MXC radios this is prompted in the Networking screen.
  - At a NOC or at other sites where there are many LAN connected devices only one DHCP server should be active to avoid potential for incompatible IP address assignments. (On a company LAN typically one DHCP server is assigned to support dynamic address assignments to all LAN connected devices).
- The DHCP address range check box (to the immediate right side of address range entry) supports basic checks on the validity of the entered address range. A red cross is displayed if:
  - First IP Address is not a valid host address.
  - Last IP Address is not a valid host address.
  - IP address is not recognized as an IP address. For example is not of the form 192.168.2.1.
  - The first IP Address is not in the subnet.
  - The last IP Address is not in the subnet.
  - The first IP address is greater than the last IP address.
  - IP address range does not contain enough free addresses (one is the minimum).
- When the DHCP server function is enabled, the network portion of the IP address for the radio appears in the entry boxes for IP address range (First and Last).
- In the unlikely situation where interface addressing has been selected (Advanced) and multiple interfaces have been assigned a LAN compatible address, the DHCP address range must not include the addresses assigned to these interfaces.
- The DHCP address range *must not* include 192.168.255.0 to 192.168.255.255 as they are used for internal (embedded) addressing within 9500 MXC.

Configuring The DHCP Server

Configuring the DHCP server only requires it to be enabled and a valid address range established. An address range specifies the range of IP addresses that a server has available to assign to devices that are connected to it, in this case the address range available to CT PCs.

As the number of CT PCs likely to be connected to the NMS LAN at a 9500 MXC site is small, the address range can be kept small. Bear in mind that if all addresses are assigned, a subsequent CT PC *DHCP*[3] connection will not be possible - not until the lease-time on an issued address expires (nominally 30 seconds after an assignment disconnection).

[3] *It would still be possible to secure an Ethernet connection by entering a LAN compatible address in the TCP/IP properties window on your CT PC, providing the address entered was not the same as an address assigned to another currently connected PC.*

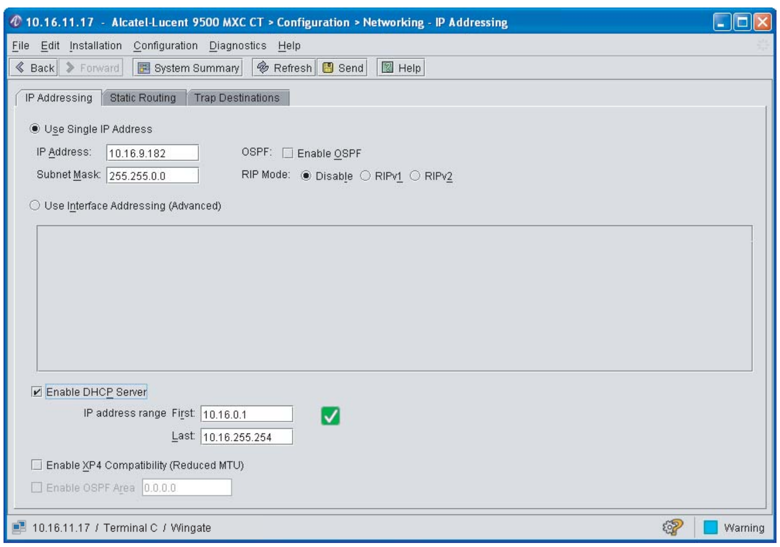
When considering the address range, bear in mind that where there are two or more 9500 MXC devices on the NMS LAN, such as a protected IDU pairing or back-to-back INU/IDUs, the server address range should be different and non-overlapping, so that there is no potential for the devices trying to issue the same IP address. While this is unlikely to cause a problem for a CT connection, good practice dictates that each device should support a unique range of addresses.

On the other hand, the range of addresses is typically large for the number of different CT PCs that are ever likely to be connected within the lease time. There will normally be a minimum of 253 LAN-specific IP addresses[4] available so even if the address range is extended to 10 IP addresses per 9500 MXC device, there is no potential for insufficient address availability, either to issue or being available for CT PC connection.

Figure 10-5 shows a typical Networking screen and its DHCP server configuration prompts.

- The IP address range is set to provide a non-overlapping range with any other LAN-connected and DHCP-enabled 9500 MXC radios.
- A green tick indicates a valid range setting.

Figure 10-5. DHCP Server Configuration



Procedure

1. Click **Enable DHCP server** and check the check-box to the *right side* of the address range entry lines.
   - If green-ticked it indicates a valid address range; if red-crossed, an invalid address range.
2. Review and if necessary adjust the **IP address range**.
   - The range would normally start with the next LAN IP address after the server address (the IP address of the radio).
   - Where two or more 9500 MXC devices are on the LAN *and* are DHCP enabled, ensure the LAN address range for each device is non-overlapping.

[4] *The host portion of an IP address will normally have 253 possible addresses; 255 less 2.*

- Valid examples for single terminals:

  9500 MXC Ethernet IP address: 192.168.0.1 (255.255.255.0)

  First: 192.168.0.2

  Last: 192.168.0.10

  9500 MXC Ethernet IP address: 10.16.11.1 (255.255.0.0)

  First: 10.16.11.2

  Last: 10.16.11.11

- Valid example for protected IDUs (both DHCP server enabled):

  IDU 1 9500 MXC Ethernet IP address: 192.168.0.1 (255.255.255.0)

  First: 192.168.0.3

  Last: 192.168.0.10

  IDU2 9500 MXC Ethernet IP address: 192.168.0.2 (255.255.255.0)

  First: 192.168.0.11

  Last: 192.168.0.20

3. Click **Send** to commit the configuration.

Chapter 11. 9500 MXC Node and Terminal Alarm Actions

The Alarm Actions screen supports mapping of alarms to/from an AUX module:

- TTL alarm inputs can be mapped to an output on the same AUX or to another AUX within a 9500 MXC network.
- Internal alarms can be mapped to relay output on any AUX in a 9500 MXC network.

Alarm mapping is achieved by identifying an alarm and configuring its destination IP address, AUX and relay output port.

Refer to Alarm Actions Screen.

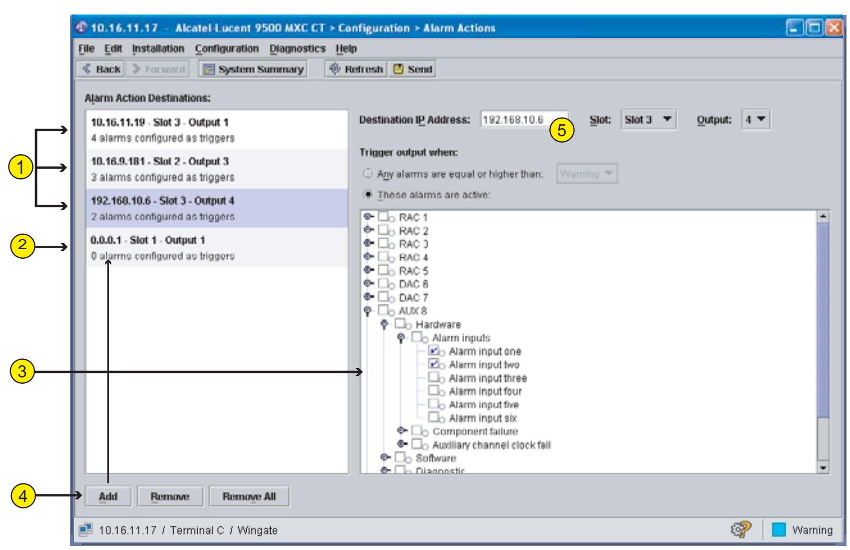
Alarm Actions Screen

Figure 11-1 shows a typical Alarm Actions screen. It enables:

- Alarm mapping for *all* AUX plug-ins installed in a Node. For a Terminal only the single Alarm I/O position is indicated.
- Mapping of alarm *inputs* to local and/or remote *outputs*.
- Mapping of *local alarms* (events) to local and/or remote *outputs*.

Inputs and/or alarms from multiple Nodes/Terminals can be mapped to a single, common output on any Node/Terminal in the network.

Figure 11-1. Alarm Actions Screen



Item	Description
1	Summarizes the setup for each alarm destination.
2	Example of a new, non-configured destination.
3	Shows an alarm tree for local Node/Terminal. Click the triggers to activate or de-activate alarm events to be mapped to selected destinations.
4	Click Add to add a new destination.
5	Enter the IP address of the destination Node/Terminal, enter the slot number of the destination AUX plug-in (Node only), and enter the output port number.

Before You Begin

When mapping alarm *inputs* and/or *outputs* at the local Node/Terminal it is recommended its AUX module is first configured for the required Alarm I/O input and output port conditions. Refer to Alarm I/O Configuration on page 7-78.

Similarly, until remote-destination AUX modules are configured, the mapped output action from the local Node/Terminal is not received.

Procedure for Alarm Actions Configuration

1. To configure alarm mapping, select **Configuration** > **Alarm Actions**. Refer to Figure 11-1 on page 11-1.
2. To add a destination Node or Terminal in the Alarm Action Destinations panel, click **Add**. Up to 30 destinations can be added.
3. In Destination Address, enter the IP address for the destination Node/Terminal. This updates the IP address for the new entry in the Alarm Actions Destination panel.
   - If the destination Node/Terminal is the *local* Node/Terminal (output port is on the same Node/Terminal as the input/alarm source), use the same IP address as the local Node/Terminal, or use the standard IP loopback address: 127.0.0.1.
   - Where a different set of alarms or inputs is to be sent to a *same destination* (same IP address), but to a different AUX plug-in, or different output port, use a separate Alarm Action Destination entry.
4. In Slot, select the slot location of the target AUX plug-in for the destination Node. This updates the entry in the Alarm Actions Destination panel.

Where the destination is a 9500 MXC Terminal, the Terminal resolves slot location; any valid slot number (1 to 9) entered in the originating 9500 MXC is default connected to the AUX I/O function in the destination Terminal.

For standardization purposes, it is recommended Slot 1 is used to identify an AUX destination in a Terminal.

5. In Output, select the target output port on the destination AUX plug-in. This updates the entry in the Alarm Actions Destination panel.
6. In the Triggers selection panel click to select the required input and/or alarm events.
   - The alarm tree can be expanded (toggle-tail down) to show available alarms for all installed plug-ins.
   - Inputs are found on the AUX plug-in(s).
   - Circular tags adjacent to each alarm and input selection box indicates current status. A red dot in the circle indicates active.
   - Multiple alarms and/or inputs can be selected. The number (quantity) selected updates the entry in the Alarm Actions Destination panel.
7. To commit the configuration, click **Send**.

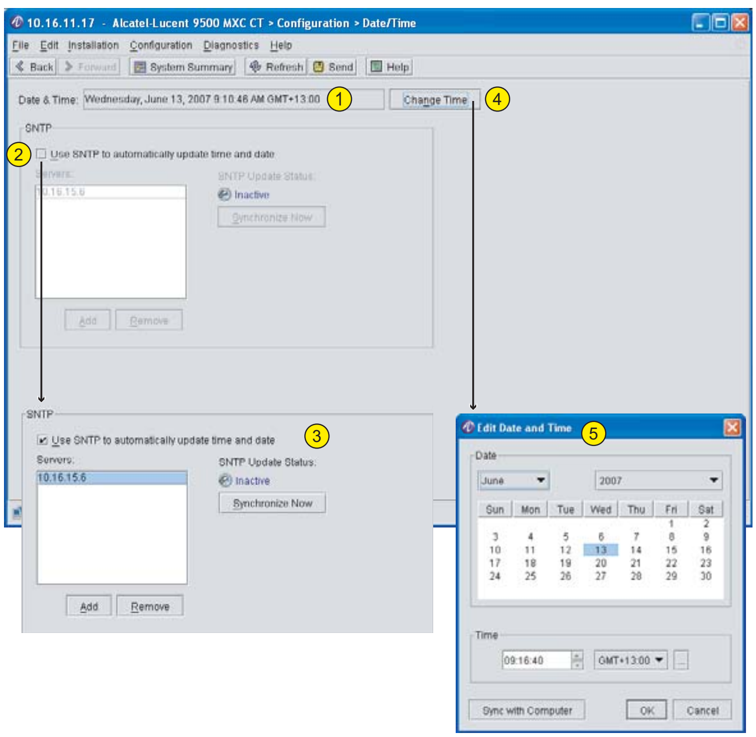
Chapter 12. Date and Time Configuration

The Date/Time configuration screen, provides options for:

- Direct entry of date and time.
- Selection from calendar and time zone prompts.
- Synchronization with the CT PC date/time (Synchronize With Computer).
- Synchronization with an external Simple Network Time Protocol (SNTP) server. SNTP is a reduced accuracy version of NTP. The protocol fields are the same, but the data values and algorithms used have reduced accuracy so that it can be implemented on limited capacity systems.

Refer to Figure 12-1.

Figure 12-1. Date/Time Screen



Item	Description
1	Current date and time.
2	Click to select SNTP time synchronization. Enables synchronization to an external SNTP server - timing is continuously maintained by the server, or servers.
3	SNTP configuration panel. Servers are added and their status (active or inactive) confirmed.
4	Click to open Change Time editing.

Item	Description
5	A date time can be direct-entered, or set from the CT PC clock. Subsequent timing is maintained by the internal Node/Terminal clock.

SNTP Operation supports connection to one or more external SNTP time servers via the NMS network.

- The server is identified by its IP address. When first configuring the time server option, the Synchronize Now button should be used, which will immediately reset the Node/Terminal time to the server time.
- Thereafter the built-in SNTP client automatically establishes connection to the time server each hour.
  - Providing the local Node/Terminal time is within 30 seconds of the server time it will drift towards the server time at a rate not more than 1 second per 33 minutes. The slow adjustment of time ensures no time-related disturbances to NMS network timing and/or internally timed routines.
  - In the unlikely event the local Node/Terminal time is more than 30 seconds from the server time it will jump to the server time.
  - If connection cannot be established at the scheduled hourly prompt, it will automatically retry after 5 minutes and continue to retry every 5 minutes until connection is re-established.
- More than one SNTP server can be listed, in which case the Node/Terminal will contact all servers hourly and adjust to the average of the times presented from each server. Having more than one server provides redundancy; in the event one server cannot be contacted, the other (or others) should be contactable to provide continuity.
- The time server may be a device on the NMS network or a 3rd-party server with connection via the Internet.
  - SNTP server applications are available to run on PCs.
  - For more information on SNTP servers and server sites, do a search on the Internet using ‘SNTP server’.

Chapter 13. Software Management

Software management enables viewing of installed SW versions, and the selecting and loading of new SW versions. A software rollback option is available. Refer to:

- Software Version Control
- Software Management Screen.

The customer is responsible for any decision to update 9500 MXC software to a later version.

Software Version Control

When a 9500 MXC Node or Terminal is shipped the software installed and the version supplied on its installation CD should be the current release or the immediately prior release, *as defined by its Major and Minor version numbers only*.

A version number incorporates major, minor and build numbers. For example in the 3.1.65 release ‘3’ is the major, ‘1’ the minor, and ‘65’ is the build.

- Major: increments for major functionality changes or platform changes.
- Minor: increments for minor functionality changes.
- Build: automatically increments as part of the development check/fix process.

The first two numbers, major and minor, define the release version. It is this combination that should be checked to confirm the expectation that at the time of shipment the 9500 MXC Node/Terminal was loaded with the most recent or immediately prior release version.

The current software release version can be checked by contacting an Alcatel-Lucent support center or your supplier.

Software Management Screen

The Software Management screen displays the existing software version, its status, and provides an ability to select a new software version for loading from a folder on your PC.

Refer to Typical Loading Sequence on page 13-2 and to the Software Management Screen in Figure 13-1 on page 13-5.

- For the 9500 MXC Node the load destinations are the NCC and ODU, or ODUs.
- Load destinations are not user selectable - all destinations are loaded.
- For the 9500 MXC Terminal the load destinations are the IDU and ODU both destinations are loaded.
- The Load Status box automatically lists all load destinations within a Node or Terminal.
- For Node ODUs, the Module graphics show the location of its associated RAC.
- Three load and activation options are provided. The Transfer-only and Activate-only options are to allow software transfer at any time without affecting traffic, and then subsequent activation at a time when traffic will be least affected.
  - **Transfer and Activate**: transfers the software pack to the Node and activates it. The Node will soft-reset during the load, which may take several minutes and may affect customer traffic. (Traffic may or may not be affected depending on the change/update).
  - **Transfer Only**: transfers the software pack to the Node but does not activate it. This does not affect customer traffic.
  - **Activate Transferred Software**: activates the previously transferred software pack. The Node will soft-reset during the activation, which may take several minutes and may affect customer traffic.

    On-screen information strips provide a description of these three options and their operation. Refer to Typical Loading Sequence.
- A software rollback feature is incorporated under the Advanced tab.

Software loading may take several minutes using an Ethernet connection from your CT PC to 9500 MXC, but take many minutes with a V.24 connection.

Refer to:

- Typical Loading Sequence
- Software Rollback

Typical Loading Sequence

Having selected the software pack to load and a transfer/activate option, the new software installation process is initiated by clicking the Start button. Sequences are described for the three transfer/activate options:

- Transfer and Activate
- Transfer Only
- Activate Transferred Software

Depending on the changes in the new software load, traffic and/or the CT connection can be momentarily interrupted.

Transfer and Activate

Upon clicking the **Start** button:

1. "Transferring software" is displayed in the Software State load destination lines, and the load state LEDs indicate grey.
   - All destination lines will be loaded where the new software is a later release for all destinations.
   - Where a new RAC is installed with an ODU 300 which has an earlier version of software loaded in the ODU and you wish to upgrade to the same version for existing load destinations, the normal load sequence must be followed but only the new ODU will be loaded.
2. The Progress lines indicate 0% for an initial period and then as the software loads, gradually increments towards 100%.

> The load state LEDs can toggle between grey and orange several times during the transfer process. For a large upgrade, for example upgrading from a very early version, the load to an NCC/IDU may take just a few minutes, but may take many minutes (up to 20+) for the ODU. The reason for this is that the NCC/IDU is directly connected to the load source, which loads directly at high-speed if an Ethernet NMS connection is used. However, an ODU must be loaded over its telemetry connection (from its NCC/IDU), which at 38.4 kbps occurs much more slowly, and at times may appear to hang. Simply wait until both LEDs are green and the new version of software is displayed in the Active Version column, and Software OK is displayed in the Software Status column.

3. On reaching 100%, "Activating software (version number)" is displayed in the Software State lines to indicate that it is switching to the new software.
4. Depending on the load, activation may be completed within a few seconds, or take up to two minutes, during which period "Cannot contact the unit" may be displayed along with orange load-state LEDs and cycling of *front panel* LEDs.
5. At the end of this period 9500 MXC returns to normal operation. There is no requirement to reset a 9500 MXC Node or Terminal on completion of a software load - the new version automatically replaces the old version. The previous version of software is retained for rollback.
6. For CT to auto-version with the new software you must exit your CT session and log back in. For software releases from March 2005, an on-screen message prompts for CT exit and restart.
7. When logged back in, check for normal Node/Terminal operation in the System Summary screen.

Transfer Only

Upon clicking the **Start** button:

- Steps 1) and 2) of the Load and Activate process are completed, with completion indicated by a blue load state LED and "Software (version) transferred, awaiting activation" displayed in the Software State lines.

Activate Transferred Software

Upon clicking the **Start** button:

- Steps 4) and 5) of the Load and Activate process are completed, which must be followed by the CT log-out / log-in steps of 6) and 7).

Software Rollback

Click the Advanced tab to view and activate rollback. Rollback should only be used where an operational problem with the new load is evident and a return to the previous software is desired. Note that **ODU 300hp does not support SW rollback**. It only supports roll-forward[1].

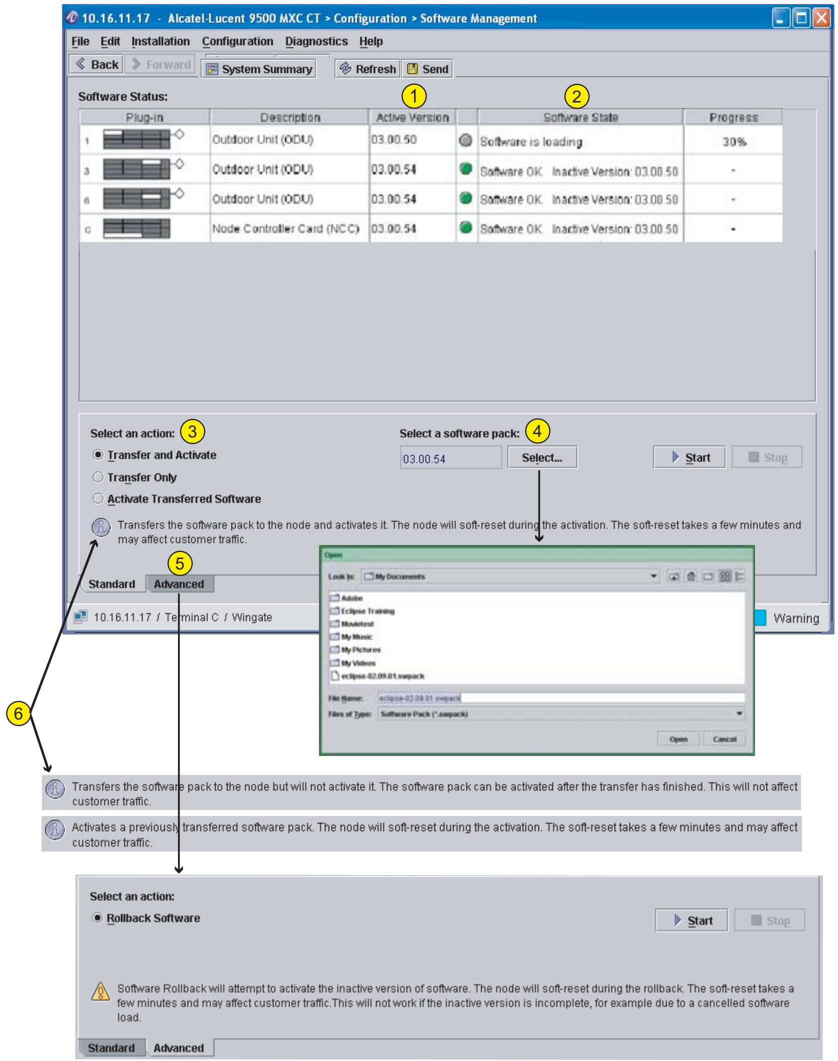
- 9500 MXC maintains two software load spaces on the CompactFlash card.
  - One load space is always reserved for the active (current) software load.
  - The second load space is occupied by the inactive (previous) software version *unless replaced by a new load that is ready for activation*.

The most recently replaced software load is held in reserve for rollback purposes, but will be discarded where the Transfer Only option is selected - the transferred software occupies the load space previously held by the most recently replaced software.

- The software management screen indicates the active and inactive software versions. The inactive version is the version available for rollback - or for activation after a Transfer Only load selection.
- If the software held under rollback is not applicable to the selection, it will not be activated. Such non-activation is advised in an on-screen window.
- Where rollback is selected, the Software State will indicate that rollback is in progress. *Software rollback is not supported by ODU 300hp.*
- When a rollback has been executed the second load slot is occupied by what was the active version before rollback.

[1] *In the event there is a genuine (documented) customer need to change ODU 300hp SW, it will be done as a new SW release (roll forward).*

Figure 13-1. Software Management Screen



Item	Description
1	Software Status shows the active version for each load destination, and any current load activity. Example shows a software load in progress.
2	Shows the active software versions (ODUs and NCC/Control Module).
3	Select an action option for software transfer and/or activate.
4	The Select button opens a browser on your PC to locate and select software to load.
5	To select the software rollback option click the Advanced button. *Software rollback is not supported by ODU 300hp.*

Item	Description
6	Information displayed with the software transfer and/or activate options is context sensitive.

Chapter 14. Security Configuration

The security screen enables activation or de-activation of login security, and password editing.

Refer to Security Screen.

Security Screen

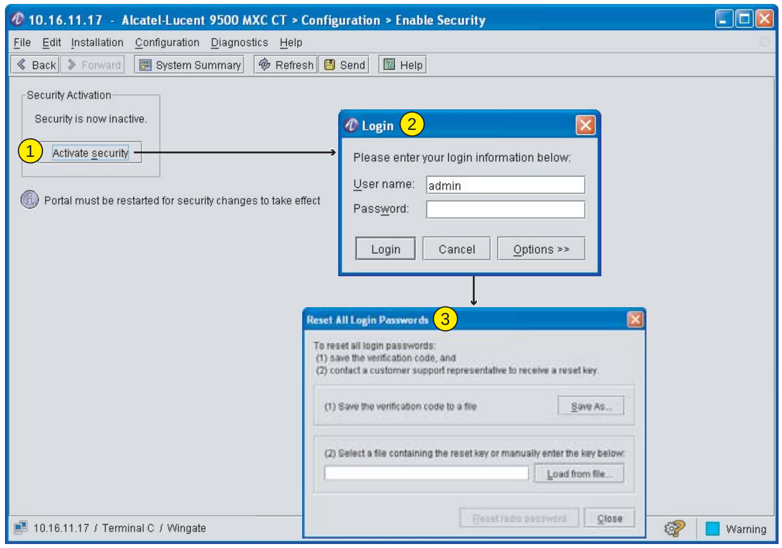
When activated, a login window is displayed after the CT Start-up window, wherein username and password are prompted for; admin, engineer, or operator. Refer to Table 14-1 for username access details.

Table 14-1. Username Categories

Username	Default Password	Enables
admin	port_adm	Security and password setting. Security can be enabled/ disabled, and passwords set and changed. Cannot view and change 9500 MXC configuration or diagnostic settings, or update software.
engineer	port_eng	Read/write access. An engineer can send changes to 9500 MXC and update software, but cannot change password or security settings.
operator	port_op	Read only. An operator cannot send changes to 9500 MXC or update software, or change password or security settings.

Figure 14-1 shows the Security screen and login window for password activation.

Figure 14-1. Security Configuration Screen

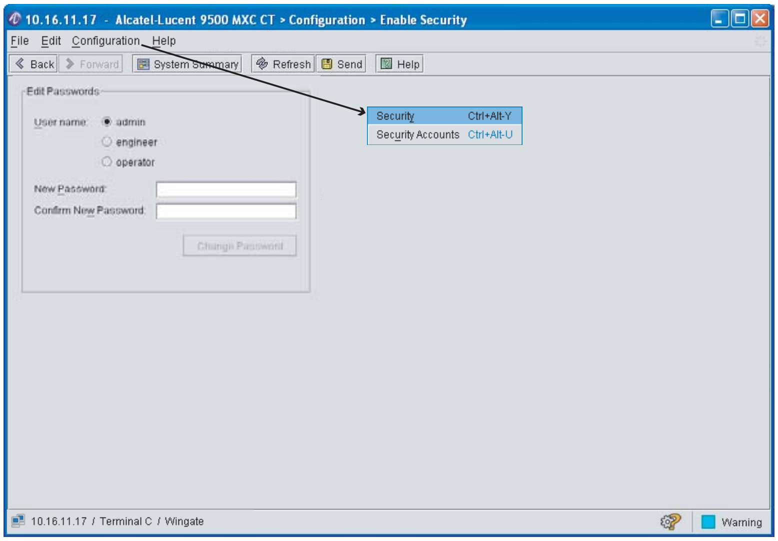


Item	Description
1	Click **Activate security** to open the login window.
2	Enter the administrator password, then click **Login.** CT must be restarted for security changes to take effect. Security can only be activated/de-activated by the administrator user name and password. The default administrator password is **port_adm**.
3	The Reset Passwords window is for use in the event the administrator password is lost. To reset a lost password, follow the procedure in Lost Password Procedure on page 2-28 of this Volume.

Figure 14-2 shows the opening screen for a password protected 9500 MXC *when opened with an admin username and password.*

- Only administrators can manage/edit passwords.
- An administrator has a restricted menu bar, and Configuration options are restricted to **Security** and **Security Accounts**.
- To deactivate security, select **Configuration** > **Security** > **Deactivate Security**, then restart CT.

Figure 14-2. Login Screen for Admin



Chapter 15. Diagnostics

The CT diagnostics screens are used to source status and performance information about 9500 MXC Nodes and Terminals, and to set diagnostic modes for testing and fault-finding.

The screens included in the 9500 MXC CT Diagnostic Menu are:

- System Summary
- Event Browser
- Alarms
- History
- Performance
- System/Controls
- Circuit Loopbacks for 9500 MXC Node
- Parts
- Advanced Management

Online Help and Context Sensitive Help

Two Diagnostics screens, Event Browser and Alarms, support context sensitive help for events and alarms. This help requires installation of the 9500 MXC Online Help.

Additionally, most CT screens support context sensitive help from 9500 MXC Online Help, where by clicking the Help button in the Toolbar (or Context Sensitive Help, under Help in the Menu bar) you are brought into the relevant section of the 9500 MXC User manual.

Refer to 9500 MXC Online Help.

9500 MXC Online Help

9500 MXC Online Help is a web-based (html) helpset for the 9500 MXC User Manual. It is installed on your CT PC, and is launched when prompted from CT.

From SW release 4.3, its installation is prompted from an installer on the 9500 MXC Setup CD, *which includes both the CT and Online Help applications.*

For information on the installation process, and navigation of online help, refer to 9500 MXC CT Introduction > Online Help.

Depending on the selected prompt, the online help is opened to provide:

- **General user manual online help.** Opens the web-based version of the 9500 MXC user manual. It is launched by clicking Help in the CT menu bar and selecting 9500 MXC Manual, or CT Manual. The CT manual is a subset of the 9500 MXC manual.
- **Context sensitive online help.** This is launched by:
  - Clicking F1.

- Clicking Help in the CT toolbar.
- Clicking Context Help, under Help in the menu bar.

Refer to Context Sensitive Help.

- **Context sensitive online help for alarm or informational events.** This is launched by clicking the relevant tab in the Diagnostics > Event Browser, or Diagnostics > Alarms screens. Refer to Help for Event and Help for Alarm Tabs.

Context Sensitive Help

Context sensitive help provides access to the most relevant page within the 9500 MXC User Manual for the CT screen that it is opened from.

From the opening online screen, you can navigate away to any other screen within 9500 MXC online help.

Help for Event and Help for Alarm Tabs

The Event Browser screen has a Help for Event tab. Similarly, the Alarms screen has a Help for Alarm tab. Providing 9500 MXC Online Help is installed on your CT PC, and help is available for the selected event or alarm, these tabs, when clicked, will provide information on the selection.

- Help for Event provides access to the 9500 MXC Online Help files for alarm and informational events.
- Help for Alarm provides access to 9500 MXC Online Help files for alarm events only.

For an alarm event, the response provides a description, probable cause and recommended action.

For an information event, the response simply provides an event description.

The information provided for these alarm and informational events is identical to the data provided in Appendix B, and from CT Alarms or Informational Events in Troubleshooting.

- If information for a selected event or alarm is not available, the help tab is greyed-out.
- The Help for Event or Help for Alarm tab must be clicked for each new help selection.
- It is not necessary to have 9500 MXC Online Help open when an event or alarm tab is clicked. CT automatically opens online help when the tab is first clicked, and it will remain open until closed from within the web browser.
- Only tree-end alarms are supported.

System Summary

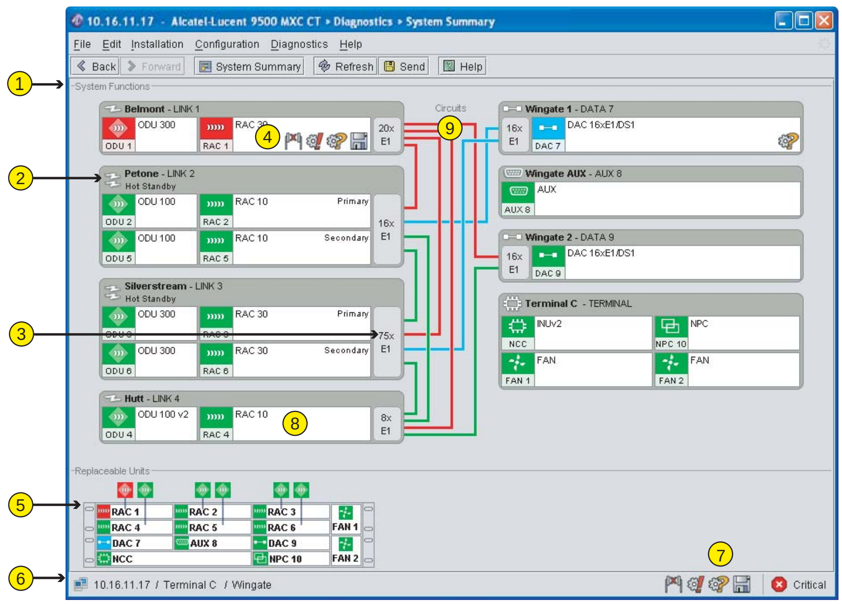
The System Summary screen is the CT opening screen. It provides a real time overview of system status for the 9500 MXC Node or Terminal, and for a Node the tools to set the system layout.

See System Summary Navigation on page 15-4.

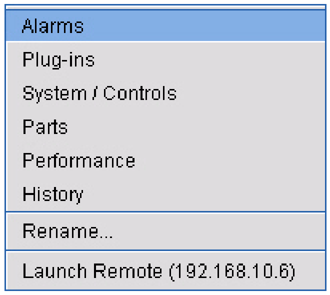
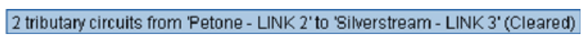
See System Layout Configuration: Node on page 15-6.

Figure 15-1 shows an example screen for a 9500 MXC Node.

Figure 15-1. Example System Summary Screen for a 9500 MXC Node



Item	Description
1	The System Functions window illustrates the plug-in type, function, location, and status.
2	Protected RACs and DACs are shown as a combined function.
3	Links show configured capacity.
4	9500 MXC problem icons assist identification of alarm situations. Mouse over the problem icon for a description of the problem.
5	Replaceable Units show the physical layout of the system, and mirror function status.
6	IP address, terminal name, and site name.
7	Icons summarize the Node/Terminal status, displaying the highest current alarm severity and all current problem icons.

Item	Description
8	Right click within a module to view and select an option from a quick-access menu. 
9	Right-click on Circuits to select screen options. Mouse over a specific circuit to view its trib data: 

System Summary Navigation

The system summary screen provides an overview of the function and health of a Node/ Terminal and the tools to set the layout (plug-in options) for a Node.

System Functions Panel

Each Node/Terminal system function is separately identified by a module. Colors used for module icons reflect alarm severity, and 9500 MXC problem icons are presented to assist problem identification with links into the relevant Alarms screen. For the Node, circuit connections are shown between traffic plug-ins, the color of which also reflects the alarm severity associated with the module at one or both ends of its connection.

For a 9500 MXC Node the functions identify:

- Plug-in type, location, and status. To update slot designations for plug-ins refer to System Layout Configuration: Node on page 15-6.
- Configured link (RAC) capacity, and status.
- Protected RAC and DAC plug-ins. Protection partners are shown within a combined function, and include identification of protection type, and primary and secondary status.
- Circuit connections, and status.
- Maximum DAC trib capacity.

For a 9500 MXC Terminal the functions identify[1]:

- Module function and status.
- Configured link capacity, and status.
- Maximum trib capacity.

Color-coded Alarm Severity

1 *Protected IDU installations are not indicated; each IDU is viewed in CT as a separate platform.*

- Green indicates no alarms, red indicates a critical alarm. Other colors reflect various warning severities. Refer to Event Browser Navigation on page 15-9 for details of alarm type/color and severity.

Problem Icons

- Mouse-over for tooltip advice.
- For a list of problem icon types, refer to 9500 MXC CT Symbols on page 1-3.

Quick-entry to Other Screens

- Right click on any module to view a short menu of selected options. Left-click a selection to go direct to the option.
  - The options provide direct links to relevant screens, and to a module renaming function.
  - A Launch Remote option is included on LINKS (RACs and DAC 155oM) providing there is an operational link to the remote end.
- Right click on the interconnecting circuit lines to view and select options to go to the Circuits Screen or the Circuit Loopbacks Screen.

To return to the System Summary (previous) screen from other screens, click on the <Back tab in the toolbar.

The right-click for quick-entry-menu is supported on other module-based screens, such as Plug-ins, but not all include the module renaming option.

Disable for Removal

Accessed by right-clicking within a module. Left-click to disable. This option is used to ensure that removal of a module will not affect other traffic traversing the INU/INUe.

- Some modules, when withdrawn, may cause a momentary hit on other traffic. This disable option ensures that when a module is withdrawn, no hit on other traffic will occur.
- Unless withdrawn, a module will be re-enabled within 60 seconds.

Disable for removal is not supported on protected modules.

Plug-in Missing or Unexpected Plug-in

Where a plug-in is missing or when a new (unexpected) plug-in is installed, text within a module indicates the relevant status. A tab is included to enable setting of as-found status, to confirmed status.

Tooltips

Mouse-over for tooltips:

- Mouse over an alarm icon for a description of the alarm.
- Mouse-over a circuit line to see its configured capacity, its interconnections, and current alarm severity as determined by the highest current severity on modules at each end of the circuit. (Node only).
- Mouse-over a color to see its severity level.

- Mouse-over a module to view its location in the INU/INUe Replaceable Units graphic (Node only).

Replaceable Units Panel

Replaceable Units shows the physical layout for a 9500 MXC Node.

- Allows easy identification of plug-in types and location. Unconfigured slots are shown as blanks.
- Colors reflect the alarm severities shown the System Functions panel.
- Mouse-over a slot to highlight its position in the System Function panel.

Status Bar Icons

The Status bar at the bottom of the screen (all CT screens) presents a summary of Node / Terminal status.

- The alarm severity icon presents the highest severity alarm found.
- The problem icons show all problem types present.
- Right-click on an icon to display a menu of screens relevant to the problem.
- When not in the System Summary screen, left-click on a problem or alarm severity icon to go directly to the System Summary screen.

Module Naming

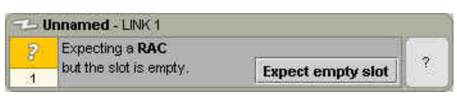
For modules a name can be entered or a name changed by right-clicking in a module, selecting **Rename**, and typing. The default name is 'unnamed'.

The name entered will appear in all CT screens where modules are identified by name. Includes Plug-ins, Protection, Circuits, Networking, System Summary, System/ Controls, History.

System Layout Configuration: Node

This procedure:

- Only applies to a 9500 MXC Node. It enables slot plug-in options to be installed, un-installed or changed it type.
- Only applies where a module conflict has arisen:
  - A vacant but configured slot is indicated as shown:



  - A slot that has a different plug-in installed to that which was configured will indicate as shown:

Procedure:

1. If a conflict is indicated, either:
   - Confirm the new, expected status by clicking the **Expect** tab followed by **Send**, or
   - Stay with the current configuration, by installing the plug-in type expected.

When changing plug-ins or inserting new plug-ins, it may take CT up to 60 seconds to reflect the update.

When changing a 2RU FAN for two 1RU FANs or vice-versa in an INUe it may be necessary to restart CT to capture the change.

2. Where there are multiple conflicts, such as may occur when a new INU/INUe is configured, a quick update to the required status can be made by clicking the Use Detected For All tab.
   - This tab only appears when a conflict is found:

   - To commit the changes click **Send**.

Next Step

To change or enter a new plug-in configuration, go to the Plug-ins screen. Refer to Node and Terminal Plug-ins on page 7-1.

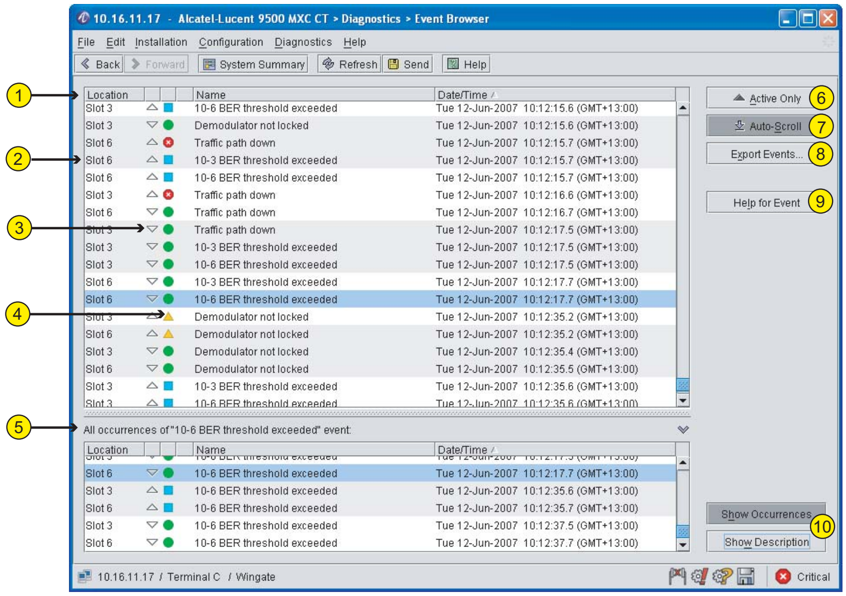
Changes to configuration are limited to detected *and* accepted plug-ins. CT does not allow configuration of expected plug-ins (a Plug-in must be installed and accepted).

Event Browser

The Event Browser, in Figure 15-2, provides a real time view of all events, both active and cleared, for the selected 9500 MXC Node or Terminal. The browser has a nominal capacity of 5000 events, after which time new events replace earliest events on a one-for-one basis.

See Event Browser Screen Description on page 15-9 and Event Browser Navigation on page 15-9.

Figure 15-2. Event Browser Screen for a 9500 MXC Node



Item	Description
1	Event Box.
2	The location indicates the slot that is generating the event.
3	Triangles indicate event status: • Black triangle = Event active • White triangle pointing up = Event was raised • White triangle pointing down = Event was cleared
4	The color indicates the event severity. • White = Informational • Cyan = Warning • Yellow = Minor • Orange = Major • Red = Critical • Green = Cleared
5	All Occurrences lists all events of the type selected in the Events box. To enable, click **Show Occurrences**. Click and drag on the divider bar to set the sizing for the Events and All Occurrences windows.
6	Click **Active Only** to view only active events.
7	**Auto Scroll** is default enabled. It automatically scrolls the events list towards the most recent event. The most recent event is default shown at the bottom of the list. To reverse the listing, click on the triangle immediately to the right of the Date/Time header.

Item	Description
8	**Export Events** exports events as a .csv file. Click to open a browser.
9	**Help for Event**. Click to view context-sensitive help. The helpset for 9500 MXC must be loaded on your CT PC for this operate.
10	Click to enable the **All Occurrences** and **Description** views. The Description view mirrors the event description for a selected event.

Event Browser Screen Description

The screen opens to an event listing, which scrolls down to the latest event, unless auto-scroll is turned off. Other lists (boxes) can be enabled using tabs on the lower right.

Event box provides a date/time-stamped listing for each new event (alarm and informational). Events are shown in true chronological order with time-stamping to a 0.1 second resolution. Indicators assist with identification of event source (plug-in location), whether it is a new or cleared event, and the severity and status of the event.

All Occurrences box is user-selected by clicking the ‘Show Occurrences’ tab. It provides an automatic listing for all like events selected (highlighted) in the Event box. For instance, if an SESR line is selected in the Event box, then the All Occurrences box is populated only with SESR events and in the same time and date order as in the Event box. It is particularly useful in matching and viewing the history of one event type, and when coupled with the plug-in location graphic, also by plug-in.

Description box is user-selected by clicking the ‘Show Description’ tab. It currently only replicates event-line data.

Event Browser Navigation

The INU graphic shows which card in an INU has raised the listed event.

Triangles indicate one of three event status types:

▲ Event active

△ Event was raised

▽ Event was cleared

Colors indicate event type/severity:

White	□	Informational
Cyan	■	Warning
Yellow	■	Minor
Orange	■	Major
Red	■	Critical
Green	■	Cleared

Date/Time Setting

The default setting has latest events listed at the bottom. To put the latest event at the top, click on Date/Time to reverse the date/time triangle.

Active Only Tab

Selecting this tab removes all cleared events to show only black triangle, uncleared events.

Auto Scroll Tab

Auto Scroll automatically scrolls the Event Browser listing down to the latest event. It is default activated but can be turned off by clicking the tab.

Export Events Tab

- Clicking opens up a Save-In window, which is default set to My Documents. This facility allows the event listing to be saved as an Excel compatible CSV file to a folder of your choice. With Active-Only turned off, all events are exported. With Active Only selected, only active events are exported.
- If the CSV delimiter parameter has not previously been set on your laptop, when the Export tab is first clicked the Edit > Preferences window will be presented. Refer to 9500 MXC CT Menus on page 3-4 of Volume IV.

Help for Event Tab

Clicking the Help for Event tab provides access to the 9500 MXC Helpset alarm files, which provide an on-screen alarm description, probable cause and recommended action for the selected alarm. The information is identical to alarm data provided in Appendix B, 9500 MXC Alarms, and in CT Alarms on page 2-15 of the Troubleshooting chapter in Volume 5.

Help for Event, and the Help for Alarm provided in the CT Alarms screen, access the same Helpset files.

- 9500 MXC Online Help must be installed on your PC prior to logging in with CT. Refer to 9500 MXC Online Help on page 15-1.
- If the Helpset is not available (has not been loaded on your PC), the Help for Event tab will remain greyed-out and a Help Not Installed message will appear below the Help for Event tab.
- 9500 MXC Online Help is automatically opened to the relevant alarm page when the Help for Event tab is clicked on a valid (un-greyed) alarm selection.
  - It is not necessary to have Online Help open when the Help for Event tab is clicked. CT automatically opens Online Help when the tab is first clicked, and it will remain open until closed from within Help.
  - The Help for Event tab must be clicked for each new event help selection.
- Figure 15-3 shows the event help for ESR Threshold Exceeded.

Figure 15-3. Example Help Page

ESR Threshold Exceeded

G.826 ESR threshold exceeded. This is a path warning alarm.

Probable Cause

Path conditions, interference, or equipment malfunction.

Recommended Actions

1. Check for other alarms, particularly those that indicate a total LOS due to a component failure, or a complete path failure:
   - Component failure or Rx path failure alarms must be checked before investigating an RSL Below Threshold alarm.
   - If the only other alarms are Demodulator Not Locked, and its downstream path failure and path warning alarms, a path failure is indicated, which may be caused by a complete path fade or a remote Tx failure.
2. If ESR Threshold Exceeded is the only alarm, or the only other alarms *are also path warning alarms*, check G.826 and RSL measurements at both ends using the Portal Performance screen:
   - If low RSL and G.826 alarms are present *at both ends of the link*, a path problem is indicated, which most likely will be caused by a degraded path due to rain, diffraction or mulipath fading. Check recommended actions for BER alarms.
   - If an ESR alarm is present *at just the local end and RSL is normal*, interference from another link should be suspected. Use the Portal History and Event Browser screens to track the onset of ESR alarms, which for a newly installed interferring link should show a repetition of G.826 alarm occurences as the new link is installed and commissioned.

Additional Information

An ES (errored second) is a one-second period with one or more errored blocks or at least one defect.

ESR (errored second ratio) is the ratio of ES to total seconds in available time during a fixed measurement interval. For Eclipse the measurement interval is 60 seconds, and the ESR alarm threshold is set at 20%.

Show Occurrences

Click tab to open the All occurrences box. Provides a listing of all events of the same type selected (highlighted) in the Events box.

Show Description

Click tab to open the Description box. Currently replicates the selected event.

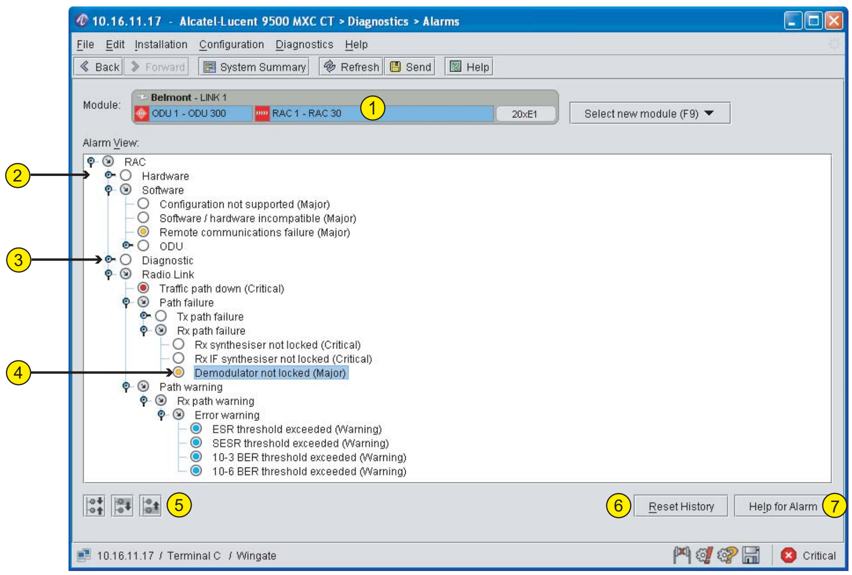
Box heights for Show Occurrences and Show Description may be changed by clicking and dragging on the divider bars.

Alarms

The Alarms screen provides a tree view of alarm history for a selected module since logon or since a History reset as shown in Figure 15-4.

Only alarms relevant to the selected module are displayed. See Alarms Screen Navigation on page 15-13.

Figure 15-4. Example Alarms Screen



Item	Description
1	Screen default opens to the lowest-number plug-in, Link 1 in this example.
2	The alarm tree auto-opens to show current alarms.
3	Toggle is up; there is no current alarm beyond this point. However you can click the toggle down to view alarm paths beyond this point.
4	The color of an alarm tab indicates its severity level.
5	Click these icons to: • View active alarms only • View previous or next alarm on the alarm tree
6	Click **Reset History** to reset the Alarm Tree.
7	Select an Alarm event then click **Help for Alarm** to view context-sensitive help (requires installation of HSX Help on your PC).

Alarms Screen Navigation

Module. The Alarms screen for the 9500 MXC Node opens on the first filled slot in an INU/INUe. Clicking the **Select new module** tab brings up a menu of links and cards installed. In the example, RAC 2 (slot 2) has been selected. For the 9500 MXC Terminal the screen opens to the Radio module.

The alarm tree shows the opened-out history of the selected module. Where paths in the tree have no alarm history the associated toggle is horizontal. Where there is history, the toggle(s) are down through to the base level of the highlighted alarm point.

Infill on the circular tabs indicate an active alarm point, and the color its severity. Colors used reflect the international severity standard. See 9500 MXC CT Symbols on page 1-3 of Volume IV, Chapter 1.

Where alarm events have been raised and then cleared within the period of history capture, an up-down arrow is displayed next to the relevant circular tab(s).

Active Alarm Icons

The three icons at the lower left of the screen provide quick identification of, and navigation between active alarms, with controls for:

- View active alarms only
- Move to the next active alarm
- Move to the previous active alarm

Reset History

Click on Reset History to reset the tree. Historical events are removed to display only currently active alarms and subsequently any new alarms, or change in alarm status, from the time of resetting.

Help for Alarm

Clicking the Help for Alarm tab provides access to the 9500 MXC Online Help alarm files, which provide an on-screen alarm description, probable cause and recommended action for the selected alarm. The information is identical to Alarm data provided in Appendix B, 9500 MXC Alarms, and in CT Alarms in Volume V, Troubleshooting.

- 9500 MXC Online Help must be installed on your PC prior to logging in with CT. Refer to 9500 MXC Online Help on page 15-1.
- If 9500 MXC Online Help is not available (has not been loaded on your PC), the Help for Alarm tab will remain greyed-out and a Help Not Installed message will appear below the Help for Alarm tab.
- 9500 MXC Online Help is automatically opened to the relevant alarm page when the Help for Alarm tab is clicked on a valid (un-greyed) alarm selection.
  - Only tree-end alarms are supported.
  - It is not necessary to have 9500 MXC Online Help open when the Help for Alarm tab is clicked. CT automatically opens Online Help when the tab is first clicked, and it will remain open until closed from within Help.
- The Help for Alarm tab must be clicked for each new alarm selection..
- Figure 15-3 on page 15-11 shows the Help for Alarm information for an ESR Threshold Exceeded selection.

History

The History screen supports RAC and Ethernet modules.

For RACs the screen provides graphical and report views. Refer to History Screen: RACs.

For DAC ES, DAC GE and IDU ES the History screen provides graphical and summary report data for ports and channels. Refer to History Screen: Ethernet.

History Screen: RACs

The RAC History screen supports graph, report, and combined graph and report screen views.

A resolution option provides selection of 15-minute or 24-hour options. 15-minute provides viewing of seven days worth of 15 minute data bins; 24-hour provides one months worth of 1 day data bins.

- The graph screen provides a histogram of 15 minute or daily (24 hour) data bins of RSL, G.826 statistics, event detected, and configuration changes.
- The report screen enables selection of summary data for a selected period (min, max and mean). It also supports an event listing for the selected period.

Tooltips provide information on screen options and function.

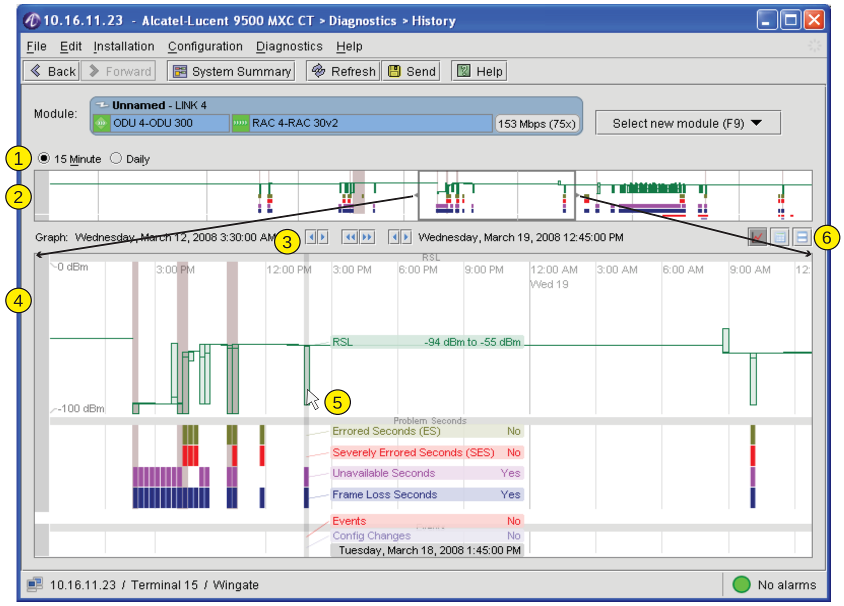
Both 15-minute *and* one-day data bins are captured from power-on.

History data is held on a FIFO basis. Data in excess of the 15 minute or daily bin maximums is deleted in favor of new-in data.

The history screen has a 1.5 second sampling rate for RSL capture. Events of less than this duration may not be presented.

- The **Graph Screen**, as shown in Figure 15-5, provides a link-based view of operational status. For a protected link, the path data (RSL and G.826) is duplicated.

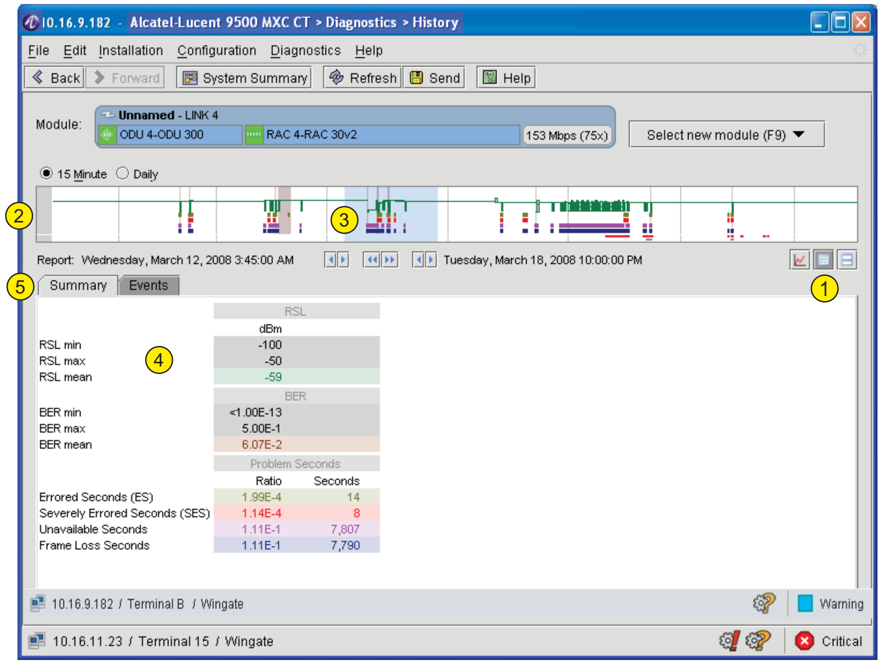
Figure 15-5. History Graph Screen



Item	Description
1	Select a resolution type, 15-minute or Daily. 15 minute is the default, and is shown in the example screen. Both 15 minute and daily data bins are captured from power-on.
2	Complete History view. Up to one weeks worth or 15 minute bins, or one month of daily bins.
3	Set the range for the expanded view (4). Either left-click within the complete history view to drag and set the range edges, or use the buttons. Left-side buttons move the start, right-side buttons move the end, and the middle buttons move the whole range. The selected start and end date/times are displayed to each side of the buttons. The default range for the expanded view is the same as the full-history view.
4	The expanded view enables easy viewing of each 15 minute or daily event.
5	Mouse over any segment for a summary of its data. Data displayed is RSL, errored seconds, severely errored seconds, unavailable seconds, frame loss seconds, events, configuration changes, and date/time of segment capture.
6	Use these buttons to select graph, report, or combined graph and report screen views. Graph is the default screen.

The **Report screen**, as shown in Figure 15-6, provides a summary view of operational status for a selected period. For a protected link, the path data (RSL and G.826) is duplicated.

Figure 15-6. History Report Screen



Item	Description
1	Report screen view is selected.
2	Complete history view.
3	Left click within the view, and drag to the left or right to set a report range. The range is shown by blue highlighting.
	Once a range is selected, it also displays in the graph screen, and can be adjusted from within the graph screen by clicking and dragging edges in the expanded view.
	Summary data for the selected report range. Data displayed is RSL (min, max, mean), BER (min, max, mean), errored seconds, seriously errored seconds, unavailable seconds, and frame loss seconds.
	Click Events to view a listing of events for the selected period. The listing mirrors the listing for the same period in the Events Browser screen.

History Screen: Ethernet

The Ethernet History screens support graph, report, and combined graph and report screen views for DAC ES, DAC GE, and IDU ES.

15-minute or 24-hour resolution options are provided:

- 15-minute provides viewing of seven days worth of 15 minute data bins.
- 24-hour provides one months worth of 1 day data bins.

Both 15-minute and one-day data bins are captured from power-on. The data is held on a FIFO basis; data in excess of the 15 minute or daily bin maximums is deleted in favor of new-in data.

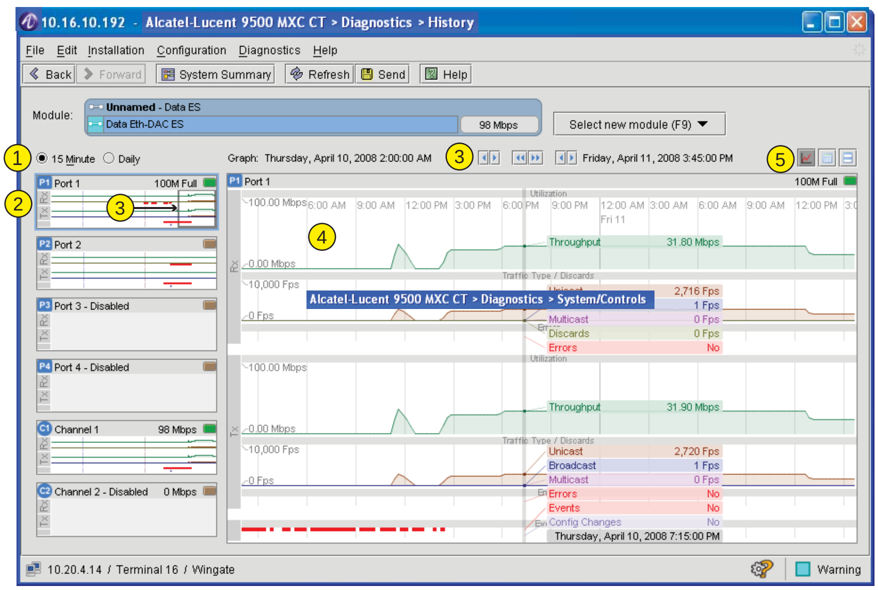
Statistical data is lost when the -48 Vdc supply is turned off, or when a new SW version is loaded.

The data captured includes:

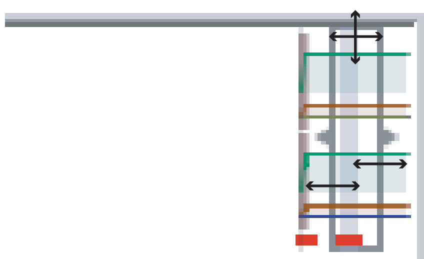
- Ethernet Rx and Tx statistics
- Events
- Configuration changes

The **Graph Screen**, as shown in Figure 15-7, shows a typical opening screen. Screens have the same appearance and function for DAC ES, DAC GE, and for the DAC ES module in the IDU ES. It default opens to 15 minute resolution.

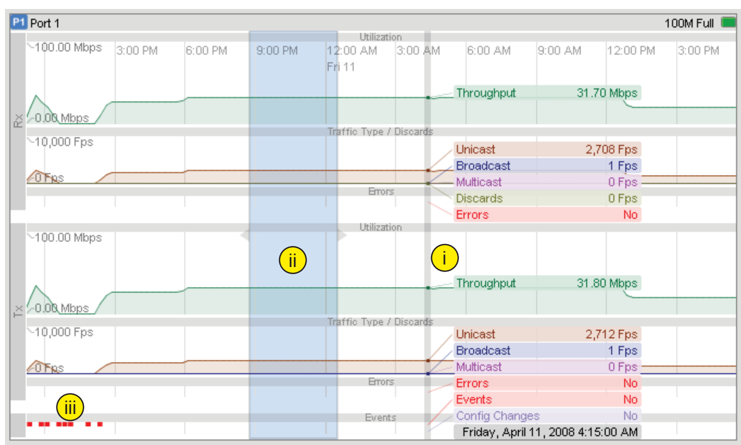
Figure 15-7. History Screen: DAC ES



Item	Description
1	Port/Channel summary windows. Data is displayed from right to left in time order. See Item 2. Higher resolution data for the selected port/ channel is displayed in the Detail window to the right, see Item 3. The example shows data collection for a period of approximately 12 hours. Data is collected (binned) from the time an INU/INUe/IDU is powered on. Statistical data is lost when the -48 Vdc supply is turned off, or when a new SW version is loaded. • Double click within a port/channel window to have its data displayed in the Detail window.

Item	Description
2	Port/Channel summary windows. Data is displayed from right to left in time order. See Item 3. Higher resolution data for the selected port/channel is displayed in the Detail window to the right, see Item 4. The example shows data collection for a period of 7 days. Data is collected (binned) from the time an INU/INUe/IDU is powered on. A green marker in the top right corner of a summary window indicates that the port/channel is up. Brown indicates the port/channel is down. Click within a port/channel window to have its data displayed in the Detail window, Item 3.
3	ummary data window. The most recent 15 minute data bins (up to 7 days) are default displayed. The same collection period is also displayed in the Detail window. The most recent data is displayed to the right side of the window. • Use your mouse to click and drag a (shorter) period of time (reduced number of bins) for display within the Detail window. • The edges (start and finish times) can be separately set. • The selected period (number of bins) can be moved within the widow by dragging the crossed arrow icon, which is displayed when your mouse is moved to the top of the selected period.  • Alternatively, use the use the buttons above the Detail window. Left-side buttons move the start, right-side buttons move the end, and the middle buttons move the whole range. • The selected start and end date/times are displayed to each side of the buttons.

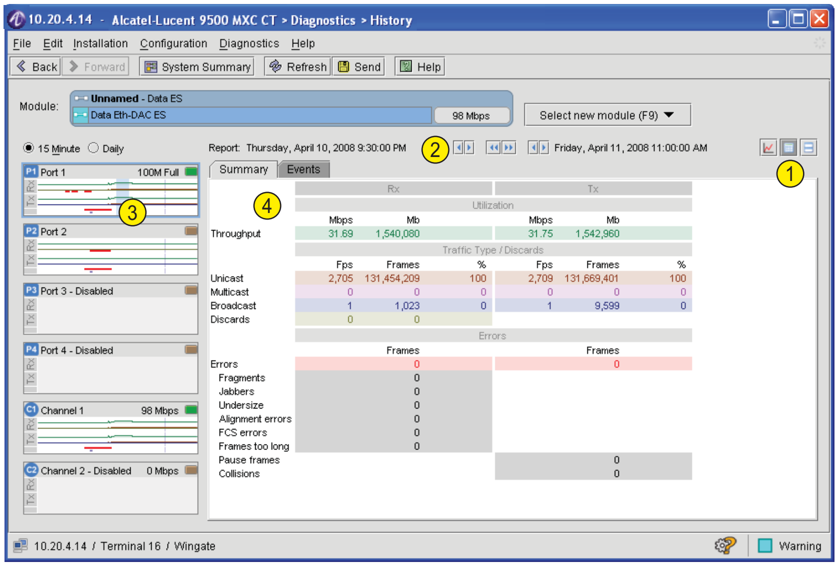
Item	Description
4	Detail window. Presents higher resolution data and the ability to select a report range. The most recent data is to the right side of the window.The period displayed (number of bins) is selected in the summary window (Item 2). Data is separately displayed for Tx and Rx traffic and for events. Throughputs, frame types, discards and errors are graphed. Mouse-over to identify the data. Each bin is presented as a vertical segment, with the width of the segment dependent on the period selected. Where data is incomplete the relevant bin segments are shown with dark grey highlighting and 'Incomplete' will appear at the top of the segment when moused-over. i) Statistical data is displayed for a selected bin, simply mouse-over to display. Any bin within the window can be selected. ii) Select a report range (optional), as shown by the blue highlighted selection. Select the full period by double-clicking in the window, or select a range by clicking in the Detail window and dragging. Data for this selection is displayed in the Report window. See Item 5. iii) Red markers at the bottom of a bin indicate that an event (alarm or informational) has occurred during the bin period. To view events, select the Events report tab. See Item 5. Events are mirrored from the Events Browser screen.



Item	Description
5	Select Graph (default) Report, or combined Graph and Report screens. Report window. Use these buttons to select graph, report, or combined graph and report screen views. Graph is the default screen. Use the Ethernet Report. Rx and Tx statistics are displayed for the report range selected in the Detail window.

The **Report screen**, as shown in Figure 15-8, provides a summary view of operational status for a selected period.

Figure 15-8. History Report Screen: DAC ES



Item	Description
1	Report screen view is selected.
2	Report range can be selected using these buttons, or by clicking and dragging a selection in the *Graph* detail window. Mouse over the buttons for a description of their action. The selected start and end date/times are displayed to each side of the buttons.
3	The selected range is also indicated in the summary window by the blue highlighting.
4	Summary Ethernet statistical data is presented for the selected range.

Performance

For 9500 MXC Node the Performance screen supports selections of:

- Link Performance on page 15-21
- NCC Performance on page 15-24
- DAC 16x/4x E1 Performance on page 15-24
- Ethernet Performance on page 15-26

For the 9500 MXC Terminal, Radio and Controller modules are enabled, which are similar in appearance and operation to the Link and NCC screens respectively.

All performance screens include an Export tab, which allows data to be saved to an Excel compatible CSV file on your CT laptop. If the CSV delimiter parameter has not previously been set on your laptop, when the Export tab is first clicked the Edit > Preferences window will be presented. Refer to 9500 MXC CT Menus on page 3-4 of Volume IV.

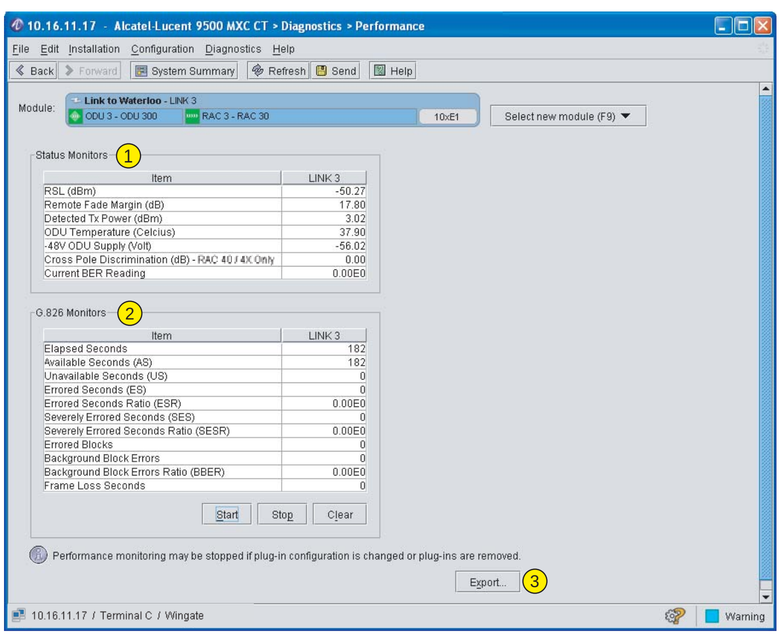
Link Performance

The Link Performance screen as shown in Figure 15-9, provides G.826 data for the selected link, plus Tx power, RSL, PA temperature, -48Vdc supply voltage at the ODU, and an estimate of current BER and remote fade margin (fade margin at the far-end Rx). For RAC 40s it also provides a measure of received-signal cross-polarization discrimination.

The link performance screen applies only to RAC/Radio links.

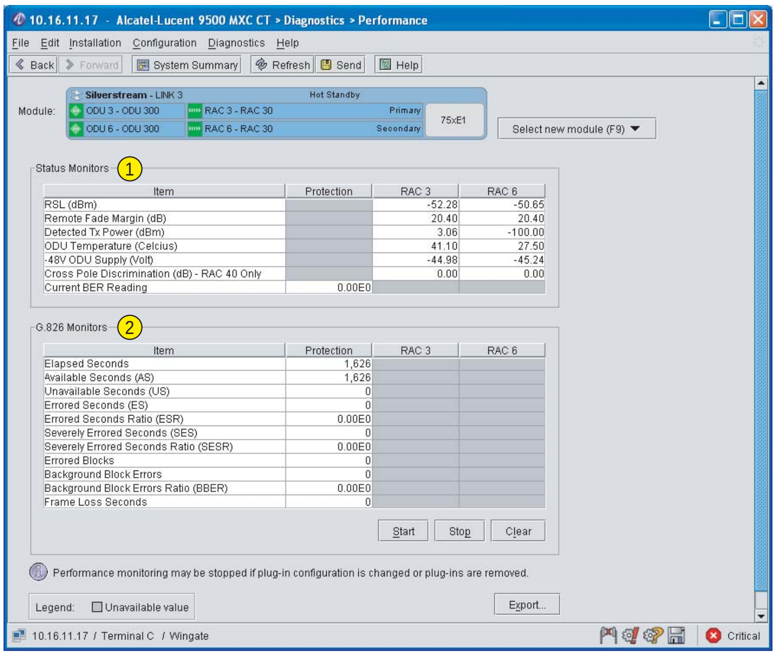
Figure 15-10 and Figure 15-11 show performance screens for protected links.

Figure 15-9. Example Link Performance Screen



Item	Description
1	Status Monitors provide a real time view of operational status/ performance. Data is updated at 2 second intervals. The cross polarization discrimination entry only applies to RAC 40.
2	G.826 Monitors. Set with the Start, Stop and Clear tabs.
3	Click Export to save the data to your PC as a .csv file.

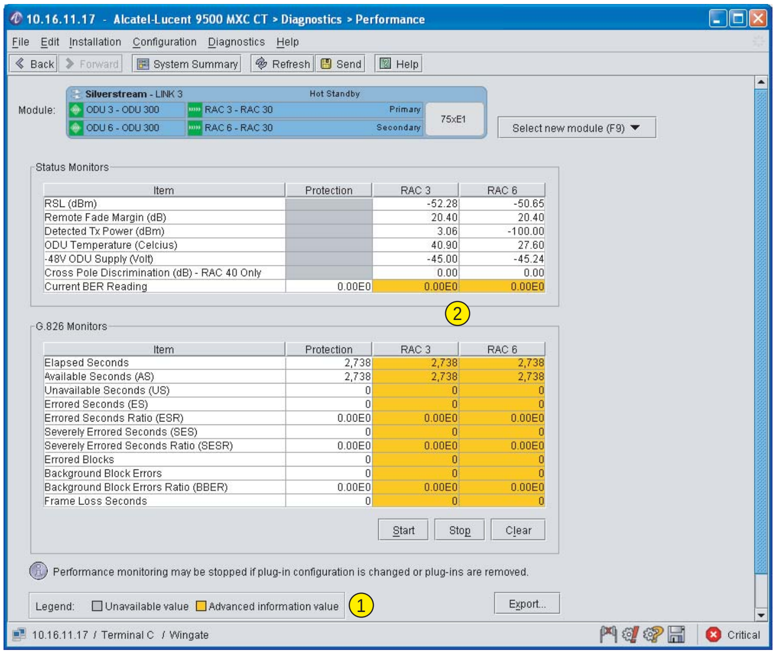
Figure 15-10. Example Performance Screen for a Protected Link



Item	Description
1	Status Monitors provide a real time view of operational status/ performance for both RACs. • Detected Tx power is only shown for the online transmitter (s). The primary Tx is default online for hot-standby and space diversity. Both are online for frequency diversity. • Current BER reading applies to the protected link[1] - it is not RAC specific.
2	G.826 Monitors provide statistics for the protected link[1] - data is not RAC specific.

1. Current BER and G.826 statistics are the aggregate for the 1+1 link (the aggregate of the secondary and primary RACs).

Figure 15-11. Advanced Performance Screen for a Protected Link



Item	Description
1	The advanced screen view for protected links is enabled in Edit > Preferences > Show Advanced protection Diagnostics.
2	Current BER and G-826 stats are shown for both RACs, as well as the Protected link: • **Data in the Protection column is the same as that for the online RAC**. The online RAC controls the hitless path switching (voting) between the primary and secondary RACs, *so presents the aggregate for the 1+1 protected link data*. The secondary RAC is default online - to confirm which RAC is online, go to the System/ Controls screen. • Where both RACs in a protected link are operating error-free, the data in both RAC columns will be identical. When this is not the case the RAC data will be different, but data for the online RAC will always be the same as that shown for Protection.

Link Performance Screen Navigation

Select the required link from **Select new module**.

Status Monitors captures RSL, Remote Fade Margin, Detected Tx power, ODU Temperature, -48Vdc ODU Supply Voltage, Cross-polarization Discrimination, Current BER Reading. The cross-polarization discrimination data only applies to RAC 40s, and is as measured at the input to RACs (before XPIC discrimination improvement). Data is updated at 2 second intervals.

The current BER reading is just that. It presents a BER estimate from one 2-second measurement interval to the next. It does not reflect an average-over-time BER.

G.826 Monitors captures link G.826 statistics. On opening, these data lines are empty. To enable, click the Start button. G.826 data aggregates from this point forward for as long as CT is logged on, or until the Stop or Clear buttons are selected. Data is updated at 2 second intervals.

For the 9500 MXC Node the Performance Monitor screen can be enabled for all links on the node. Viewing other CT screens does not affect the aggregation of performance data.

If the Node/Terminal is powered off, reset, the link (RAC) withdrawn or its ODU disconnected during data capture, a warning is displayed advising that collected data has been interrupted.

NCC Performance

The NCC Performance screen presents NCC temperature and -48Vdc supply voltage to the NCC. Screen presentation and navigation is identical to the Link Performance screen.

DAC 16x/4x E1 Performance

The Performance screen for the DAC 16x and DAC 4x enables two monitoring functions, buffer slip warning events, and tributary CRC error measurement. These functions apply only to an E1 bus rate (Bus Connection Size set to 2.048 Mbps / E1 in the Circuits screen).

Buffer Slip Warning

Selection enables buffer slip events to be captured as warnings (informational events) in the Event Browser screen for the DAC 16x and DAC 4x. Applies only to the DAC 16X/4X INU plug-ins.

Buffers are used to absorb any small fluctuations between the frequency of the incoming signal with that of the local (DAC) clock frequency. Buffers slips occur when there is excessive jitter or wander on E1 tribs - the buffer is unable to cope with the frequency difference.

- Data is written into the buffer at its arrival rate and read at the local frequency.
- The buffer absorbs any small random zero-mean-frequency fluctuations, but frequency offsets will make the buffer empty or overflow, sooner or later.
- There are two buffer slip event types; Trib Input, and Trib Output. A trib input event records a buffer slip on the trib input to the DAC 16x/4X. A trib output event records a buffer slip on the trib input *from the backplane bus,* which is in the trib output direction.

E1 Error Performance

A CRC (Cyclic Redundancy Check) function can be enabled on E1 DACs to provide a background error performance indicator for a selected E1 trib circuit.

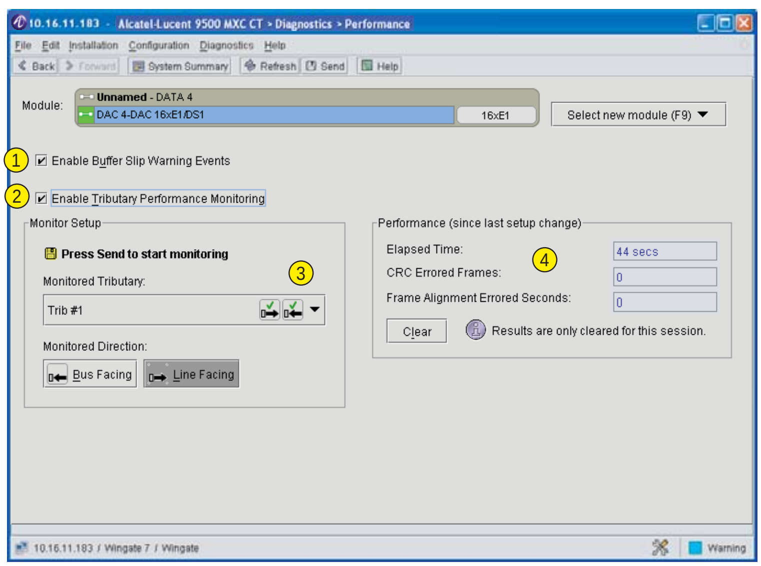
- This CRC function is provided for E1 rates only.
- It is currently supported only on DAC 16x and DAC 4x.
- It can only be enabled on one trib at a time.

The check process accesses the G.704, CRC4 Multiframe, which is a background error check function provided between devices operating with G.704 framing.

- The circuit being monitored must be end-to-end terminated on framed-rate multiplexers, or similar, to generate the G.704 framing, which includes the CRC function. In other words, the *circuit* supported by the DAC 16x/4x must be operational for user traffic to provide the multiframe needed for the monitoring process.
- The errors detected by the monitoring process are *circuit* errors. That is, they may have been generated by any device within the circuit, which includes all upstream or downstream devices from the DAC 16x/4x.
- Separate monitoring options are provided for upstream and downstream traffic directions.
    - The Line Facing option monitors CRC error counts on the E1 stream from the trib interface.
    - The Bus Facing option monitors counts on the E1 stream from a link (RAC or other DAC) via the backplane bus.
- Traffic on the selected trib is not affected.

Figure 15-12 shows a typical trib error performance screen.

Figure 15-12. Tributary Performance Monitoring Screen



Item	Description
1	Click to enable tributary performance monitoring.
2	Select a trib and a monitored direction, then click Send to start the monitoring. Line facing monitors error performance on the E1 circuits from the trib interface. Bus facing monitors error performance on E1 circuits from the backplane bus.

Item	Description
3	Shows the elapsed time since monitoring was enabled, and the error counts. The Frame Alignment Errored Seconds counts invalid framing or no framing (no circuit connection to the source E1 multiplexer or other G.704 device). The Clear button clears the elapsed time and counts, but only for the current CT session. Providing the monitoring remains enabled, the elapsed time and error counts continue to accrue from the time it was enabled, to support long-term capture of counts at a subsequent CT session.

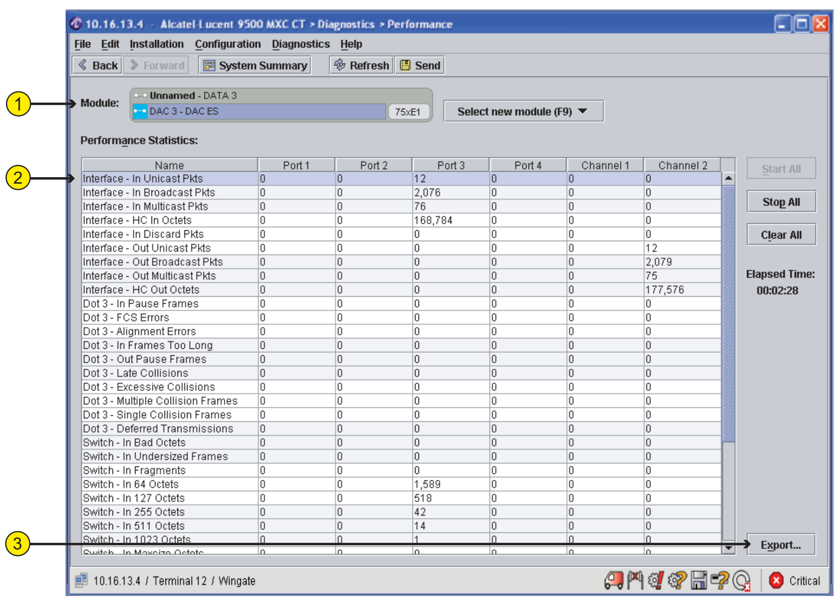
Ethernet Performance

The Ethernet performance screens for the DAC GE and DAC ES modules (DAC GE, DAC ES, IDU ES) support two screen views, Statistics and Graphs.

Statistics Screen

The Statistics screen, as shown in Figure 15-13 for a DAC ES, provides RMON performance statistics for each port and channel. Screens for the IDU ES and for the DAC GE are functionally identical.

Figure 15-13. DAC ES Performance Screen



Item	Description
1	Click Start All to display RMON performance statistics. Data is captured for each DAC ES port and channel.
2	Click Export to save data to your PC as a .csv file.

Ethernet Performance Screen Navigation

On opening, the Performance Statistics lines are empty. To enable, click the Start All button. Data aggregates from this point forward for as long as CT is logged on, or until the Stop All or Clear All buttons are selected.

Error events are shown with red text.

Viewing other CT screens does not affect the aggregation of performance statistics.

The Stop All button terminates the data aggregation, but leaves for viewing the data collected / displayed to that point.

The Clear All button clears all data.

If the Node is powered off, reset or the DAC ES withdrawn during data capture, a warning is displayed advising that collected data has been interrupted.

Table 15-1 describes each statistic for the DAC ES (DAC ES card and DAC ES module in the IDU ES).

Table 15-2 describes each statistic for the DAC GE.

Table 15-1. Description of DAC ES RMON Performance Statistics

Statistic	Description
In Ucast Pkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
In Broadcast Pkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a broadcast address at this sub-layer.
In Multicast Pkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer. For a MAC layer protocol, this includes both Group and Functional addresses.
HC In Octets	The total number of octets received on the interface, including framing characters. This object is a 64-bit version of If In Octets.
In Discards	The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent them being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
Out UCast Pkts	The total number of packets that higher-level protocols requested be transmitted, and which were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.
Out Broadcast Pkts	The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent.

Statistic	Description
Out Multicast Pkts	The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent. For a MAC layer protocol, this includes both Group and Functional addresses.
HC Out Octets	The total number of octets transmitted out of the interface, including framing characters. This object is a 64-bit version of If Out Octets.
Dot3 In Pause Frames	Number of valid pause frames received.
Dot3 Stats FCS Errors	A count of frames received on a particular interface that are an integral number of octets in length but do not pass the FCS check. This count does not include frames received with frame-too-long or frame-too-short error. The count represented by an instance of this object is incremented when the frameCheckError status is returned by the MAC service to the LLC (or other MAC user). Received frames for which multiple error conditions obtain are, according to the conventions of IEEE 802.3 Layer Management, counted exclusively according to the error status presented to the LLC. Coding errors detected by the physical layer for speeds above 10 Mb/s will cause the frame to fail the FCS check.
Dot3 Stats Alignment Errors	A count of frames received on a particular interface that are not an integral number of octets in length and do not pass the FCS check. The count represented by an instance of this object is incremented when the alignmentError status is returned by the MAC service to the LLC (or other MAC user). Received frames for which multiple error conditions obtain are, according to the conventions of IEEE 802.3 Layer Management, counted exclusively according to the error status presented to the LLC. This counter does not increment for 8-bit wide group encoding schemes.
Dot3 Stats Frame Too Long	A count of frames received on a particular interface that exceed the maximum permitted frame size. The count represented by an instance of this object is incremented when the frameTooLong status is returned by the MAC service to the LLC (or other MAC user). Received frames for which multiple error conditions obtain are, according to the conventions of IEEE 802.3 Layer Management, counted exclusively according to the error status presented to the LLC.
Dot3 Out Pause Frames	Number of pause frames transmitted.

Statistic	Description
Dot3 Stats Late Collisions	The number of times that a collision is detected on a particular interface later than one slotTime into the transmission of a packet. A (late) collision included in a count represented by an instance of this object is also considered as a (generic) collision for purposes of other collision-related statistics. This counter does not increment when the interface is operating in full-duplex mode.
Dot3 Stats Excessive Collisions	A count of frames for which transmission on a particular interface fails due to excessive collisions. This counter does not increment when the interface is operating in full-duplex mode.
Dot3 Stats Multiple Collision Frames	A count of successfully transmitted frames on a particular interface for which transmission is inhibited by more than one collision. A frame that is counted by an instance of this object is also counted by the corresponding instance of either the ifOutUcastPkts, ifOutMulticastPkts, or ifOutBroadcastPkts, and is not counted by the corresponding instance of the dot3StatsSingleCollisionFrames object. This counter does not increment when the interface is operating in full-duplex mode.
Dot3 Stats Single Collision Frames	A count of successfully transmitted frames on a particular interface for which transmission is inhibited by exactly one collision. A frame that is counted by an instance of this object is also counted by the corresponding instance of either the ifOutUcastPkts, ifOutMulticastPkts, or ifOutBroadcastPkts, and is not counted by the corresponding instance of the dot3StatsMultipleCollisionFrames object. This counter does not increment when the interface is operating in full-duplex mode.
Dot3 Stats Deferred Transmissions	A count of frames for which the first transmission attempt on a particular interface is delayed because the medium is busy. The count represented by an instance of this object does not include frames involved in collisions. This counter does not increment when the interface is operating in full-duplex mode.
Switch Stats In Bad Octets	Total data octets received in frames with a invalid FCS. Fragments and jabbers are included. The count includes the FCS but not the preamble.
Switch Stats Undersized Frames	Total frames received with a length of less than 64 octets buts with a valid FCS.
Switch Stats In Fragments	Total frames received with a length of less than 64 octets and an invalid FCS.

Statistic	Description
Switch Stats In 64 Octets	Total frames received with a length of exactly 64 octets, including those with errors.
Switch Stats In 127 Octets	Total frames received with a length of between 65 and 127 octets inclusive, including those with errors.
Switch Stats In 255 Octets	Total frames received with a length of between 128 and 255 octets inclusive, including those with errors.
Switch Stats In 511 Octets	Total frames received with a length of between 256 and 511 octets inclusive, including those with errors.
Switch Stats In 1023 Octets	Total frames received with a length of between 512 and 1023 octets inclusive, including those with errors.
Switch Stats In Max Octet	Total frames received with a length of between 1024 and MaxSize octets inclusive, including those with errors.
Switch Stats In Jabber	Total frames received with a length of more than MaxSize octets but with an invalid FCS.
Switch Stats In Filtered	If 802.1Q is disabled on this port: Total valid frames received that are not forwarded to the destination port. Valid frames discarded due to a lack of buffer space are not included. If 802.1Q is enabled on this port: Total valid frames received (tagged or untagged) that were discarded due to a unknown VID (for example, the frame's VID was not in the VTU.
Switch Stats Out FCS Errored	Total frames transmitted with an invalid FCS. Whenever a frame is modified (such as to add or remove a tag) and a new FCS is computed for the frame, before the new FCS is added into the frame the old FCS is inspected to insure the original unmodified frame was still good. If an error is detected the new FCS is added with a bad FCS and Switch Stats Out FCS Errored is incremented.
Switch Stats Out 64 Octets	The total number of frames transmitted with a length of exactly 64 octets, including those with errors.
Switch Stats Out 127 Octets	The total number of frames transmitted with a length of between 65 and 127 octets inclusive, including those with errors.
Switch Stats Out 255 Octets	The total number of frames transmitted with a length of between 128 and 255 octets inclusive, including those with errors.
Switch Stats Out 511 Octets	The total number of frames transmitted with a length of between 256 and 511 octets inclusive, including those with errors.
Switch Stats Out 1023 Octets	The total number of frames transmitted with a length of between 512 and 1023 octets inclusive, including those with errors.
Switch Stats Out Max Octets	Total frames transmitted with a length of between 1024 and 1522 octets inclusive, including those with errors.

Statistic	Description
Switch Stats Collisions	Total number of collisions during the frame transmission.

Table 15-2. Description of DAC GE RMON Performance Statistics

Name	Description
InUcastPkts	Number of Unicast frames received.
InBroadcastPkts	Number of broadcast frames received. (InBroadcasts)
InMulticastPkts	Number of multicast frames received. (InMulticasts)
HCInOctets	Total data octets received in frames with a valid FCS (64-bit counter). (InGoodOctets)
InDiscards	Number of valid frames received that are discarded due to a lack of buffer space. (InDiscards)
OutUCastPkts	Number of unicast frames transmitted. (OutUnicasts)
OutBroadcastPkts	Number of broadcast frames transmitted. (OutBroadcasts)
OutMulticastPkts	Number of multicast frames transmitted. (OutMulticasts)
OutMulticastPkts	Total data octets transmitted. (64-bit counter) (OutOctets)
Dot3 InPauseFrames	Number of valid pause frames received.
Dot3 FCSErrors	Number of frames received with valid length and integral number of octets but invalid FCS.
Dot3 AlignmentErrors	Number of frames received with valid length but non-integral number of octets.
Dot3 FrameTooLongs	Number of frames received with valid FCS but which are more than 1518 octets long.
Dot3 OutPauseFrames	Number of pause frames transmitted.
Dot3 StatsLateCollisions	Number of times that a late collision was detected during a frame transmission.
Dot3 ExcessiveCollisions	Number of frames discarded after 16 failed transmission attempts.
Dot3 MultipleCollisionFrames	Number of transmitted frames that experienced more than one collision.
Dot3 SingleCollisionFrames	Number of transmitted frames that experienced exactly one collision.
Dot3 DeferredTransmissions	Number of transmitted frames that were delayed because the medium was busy.

Name	Description
InBadOctets	Total data octets received in frames with a valid FCS. Undersize and oversize frames are included. The count includes the FCS but not the preamble.
UndersizedFrames	Total frames received with a length of less than 64 octets but with a valid FCS.
InFragments	Total frames received with a length of less than 64 octets and an invalid FCS.
In64Octets	Total frames received with a length of exactly 64 octets, including those with errors.
In127Octets	Total frames received with a length of between 65 and 127 octets inclusive, including those with errors.
In255Octets	Total frames received with a length of between 128 and 255 octets inclusive, including those with errors.
In511Octets	Total frames received with a length of between 256 and 511 octets inclusive, including those with errors.
In1023Octets	Total frames received with a length of between 512 and 1023 octets inclusive, including those with errors.
InMaxOctets	Total frames received with a length of between 1024 and MaxSize octets inclusive, including those with errors.
InJabber	Total frames received with a length of more than MaxSize octets but with an invalid FCS.
InFiltered	If 802.1q is disabled on this port: Total valid frames received that are not forwarded to the destination port. Valid frames discarded due to a lack of buffer space are not included. If 802.1q is enabled on this port: Total valid frames received (tagged or untagged) that were discarded due to a unknown VID (i.e., the frame's VID was not in the VTU).
OutFCSErrored	Total frames transmitted with an invalid FCS.
Out64Octets	The total number of frames transmitted with a length of exactly 64 octets, including those with errors. (Out64Octets)
Out127Octets	The total number of frames transmitted with a length of between 65 and 127 octets inclusive, including those with errors.
Out255Octets	The total number of frames transmitted with a length of between 128 and 255 octets inclusive, including those with errors.

Name	Description
Out511Octets	The total number of frames transmitted with a length of between 256 and 511 octets inclusive, including those with errors.
Out1023Octets	The total number of frames transmitted with a length of between 512 and 1023 octets inclusive, including those with errors
OutMaxOctets	Total frames transmitted with a length of between 1024 and 1522 octets inclusive, including those with errors.
Collisions	Total number of collisions during the frame transmission.

Ethernet Graphs Screen

On opening, the graphs are blank. To enable, click the Start button. Data aggregates from this point forward for as long as CT is logged on, or until the Stop or Clear buttons are selected.

Viewing other CT screens does not affect the aggregation of performance statistics.

The Stop button terminates the data aggregation, but leaves for viewing the data collected / displayed to that point.

The Clear button clears all data.

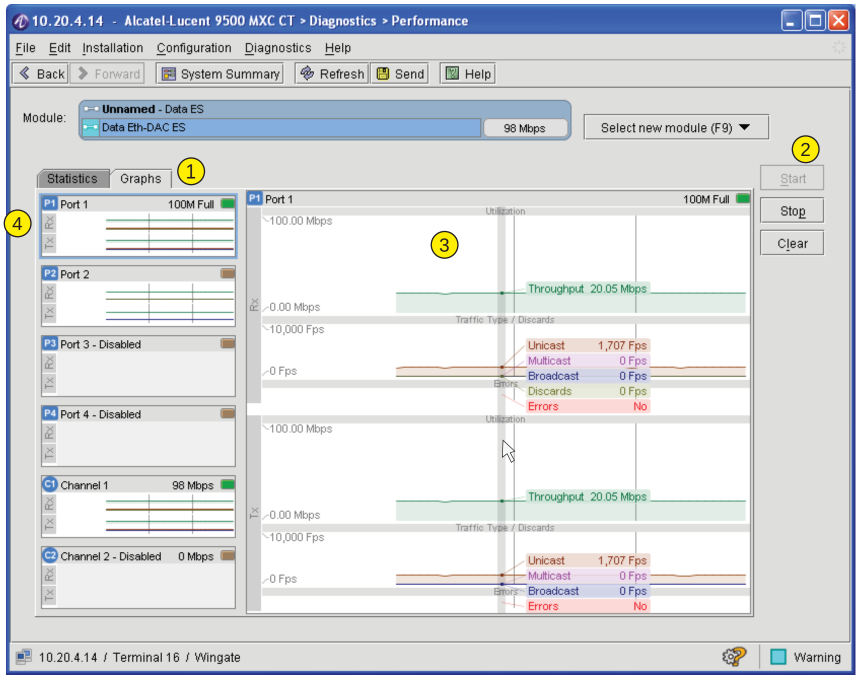
If a radio is powered off, reset, or a DAC ES or DAC GE is withdrawn from an INU during data capture, a warning is displayed advising that collected data has been interrupted.

Data is displayed from right to left in either 1.5 second or 3 second increments, over a period of about 1 minute.

- The DAC ES card/module increments at 1.5 second intervals.
- The DAC GE card/module increments at 3 second intervals.
- Performance data or counts are the average/total for each 1.5 or 3 second interval.

Figure 15-14 shows a Performance screen for a DAC ES. Screen functionality is identical for all Ethernet DAC cards and modules.

Figure 15-14. Ethernet Graphs Screen



Item	Description
1	Graphs screen view selected.
2	Start is selected.
3	The detail window displays Ethernet performance data. Mouse-over to view data per capture interval; 1.5 seconds for the DAC ES, 3 seconds for the DAC GE (data/counts are the average/total for the interval.
4	Summary windows are provided for all ports/channels. Click an enabled port/channel to view its data in the detail window (3).

System/Controls

The System/Controls screen presents Node and Terminal diagnostic menus for LINK (RAC/Radio), DATA (DAC/Trib), and AUX modules.

Information is provided on:

- Link Menu on page 15-35
- Ring Menu on page 15-42
- DAC/Tributary Menu on page 15-45
- DAC ES and DAC GE Menu on page 15-50
- AUX Menu on page 15-55
- Loopback Points on page 15-55

Link Menu

For a 1+0 non-protected link the screen options are:

- Tx Mute: Mutes the ODU transmitter.
- Digital Loopback: Applies a bus facing digital loopback.

IF Loopback: Applies a bus facing IF loopback.

For Tx Mute and Loopback operation refer to Link Menu Operation on page 15-39

For information on where loopbacks are applied in the equipment, refer to Figure 15-27 on page 15-56.

Applying an IF loopback on a RAC 40 causes the opposite polarity RAC 40 to lose sync (removes the XPIC interferer sample necessary for normal XPIC operation).

For information of auto insertion of AIS/PRBS under a demodulator unlock or loopback options, refer to Auto Insertion of AIS or PRBS on Tribs on page 15-48.

For a 1+1 protected link the screen options include:

- An indication of which Tx and Rx is online.
- Controls to lock a Tx and/or Rx online.
- An ability to switch to an *online* secondary from primary, and vice-versa. This has application in the event a failed RAC/Terminal is restored to service. For instance, if the primary designated RAC has failed (or is withdrawn), it is not auto-restored to online transmit, on repair or replacement.
- A graphical indication of protection status.
- Tx mute and digital or IF loopbacks per RAC or IDU, as for a 1+0 link.

Safety Timers:

A safety timer acts on all “On” selections. Applies to Tx mute, digital and IF loopbacks, and to Tx and Rx locks for protected operation. Refer to Safety Timer Operation on page 15-40. Timer options are:

- Test for 60 seconds
- On for a user-set time
- Always on (until manually turned off)

Diagnostic Indications of a System/Controls Application

The Event Browser and Alarm screens capture the application and subsequent release of System/Controls diagnostic options. While options are active:

- The diagnostic icon is displayed in the CT status bar.
- For a Node the NCC Test LED flashes orange.
- For a Terminal the IDU or ODU Status LEDS flash orange depending on the diagnostic option:
  - For an IF or digital loopback the IDU Status flashes orange.
  - For a TX mute the ODU Status flashes orange.

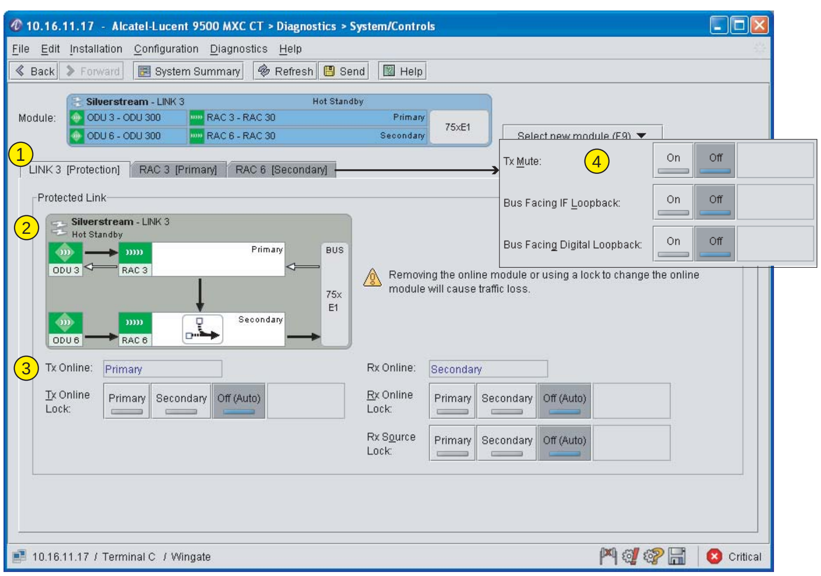
System/Controls Screens for Protected RACs and IDUs

Figure 15-15 shows a System/Controls screen for a protected 9500 MXC Node link

Figure 15-16 shows a System/Controls screen for a protected 9500 MXC Terminal.

Figure 15-17 shows a System/Controls screen for a 40xE1 IDU 20x protected Terminal.

Figure 15-15. Link System/Controls Screen: Protected INU/INUe



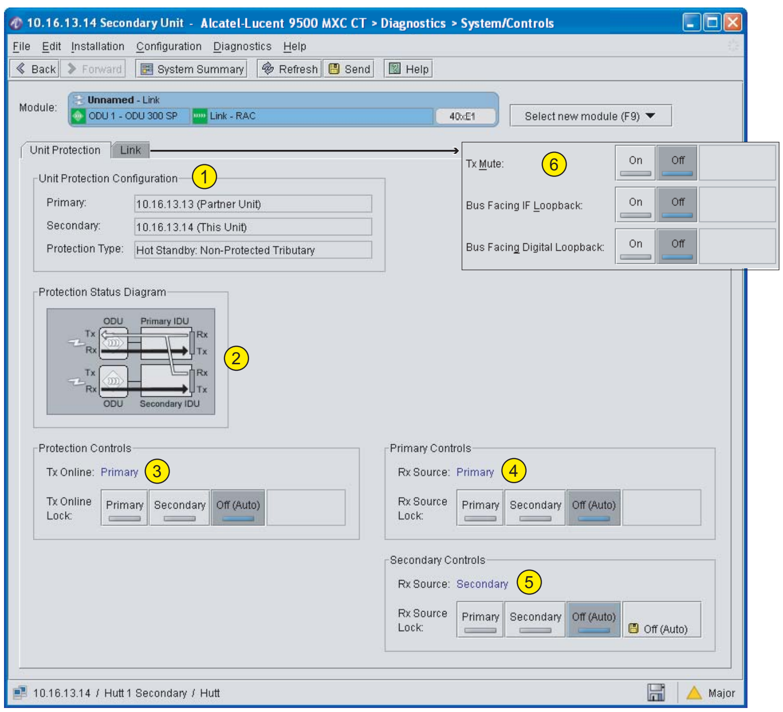
Item	Description
1	Screen default opens to Link Protection. Tabs provide access to controls for RAC Tx mute and loopbacks.

Item	Description
2	Graphic indicates RAC settings. The default settings have the primary RAC as Tx online and the secondary RAC as Rx online. The online Rx controls the Rx diversity bus; Rx data is selected from each RAC on a block-by-block basis for delivery to the backplane bus. The graphic in the example screen shows default RAC settings for primary and secondary.
3	Tx and Rx locks are supported by a safety timer. Lock status is shown in the graphic. Mouse-over for details.
4	RAC controls window.

For protected IDUs, separate CT sessions must be opened for the protection partners. Screens should be positioned above/below or side/side for easy simultaneous viewing.

Log into one IDU then open its partner by selecting File > New CT > Partner IDU

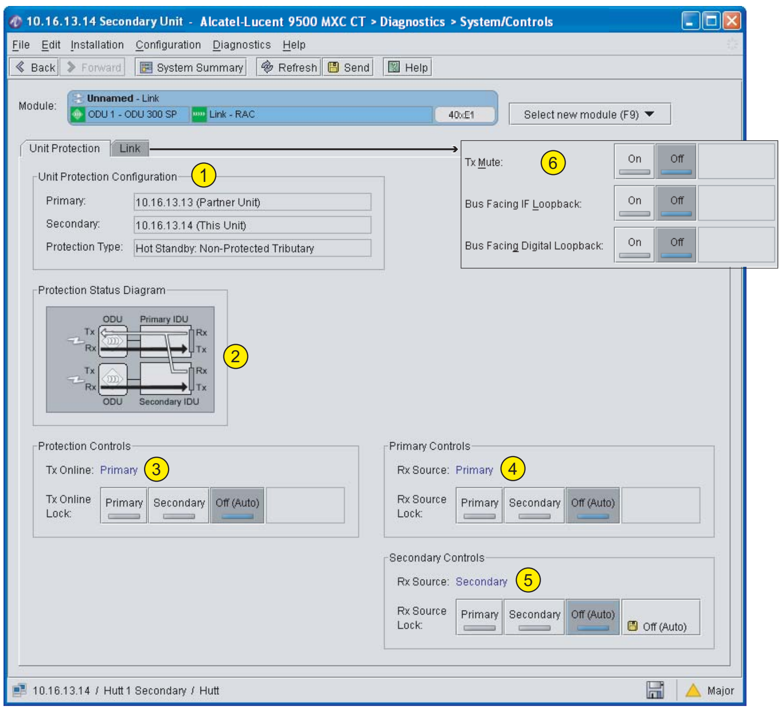
Figure 15-16. Link Systems/Controls Screen: Protected IDUs



Item	Description
1	Screen default opens to Unit Protection. A Tab provides access to controls for IDU Tx mute and loopbacks. The Unit Protection window confirms the relationship with its partner unit, providing the protection cable is fitted and networking has been configured. It also confirms the protection type.

Item	Description
2	Graphic indicates the protection status. Note that for the IDU 20x (except Hot Standby: Non-protected Tributary mode) and IDU 155o, which support hitless Rx path switching (voting), both receivers are receiving, with the *online* IDU Rx selecting which Rx stream to deliver to its tribs on a block-by-block basis. The arrows indicate the *online* Tx and Rx status.
3, 4	Tx and Rx online protection controls. For IDUs, the default protection configuration has the primary IDU as *online* for Tx and Rx. Locks are supported by a safety timer. (The example screen shows that the secondary IDU is online for Tx and Rx).
5	IDU Tx mute and loopback controls window.

Figure 15-17. Link Sys/Controls Screen: Protected 40xE1 IDU 20x



Item	Description
1	Screen default opens to Unit Protection. A Tab provides access to controls for IDU Tx mute and loopbacks. The Unit Protection window confirms the relationship with its partner unit, providing the protection cable is fitted and networking has been configured. It also confirms the protection type.

Item	Description
2	Graphic indicates the online protection status for an IDU 20x when configured for Hot Standby: Non-protected Tributary. The example screen shows normal (default) 40xE1 link operation, where the 20xE1 tribs from both IDUs are sent over the online Tx IDU. At the receive end both IDUs are sourcing their trib data directly from their ODUs. For more information on IDU 20x configuration and operation, refer to Additional Procedures for IDU 20x, Volume IV, Chapter 8.
3	Tx online protection controls.
4	Primary Controls: RX Source. Locks enable Rx trib data for the primary IDU to be sourced from either the primary or secondary IDUs (one or the other). Primary is default.
5	Secondary Controls: RX Source. Locks enable Rx trib data for the secondary IDU to be sourced from either the primary or secondary IDUs (one or the other). Secondary is default.
6	IDU Tx mute and loopback controls window.

Link Menu Operation

Locks

Lock options are provided to force a condition or to change the online status of the protected pairing:

- For a Node the primary designated RAC is default online transmitting, and the secondary RAC is online controlling the receive diversity bus (Rx protection switch function). The Tx and/or Rx RAC online function can be changed using the locks to first force a change from Auto to Primary or Secondary, and then back to Auto.
- For protected IDUs the primary-designated IDU is default online transmitting and receiving. The online function can be changed using the locks to first force a change from Auto to Secondary, and then back to Auto.

To change primary or secondary *online* status:

1. Click the required Lock button.
2. Select *any* timer option from the Safety Timer and click OK. Refer to Safety Timer Operation.
3. To commit the selection click Send, and check that the change in online status is confirmed.
4. Click Off (Auto), then click Send to return to normal protection operation, but with the online status now confirming the new selection.

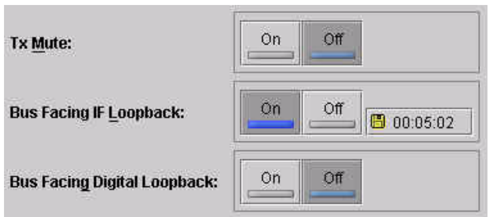
Alternatively, at step 2, a timer option can be selected (not less than 2 seconds) and left to time out, whereupon the new online status is automatically committed.

For the **IDU 155o and IDU 20x,** when a change to Tx online is made the Rx online will follow providing Rx online locks are off (Rx online lock is Off/Auto).

Tx Mute and Loopback Selection

A Tx Mute applied on the online Tx of a hot standby or space diversity *protected* pair will be interpreted by the remote receiver as a signal/path failure and result in a 'silent transmitter' switch action (remote Node/Terminal signals the local Node/Terminal to switch transmitter). If such a switch is not intended, first lock the Tx selection (Tx Lock On).

A digital or IF loopback selection removes all payload traffic over the link (local traffic to the selected link is looped back to the bus/customer interface).



Loopback selections are applied separately to each RAC/Terminal of a *protected* pair. To ensure correct operation, a loopback (Digital or IF) must be applied to *both* RACs/ Terminals. Alternatively first ensure that one (primary or secondary) is *locked* as both Tx *and* Rx online, and apply the loopback just to the online RAC/Terminal.

Safety Timer Operation

Figure 15-18 illustrates the operation of the safety timer function. To start a selection or to manually terminate a selection, the Send button must be clicked to enable the selection.

The operation illustrated assumes that:

- The default safety timer option has not previously been enabled for the *current CT session* (see below).
- The safety timer operation has not been enabled to default to the last setting used in the Edit > Preferences menu. This selection applies to *all CT sessions*. See 9500 MXC CT Menus on page 3-4, Volume IV, Chapter 3.

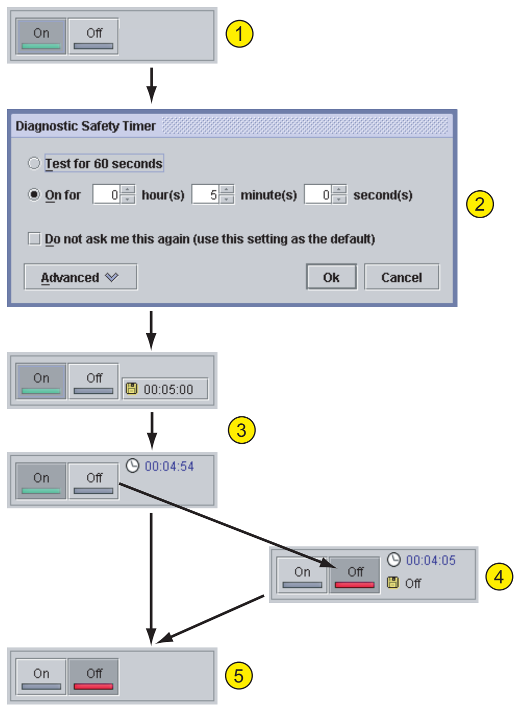
The safety timer steps, related to Figure 15-18, are:

.

Item	Description
1	Click On.
2	Select a timer option and click Ok. If you click "Do not ask me this again (use this setting as default)", the last safety timer selection will apply for all subsequent System/Controls 'On' actions for the current CT session, and the Safety Timer option box will not appear unless the timer clock is clicked. If you click on the "Advanced" button, you can enable an "always on" option. To return to the Safety Timer option box, click a new 'On' action, then click the timer indication to the right side of the Off button.

Item	Description
3	Confirm the selection and click Send to start. The real-time counter displays the countdown.
4	To terminate before expiry of countdown or to terminate an “always on” selection, click Off, then Send.
5	When the countdown expires, the default On connection is restored.

Figure 15-18. Safety Timer Operation



Do not ask me this again (use this setting as default) is linked directly to the Edit > Preferences setting for *Diagnostic safety timers default to last setting used*. However, unlike the timer default enabled in the safety timer window above, the Edit > Preferences option applies to all CT sessions, current and subsequent.

Ring Menu

Figure 15-19 on page 15-42 shows a System/Controls screen for a ring.

Three window options are provided:

- **Protection Controls**; provides a status graphic for the Node and locks for East and West Online and Offline operation.
- **RAC East**; provides locks for East RAC Tx Mute, and for digital and IF loopbacks.
- **RAC West**; provides locks for West RAC Tx Mute, and for digital and IF loopbacks.

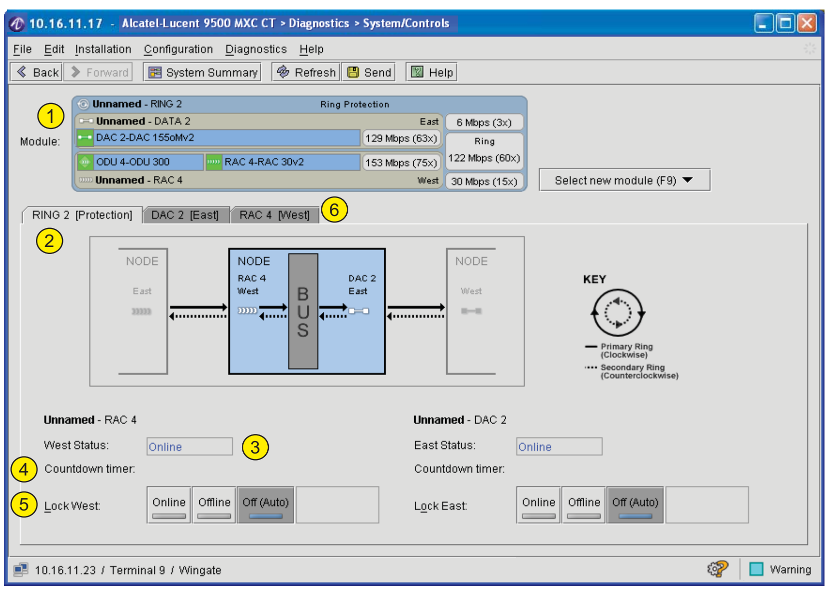
Locks include a safety timer on all “On” selections. Timer options are:

- Test for 60 seconds
- On for a user-set time
- Always on (until manually turned off)

Refer to Ring Menu Operation on page 15-43. Refer to Figure 15-27 on page 15-56 for data on loopback points and loopback directions.

The Event Browser and Alarm screens capture the application and subsequent release of diagnostic options, and while active, the diagnostic icon is displayed in the CT status bar, and the NCC Test LED flashes orange.

Figure 15-19. Ring System/Controls Screen



Item	Description
1	Module summarizes the Ring configuration.
2	Protection Controls window. Graphic depicts the operational status for the node. This example shows normal [unwrapped] operation.
3	Status indicators (Online or Offline) for east and west links.
4	Countdown timer indicates the time to go before an unwrap can occur. (No countdown is indicated in this exampl)e.

Item	Description
5	Tx and Rx lock Online/Offline buttons. Locks are supported by a safety timer.
6	Tabs to Tx mute and Loopback locks.

Ring Menu Operation

Protection Controls Operation

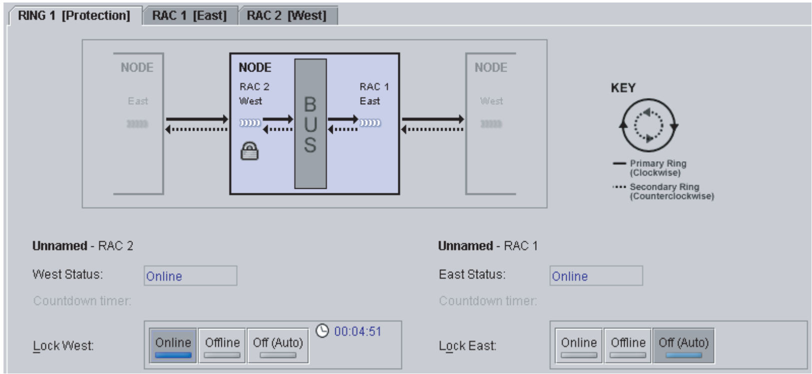
Figure 15-20 illustrates operation of the west and east Online and Offline locks. Both are supported by safety timers.

- **Online** locks the selected west and/or east RAC online; ring wrapping is disabled by the selection. It is used for situations where ring wrapping is not wanted, such as during link testing and alignment. May also be used to return a link from a wrapped state (Lock On, followed by Off (Auto) before expiration of the 5 minute revertive-switch guard time (assuming the event that caused the wrap has been cleared). Refer to Ring Protection Switching Criteria on page 3-81, Volume II, Chapter 3.
- **Offline** forces a ring wrap at the selected west or east RAC. Forcing a wrap has the same affect as a path/signal loss, and will also force a wrap at the remote Node for the affected link (providing the link is not already wrapped).
  - Note that the Countdown Timer will be activated as soon as an Offline lock is applied. The time will remain fixed at the time set for the Error-free Timer in the Protection screen, until the lock is removed, whereupon it will count down to zero before removing the wrap (assuming there are no prevailing wrap conditions). To bypass the Countdown Timer, use the Online lock: lock Online > Send > Off (Auto) > Send.
- **Countdown Timer** indicates the time to go before an unwrap can occur. (Counts down to zero). Applies to both the Error-free Timer and Delay Ring Unwrap Timer settings. Both timers are configured in the Protection screen. Refer to Node Protection Operation and Rules, Volume IV, Chapter 8.

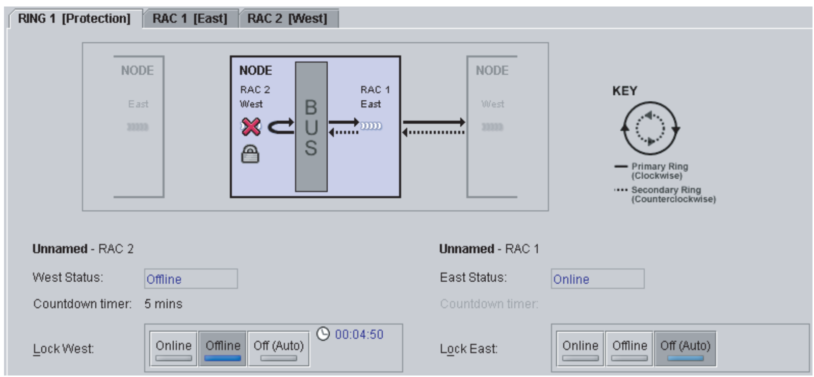
For safety timer operation refer to Safety Timer Operation on page 15-40.

Figure 15-20. Ring Protection Locks

Online Lock West



Offline Lock West



RAC/DAC East or West Diagnostics

For a RAC the East / West tabs provide access to Tx Mute, and to bus-facing IF or digital loopbacks.

- These functions are identical to those for a Link/RAC or DATA/DAC 155oM. Refer to Tx Mute and Loopback Selection on page 15-40, Committing a Tx Mute will generate a signal loss alarm at the remote Node, which will force a ring wrap at the remote and local Node.

For a DAC 155oM the East / West tabs provide access to:

- Line-facing or bus-facing Line Interface (optical trib) loopbacks.
- Transmit AIS on the optical Line Interface.
- Line-facing or radio-facing Bus Ports (NxE1/DS1)loopbacks.

All actions have a safety timer. Refer to Safety Timer Operation on page 15-40.

DAC/Tributary Menu

For a 9500 MXC Node and an IDU ES a DAC tributary screen opens to reflect the DAC *type* selected.

For 9500 MXC PDH and SDH Terminals the tributary type (NxE1/DS1, STM1/OC3) is fixed for the IDU type.

Refer to:

- DAC System/Controls Screen: PDH and SDH DACs on page 15-45
- Loopback and AIS Safety Timer Operation on page 15-47
- PRBS Generation on page 15-47
- Protected DAC Screens on page 15-49

DAC System/Controls Screen: PDH and SDH DACs

Figure 15-21 shows an NxE1/DS-1 DAC, which provides trib-by-trib selection of:

- Line facing loopback
- Radio facing (bus facing) loopback
- Transmit AIS
- PRBS generator with G.821 data receiver

A loopback ***or*** AIS can be enabled on a trib (loopback and AIS selections are mutually exclusive; only one can be selected per trib).

A loopback ***or*** AIS can be enabled on any number of tribs at the same time.

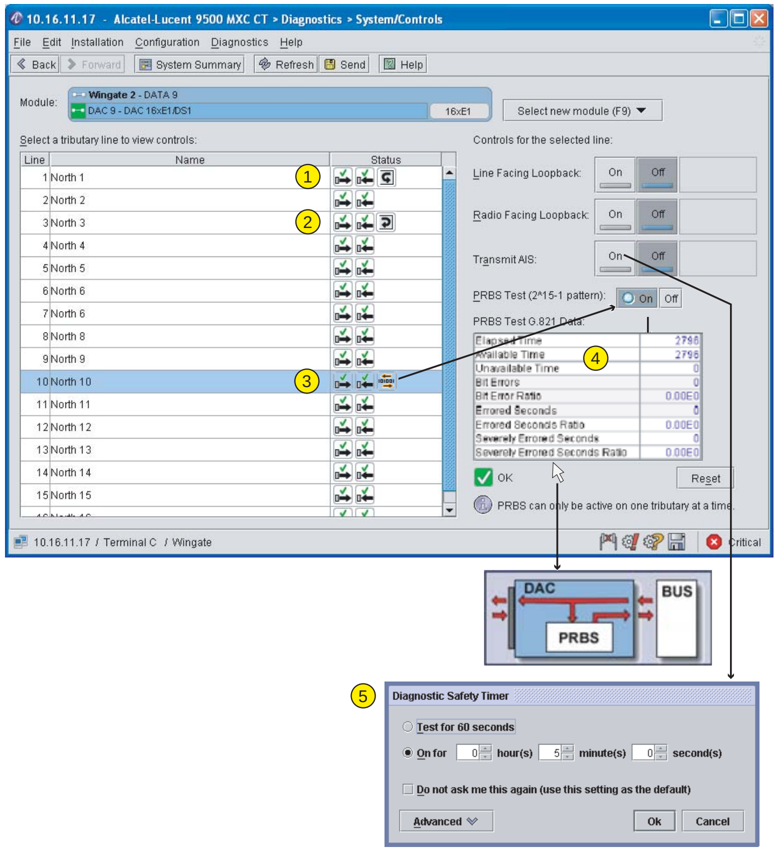
PRBS can only be enabled on one trib at a time.

Refer to Figure 15-27 on page 15-56 for DAC loopback points and loopback directions.

The Event Browser and Alarm screens capture the application and subsequent release of Link diagnostic options. While Link diagnostics are active:

- The diagnostic icon is displayed in the CT status bar.
- For a Node the NCC Test LED flashes orange.
- For a Terminal the IDU Status LED flashes orange.

Figure 15-21. DAC 16xE1 System Controls Screen



Item	Description
1	Looped icon confirms that a line facing loopback is applied to trib 1.
2	Looped icon confirms that a radio facing loopback is applied to trib 3.
3	The highlighted trib has PRBS enabled. Trib names are set from the Plug-ins screen.
4	G.821 Data from the PRBS test, as received back via a local or remote loopback, or from a PRBS test sent from the remote-end DAC. Mouse-over to view the PRBS graphic shown.
5	An ‘On’ selection of loopback or AIS brings up Safety Timer options.

For STM1/OC3 DACs, the AIS selection inserts a PRBS15 pattern (15 bit pseudo-random bit sequence).

Loopback and AIS Safety Timer Operation

For information on the operation of the Diagnostic Safety Timer associated with the loopback and AIS controls, refer to Safety Timer Operation on page 15-40.

The DAC ES and DAC GE plug-ins (Ethernet) do not support loopbacks or AIS.

IDU ES does not support loopbacks or AIS on its Ethernet ports; it does support AIS and loopbacks on its trib ports, and loopbacks on auxiliary ports and at digital and IF points.

PRBS Generation

E1/DS1, E3/DS3, and STM1/OC3 DACs, E1 IDUs, and E1/DS1 IDUs include a PRBS generator and G.821 receiver to support looped, and both-way tests on tribs. The Generator provides a standard BER 2^{15-1} test pattern.

- For a **looped** test the DAC/IDU provides the PBBS generator *and* G.821 receiver.
- For a **both-way** test, a PRBS generator on one DAC/IDU is G.821 received on its remote DAC/IDU, and vice-versa. PRBS Generation must be enabled at both ends of the trib.
- G.821 statistics have a standard latency of 10 seconds for availability and errored seconds; on activation wait for 10 seconds before checking.
- With a DAC the PRBS generator transmits to and receives from the TDM bus. Mouse-over the G.821 statistics panel to see a graphic of the connection.

External BER testers provide superior measurement accuracy and access to a wider range of test and measurement functions.

PRBS Generator and G.821 Statistics Operation

Always allow at least 10 seconds for the G.821 data to stabilize when PRBS Generation is enabled; 10 seconds after Send.

When a both-way test is to be established, the PRBS data for the DAC/IDU first turned on accrues errors until PRBS on the second DAC/IDU is activated. The second DAC/IDU should display no errors after its 10 second stabilization period.

To restart a PRBS count, click Reset.

While PRBS Generation is ON:

- INU/INUe: The NCC Test LED flashes orange and the diagnostic icon is displayed in the CT status bar.
- IDU: The IDU Status LED flashes orange and the diagnostic icon is displayed in the CT status bar.

Auto Insertion of AIS or PRBS on Tribs

This topic covers auto insertion of AIS/PRBS on tribs when:

- A demodulator unlock occurs
- Loopbacks are set

Demodulator Unlock

When a RAC/radio demodulator-unlock occurs, it inserts an alarm signal (AIS or PRBS15) on all traffic circuits *towards* the bus/customer. All cross-connected circuits *from* this RAC/radio, which for a Node may be to DAC and/or other RAC plug-ins, will carry this AIS/PRBS. At a DAC/trib, the affected tributaries will carry AIS/PRBS on the outgoing customer connection. Demodulator unlock may occur under severe fading or an equipment fault.

- For all E1, DS1, E3, DS3 DACs/IDUs, AIS is inserted on the affected data-out tributaries (towards the customer).
- For all STM1/OC3 DACs/IDUs, a PRBS15 pattern (15 bit pseudo-random bit sequence) is inserted on the affected data-out tributaries (towards the customer).

An on-board master clock within DACs/IDUs maintains customer-facing clocking references when the expected signal input and associated clocking reference from its RAC/radio is missing, or below the minimum level required.

Loopbacks

When loopbacks are applied:

- For a *PDH radio-facing tributary loopback,* AIS is transmitted on the affected tributary towards the customer.
- For an *SDH radio-facing tributary loopback,* PRBS is not transmitted on the affected tributary towards the customer (an external BERT will indicate a loss of frame alarm).
- For a *line-facing tributary loopback*, and for a *digital loopback,* AIS/PRBS is not transmitted. Instead, as well as traffic from the customer being looped back towards the customer, it is also transmitted in the radio facing direction of the affected circuit(s).
- For an *IF loopback* traffic from the customer is looped back to the customer, and at the remote end the resultant demodulator-unlock initiates AIS or PRBS15 on all traffic circuits *towards* the remote bus/customer. All cross-connected circuits *from* the remote RAC/radio, which for a Node may be to DAC and/or other RAC plug-ins, will carry this AIS/PRBS.

AIS/PRBS15 may also be *forced* onto a DAC tributary using the System Control screen.

Protected DAC Screens

For information on the protectable DACs refer to DAC/Tributary Protection on page 3-76, Volume II, Chapter 3.

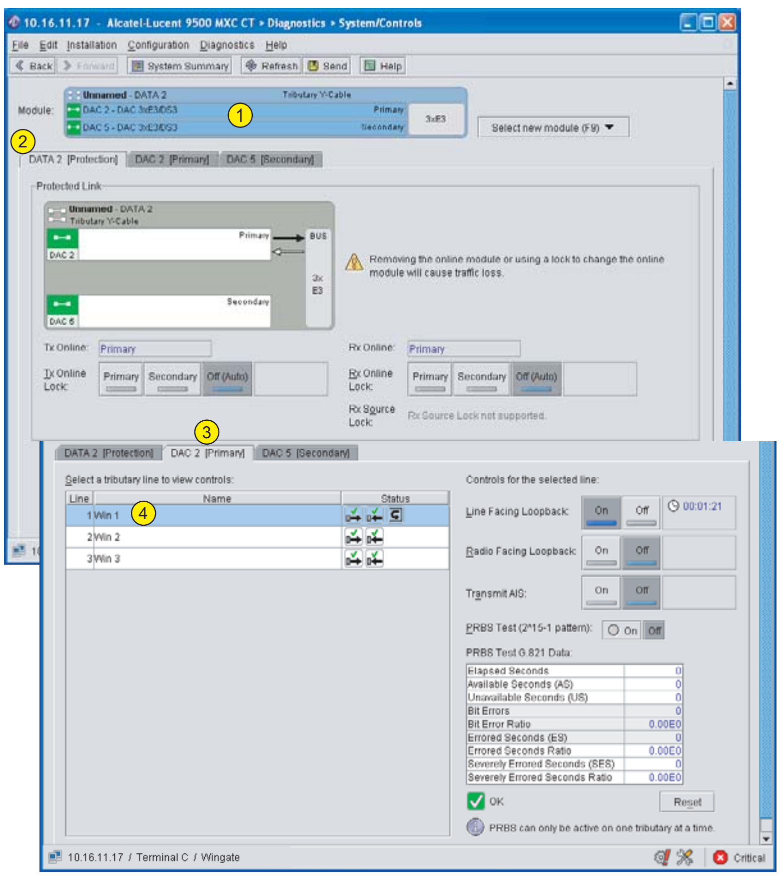
The opening DATA protection window identifies online Tx and Rx status for primary and secondary RACs and supports:

- Application of Tx and Rx locks.
- Online status change.

The DAC (primary) and DAC (secondary) windows include the same loopback, AIS and PRBS functionality displayed in Figure 15-21 on page 15-46 for a non-protected DAC.

- It is possible to set this functionality for one or both DACs, but valid data will only be presented by the online DAC.

Figure 15-22. Protected 2xSTM1 Screens



Item	Description
1	Protected 3xE3/DS3 DACs
2	Protection window provides a graphic of protected DAC status, and locks for Tx and Rx Online.
3	DAC windows support loopbacks, AIS, and G.821 BER testing per trib.

Item	Description
4	Trib names are set in Configuration > Plug-ins. Example illustrates a line (customer) facing loopback set on Trib 1 and its associated safety timer countdown.

DAC ES and DAC GE Menu

For the DAC ES and DAC GE cards, and for the equivalent Ethernet modules in the IDU ES and IDU GE 20x, the System/Controls screen presents three views.

Refer to:

- System/Controls Diagnostics. This screen applies the DAC GE only.
- System Controls Port/Channel Status
- System/Controls MAC Address Table Screen. This screen applies to the DAC GE only.

System/Controls Diagnostics

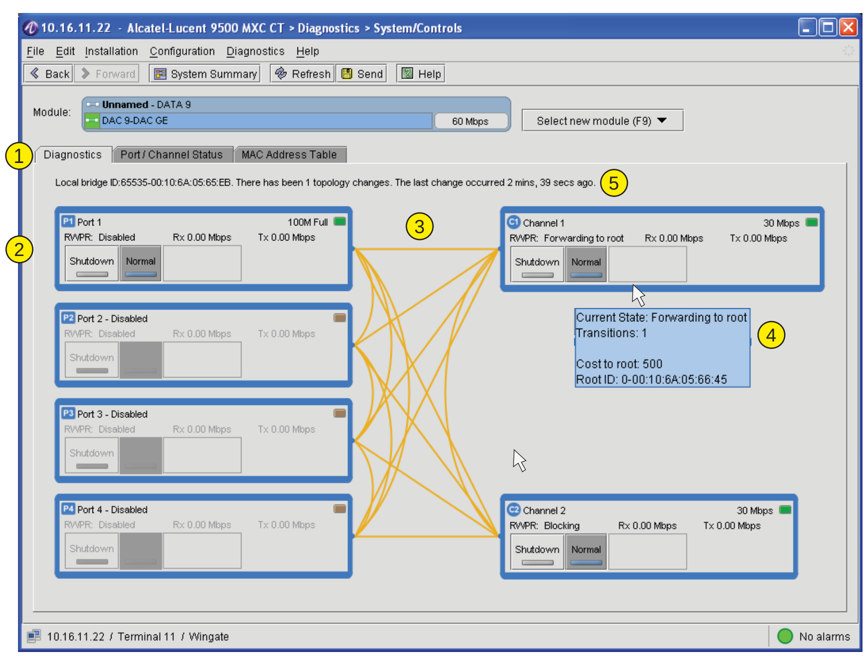
The System/Controls Diagnostics screen displays port status, operational mode, configured port and channel speeds, RWPR status, and a port shutdown prompt. The shutdown includes a safety timer function.

If RWPR is configured, the data includes:

- RWPR bridge ID.
- Number of topology changes and the time since the last change.
- Cost to root, and port/channel RWPR status: learning, forwarding, discarding/blocking, or discarding/disabled.

Figure 15-23 sh0ws a screen for an RWPR configured DAC GE.

Figure 15-23. System/Controls Diagnostics Screen



Item	Description
1	The Diagnostics screen view is selected (default view).
2	Port and channel status indicators and shutdown buttons. When a shutdown is clicked, a safety-timer window appears. Refer to Safety Timer Operation on page 15-40. Status and shutdown buttons are greyed-out for ports/channels that are not enabled (enable in the Plug-ins screen). In this example, RWPR has been enabled in the Plug-ins screen.
3	Shows the Operational Mode selected in the Plug-ins screen.
4	When RWPR is enabled, mouse-over the RWPR entry in the port/channel modules for tooltip information. The channel 1 example shows current state, transitions, cost to root, and root ID.
5	When RWPR is enabled, the local bridge ID is shown, together with the number of topology changes that have occurred under RWPR switching action.

System Controls Port/Channel Status

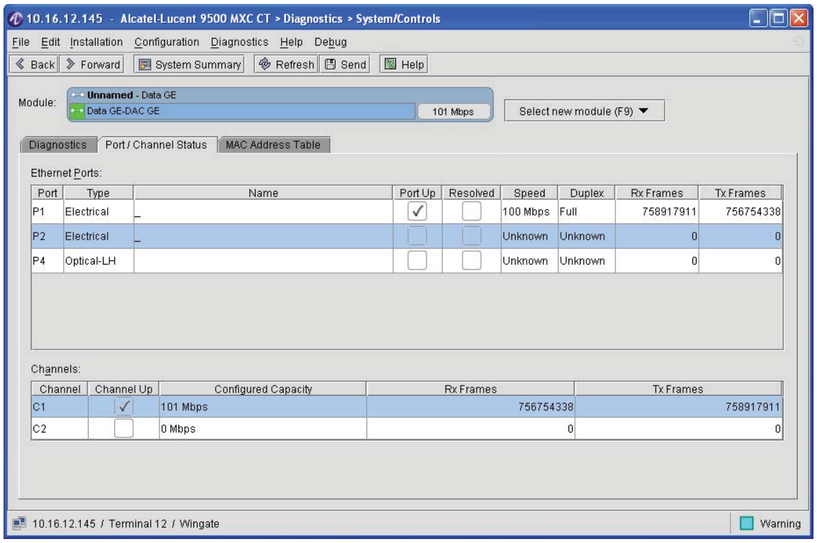
The Port/Channel Status screen details:

- Port connection status and speed setting.
- Port Rx and Tx frame totals for enabled ports.
- Channel connection status and configured capacity (DAC GE only)
- Channel Rx and Tx frame totals for enabled channels (DAC GE only).

Frame counts are captured from the time a DAC ES or DAC GE is configured providing it remains powered-up.

Figure 15-24 shows an example DAC GE screen. Port status displays in the upper frame, and Channel status in the lower.

Figure 15-24. System/Controls Port/Channel Status Screen: DAC GE

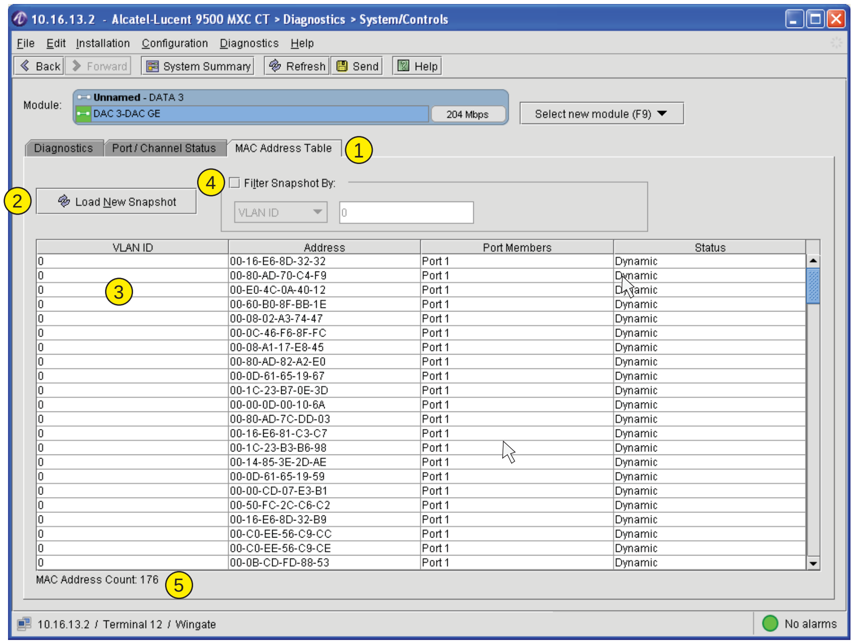


System/Controls MAC Address Table Screen

The MAC Address Table screen, Figure 15-25, lists the addresses held in the MAC register, with filter options to sort by MAC Address, Port Members, Status, and VLAN ID. This screen applies to the DAC GE - not to the DAC ES.

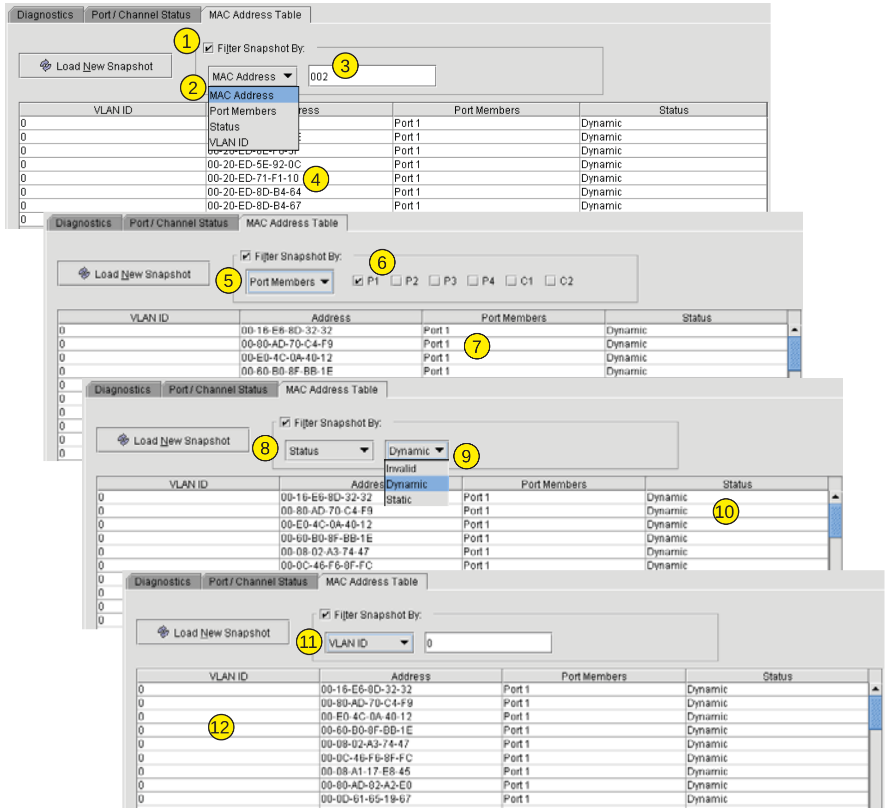
- An address can be entered to check its presence within the table.
- Port Member provides a port-based filter on the MAC address listing. One or more ports (P1 to P4), can be selected.
- Status provides a filter on address type: dynamic, static or invalid.
- VLAN ID provides a filter on the VLAN ID range: 0 to 4095.

Figure 15-25. System/Controls MAC Address Table Screen



Item	Description
1	MAC Address Table selected.
2	Click to refresh MAC address table data.
3	Panel lists MAC address table data: • VLAN ID (for VLAN tagged streams) • MAC address • Port members (DAC GE user ports 1, 2, 3, 4) • Status (dynamic, static or invalid) The list shows addresses for all ports.
4	Click to enable address table filtering. See the following figure.
5	Shows the total number of MAC addresses in the table. When filtered options are selected, the address count shows the total number of filtered addresses.

Figure 15-26. System/Controls MAC Address Filter Options



Item	Description
1	Filter button is clicked on.
2	MAC address is selected as the filter option.
3	Enter the MAC address in HEX.
4	As the HEX numbers are entered, the number of addresses in the table list dynamically reduces according the entry string.
5	Port members is selected as the filter option. Click to select one or more ports.
6	The address listing is filtered according to the port selection;
7	Addresses are only listed for the selected port or ports.
8	Status is selected as the filter option.
9	Select an address status option; dynamic, static or invalid.
10	Addresses are only listed for the selected status option. Dynamic is shown in this example.
11	VLAN ID is selected as the filter option.

Item	Description
12	Addresses are only listed for the selected VLAN IDs. The minimum VLAN ID is 0, the maximum is 4095. Enter one or multiple IDs separated by commas, such as 1, 4, 650. Or enter a range, or multiple ranges, such as 1-100, 200-600.

AUX Menu

The AUX System/Controls screen supports line and radio facing loopbacks on each of the available communications channels; three for an AUX plug-in, one for an IDU AUX module. Safety timers are not currently supported.

Loopback Points

9500 MXC supports user-setable loopbacks via CT. Data is separately provided for INUs, Circuit Loopbacks, IDUs, and DAC 155oM.

- DAC / Trib loopbacks are applied per trib and multiple loopbacks can be set at the same time. Loopbacks only affect traffic on the selected trib(s).
- RAC / Radio / Line loopbacks affect all traffic on a link.
- A Circuit loopback only affects traffic on the selected circuit.
- Loopback timers are provided. See Loopback and AIS Safety Timer Operation on page 15-47.

Note: An ODU-cable-loopback is not included. Instead, confirmation of ODU cable integrity is provided by:

- An ODU cable alarm. This is supported on all RACs and IDUs except for:
  - Early-production RAC 30s (RAC 30V1 and RAC 30V2a).
  - RAC 10.
  - IDU 8x and IDU 16x (100 series).
- Presence of ODU and ODU alarms:
  - If the ODU is shown as disconnected (cannot be seen by its RAC) a probable cause is an ODU cable failure.
  - If an ODU sourced alarm is on, its presence in the Alarms screen indicates normal ODU cable communications; an ODU cable failure is not indicated.
  - If an ODU sourced alarm is on and its associated RAC is not in demod lock alarm, the local receive function is operating normally. Conversely, if the remote end RAC is not in demod lock alarm, the local transmit function is operating normally; an ODU cable failure is not indicated.

INUs

Figure 15-27 illustrates the loopback application points within an INU/INUe for a RAC 30 and DAC 16x. For other plug-ins, the loopback points are:

- RAC 3X, RAC 40 and RAC 4X; loopbacks are as for RAC 30.
- RAC 10 only supports the digital loopback; no IF loopback.
- All E1/DS1, E3/DS3, STM1/OC3 DAC plug-ins support line and radio facing loopbacks.
- The DAC GE and DAC ES plug-ins do not support loopbacks.

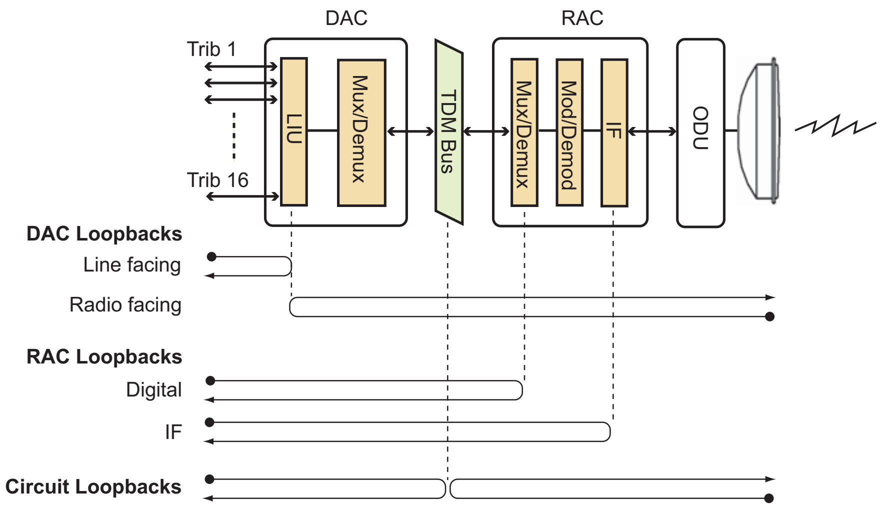
- The AUX plug-in supports line and radio facing loopbacks; as for trib DACs.

Circuit Loopbacks

A circuit loopback places a both-way loopback on the selected circuit at the backplane bus. Selection applies to all circuit rates, as set for the backplane; E1, E3, DS1, DS3 or STM1/ OC3. Auxiliary data circuits are also supported.

- Only one Circuit Loopback can be applied at a time and only traffic on the selected circuit is affected by loopback activation.
- In conjunction with the built-in PRBS Generator in DAC plug-ins, circuit loopbacks provide a user-friendly tool for tracing and checking a circuit through a 9500 MXC network.
- See Circuit Loopbacks for 9500 MXC Node on page 15-58.

Figure 15-27. 9500 MXC INU/INUe Plug-in Loopbacks

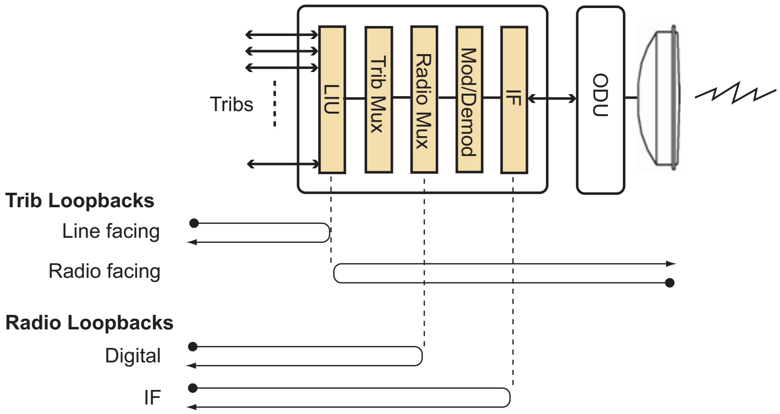


IDUs

Figure 15-28 illustrates the loopback points for IDUs (IDU 300 series) except for IDUsp.

- The IDUsp supports all loopbacks except IF.
- For IDU ES and IDU GE the trib loopbacks apply only to the NxE1/DS1 waysides; not to the DAC GE and DAC ES Ethernet modules.
- The IDU AUX module supports line and radio facing loopbacks; as for tribs.
- IDU 100 series supports all loopbacks except IF (supports trib, auxiliary, and digital).

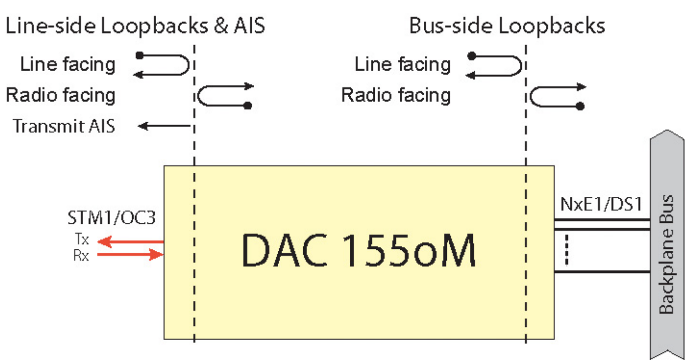
Figure 15-28. IDU Loopbacks



DAC 155oM

DAC 155oM supports both line side and bus facing loopbacks, as shown in Figure 15-29.

Figure 15-29. DAC 155oM Loopbacks



The line-facing loopbacks support troubleshooting from the STM1/OC3 line side:

- A line facing line-side loopback may be used to verify the integrity of the line connection at the STM1/OC3 level, including optical transceiver and clock recovery (for a recovered clock setting).
- A line facing bus-side loopback supports BER checks from a remote site on individual E1/DS1 (VC-12, VC-11, VT-2, VT-1.5) circuits. For information on the mapping of E1 or DS1 tribs within an STM1/OC3 frame, refer to Trib BER Measurement in Volume V, Commissioning.

The radio facing loopbacks support troubleshooting from the 9500 MXC radio network side:

- A radio facing line-side loopback loops all E1/DS1 circuits configured on the DAC 155oM.
- A radio facing bus-side loopback supports loops on individual E1/DS1 circuits.

Loopbacks can also be applied on the backplane bus using the Circuit Loopbacks screen. See Circuit Loopbacks above.

Circuit Loopbacks for 9500 MXC Node

The Circuit Loopbacks screen enables application of a both-way circuit loopback on the TDM bus.

Circuit loopbacks can only be enabled for configured circuits, identification of which is by circuit name, as entered in the Configuration > Circuits screen.

All circuit rates are supported, as set for the backplane; E1, E3, DS1, DS3 or STM1/OC3. Auxiliary data circuits are also supported.

Only one Circuit Loopback can be applied at a time. Currently there is no time-out provision; to clear a loopback an activated loopback must be de-activated.

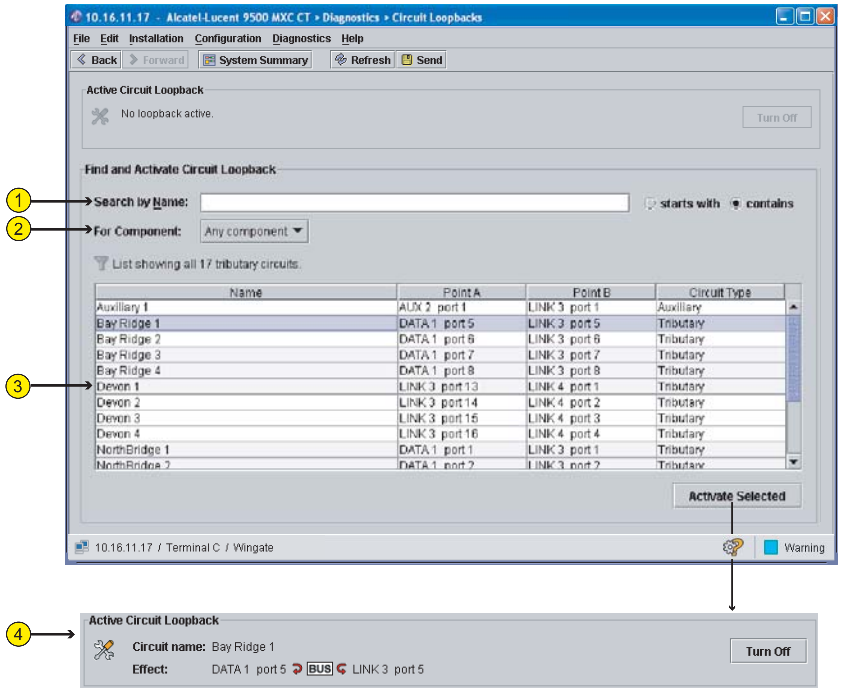
Only traffic on the selected circuit is affected by Circuit Loopback activation.

In conjunction with the built-in PRBS Generator in DAC plug-ins, Circuit Loopbacks provide a user-friendly tool for tracing and checking a circuit through a 9500 MXC network.

To permit straight-forward identification of a circuit within a 9500 MXC network, each circuit must have a unique name. A circuit name is entered in the Circuits screen, and the same name should be entered at all Nodes carrying that circuit.
It is recommended Trib names, as set in a DAC plug-ins screen, also have the same name as its circuit, or include the circuit name. This is to permit easy association of a trib with its circuit when setting a DAC PRBS test on a circuit loopback.

Figure 15-30 shows a typical Circuit Loopbacks screen for an E1-configured backplane.

Figure 15-30. Circuit Loopbacks Screen



Item	Description
1	Search by Name function, with options for “Starts With” or “Contains”.
2	Menu option for viewing all circuits, or circuits by installed module (LINK, DATA, AUX)
3	Circuit names are as entered in the Circuits screen, and listed in alphabetical order. Loopbacks can be applied to traffic and auxiliary circuits.
4	This panel shows an activated circuit loopback. Circuit loopbacks act both-ways.

Circuit Loopbacks Navigation

Only circuits configured in the Circuits screen can be viewed and selected.

Circuits can be selected by finding and clicking a circuit line in the main panel. Circuits are listed alphabetically.

Each circuit is identified by name, its port-to-port connection, and circuit type (tributary or auxiliary).

To assist location of a circuit name, use the search options:

- Search-by-name can be optioned for ‘Starts with’ or ‘Contains’.
- For-component provides a sub-menu of installed circuit-carrying modules; LINKs, DACs, AUX. Select one to view only its circuits in the main panel.

If a circuit has not been named, or if two or more circuits have the same name, an error message is displayed.

When a loopback is activated its details are displayed in the Activate Circuit Loopback panel. The loopback applies in both directions. Click De-activate to terminate the loopback.

A circuit loopback automatically de-activates if any configuration change is made in the Circuits screen.

Parts

The Parts screen presents:

- Part number
- Part revision
- Serial number
- Time -in-service

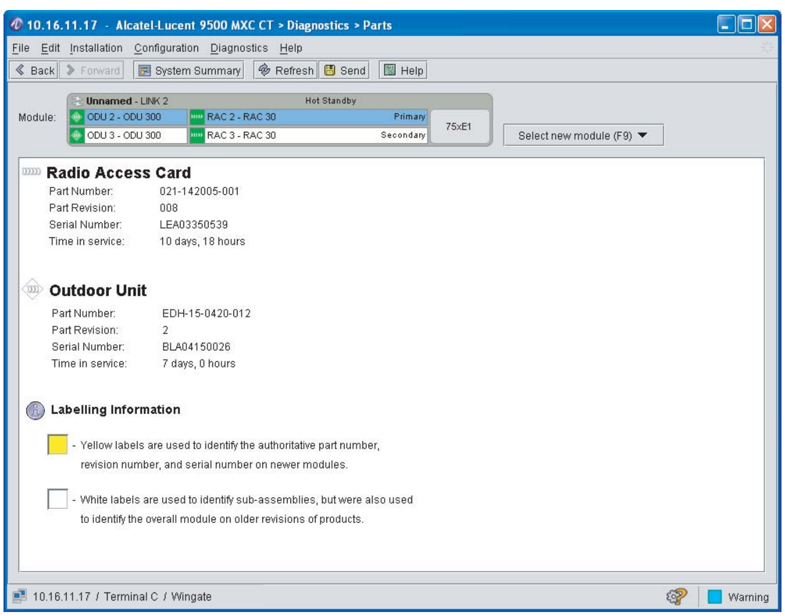
This data is provided for:

- All INU plug-ins except the FAN
- IDU modules
- ODUs

Refer to the example in Figure 15-31.

Time-in-service is initiated from the time the item is placed in operation. The counter resets to zero on removal from service or power-down. The count is in whole hours.

Figure 15-31. Example Parts Screen

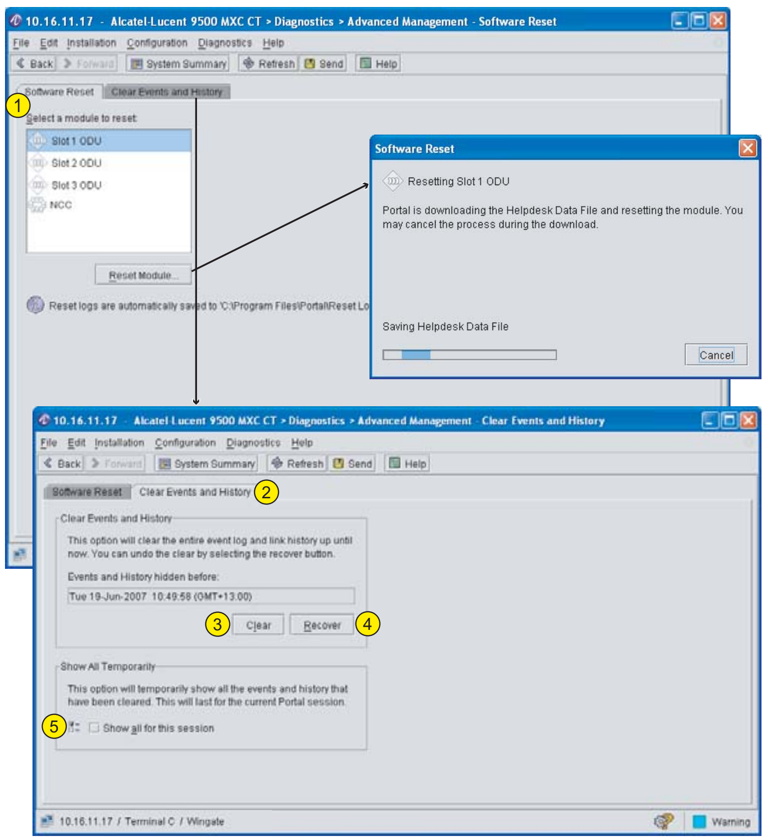


Advanced Management

The advanced management screen supports two functions:

- Software reset, which provides a hard reset for all software-resettable modules. Refer to Advanced Management Screen on page 15-61.
- Clear Events and History, which clears all historical data from the Event Browser and History screens. Refer to Clear Events and History on page 15-62.

Figure 15-32. Advanced Management Screen



Item	Description
1	Software Reset forces a hard reset for the selected module. Traffic is affected. CT automatically saves the Help Desk data file before resetting.
2	Clear Events and History window.
3	Click Clear to clear all historical data from the Event Browser and History screens.
4	Click Recover to recover all historical data.
5	Click to recover (temporarily) data for this CT session only.

Software Reset

Software reset provides a hard reset for the software-resettable modules:

- NCC and ODUs for 9500 MXC Nodes.
- Control module and ODU for 9500 MXC Terminals

A software reset is equivalent to a power-down reboot (power off - pause - power on), with one important difference; a copy of the Helpdesk Data File is automatically saved to a default folder on your CT PC at C:\Program Files\CT\Reset Logs\. For information on this file refer to Reports, Volume IV Chapter 5.

A software reset should only be used where all other avenues for fault determination are exhausted - effectively a last resort option. It can be likened to a reboot for a PC.

- Relevant 9500 MXC alarm descriptions include a reboot prompt where all other recommended actions fail to produce a result.
- 9500 MXC alarm descriptions are prompted within:
  - The Event Browser screen under Help for Event.
  - The Alarms screen under Help for Alarm.
  - The Troubleshooting chapter of this manual. Refer to CT Alarms on page 2-15 of Volume V, Chapter 2.

Clear Events and History

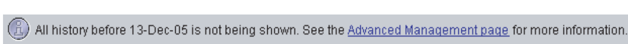
This function is designed to clear all historical data from the Event Browser and History screens. It is for use post-commissioning or after re-configuration or remedial work to clean out unwanted, prior data.

Two recovery choices are presented in the event you decide to return to the original entries:

- A recover option to fully recover from the cleared action. If not clicked, all prior data is lost once you log off - there is no subsequent recovery option.
- A temporary recover option to recover (show) data just for the current CT session.

When Clear is clicked:

- Both the Event Browser and History screens are updated to show only events/data subsequent to the Clear command.
- Both Event Browser and History screens display an information line, which remains for the current CT session unless a full recover is actioned.



Volume V

Commissioning and Troubleshooting

Chapter 1. Commissioning

This chapter describes the commissioning process and commissioning tests for 9500 MXC.

Refer to:

- Commissioning Process on page 1-1
- Commissioning Tests on page 1-3
- Commissioning Records on page 1-21

Commissioning Process

Commissioning ensures 9500 MXC:

- Is installed correctly
- Is correctly configured
- Has passed all tests
- Is operating to plan and running alarm and error-free
- Has had all relevant commissioning data recorded
- Is ready for traffic carrying duty

The nodal design of 9500 MXC means that one INU/INUe usually supports multiple links.

- Compared with a traditional single-link commissioning procedure, where the link is signed-off as one entity, for 9500 MXC a combination node-and-link procedure is required, using the node as the common reference.

The process and procedures recommended for a 9500 MXC Node also generally apply to the Terminal.

A typical commissioning process is summarized in Table 1-1.

Table 1-1. Typical Commissioning Check Process

Step	Description	Procedure
1	Physical installation inspection	A physical check prior to antenna alignment and node configuration to ensure that the physical installation is complete and correct.
2	Antenna alignment confirmation	An antenna alignment procedure is detailed in Volume II, Chapter 5. Recorded RSLs should be within 2 dB of calculated RSLs.

Ste p	Description	Procedure
3	Configuration confirmation	A check, using CT, to ensure that Node configurations are complete and correct and that: • Links are operating error-free. • All relevant alarms are extinguished. • Link performance data is as expected. • Node/Terminal visibility is provided at the network management center (where network managed).
4	Commissioning tests	Tests designed to confirm correct link operation. Refer to Commissioning Tests on page 1-3.
5	Capturing as-built data	Recording all relevant installation and performance data for future reference. Refer to Commissioning Records on page 1-21.
6	Final inspection and sign-off	Completion of ‘paperwork’ recording installation hand-over for operational use, and/or any remedial action needed to complete an installation. Refer to Commissioning Records on page 1-21

Commissioning Tests

Tests are described for:

- BER
  - Background Error Measurement
  - Trib BER Measurement
- Fade Margin
- Protection Switching

BER

A BER test is applied to check that the link is passing traffic error free for the test period; normally a minimum of 8 to 12 hours (overnight).

Two test methods can be employed:

- Background error measurement over radio paths; customer traffic is not affected. Refer to Background Error Measurement on page 1-3.
- Tributary BER measurement, where customer traffic on a trib is replaced by a BER test pattern. Refer to Trib BER Measurement on page 1-4.

Background Error Measurement

9500 MXC provides background G.826 error measurements on the radio paths, from RAC to RAC. Such tests run continuously in the background (in both directions).

- G.826 data capture is initiated in the CT Performance screen. Refer to Performance in Volume IV, Chapter 15. A capture period can be started and stopped from this screen.
- Historical G.826 error *events* are presented in the CT History screen. Refer to History, in Volume IV, Chapter 15. Depending on its setting, the history screen displays error occurrences within 15 minute blocks over seven days, or within 24 hour blocks over one month.

Trib BER Measurement

Trib BER measurements can be made using an external BER tester, or the built-in 9500 MXC capability.

Unlike a background measurement, which is single-link based, a trib test is used to check a tributary circuit from end-to-end, meaning multiple links can be involved.

Built-in BER Test

E1/DS1, E3/DS3, and STM1/OC3 DACs include a PRBS generator and a G.821 receiver to support looped, and both-way tests on tribs:

- For a **looped** test the originating DAC provides the PBBS generator *and* G.821 receiver. Requires a loopback on the trib/circuit, which can be applied using CT or a physical loop.
- For a **both-way** test, a PRBS generator on one DAC is G.821 received on its remote DAC, and vice-versa. No loopback is required.

Within 9500 MXC, loopbacks can be set within DACs, RACs, and on the TDM bus. For information on these options refer to System/Controls on page 15-35, Volume IV, and to Circuit Loopbacks for 9500 MXC Node on page 15-58.

Where an *external* BER tester is to be used, refer to manufacturer's instructions.

External testers provide superior measurement accuracy and access to a wider range of test and measurement functions.

DAC 155oM Tributary BER Measurement

BER testing on a PDH tributary in an SDH/SONET frame requires an external test set. Sets are available to provide looped and in-line test options.

A standard looped test generally involves setting a loop on the line-facing bus port for the required trib using the options in the the DAC 155oM System/Controls screen, then applying a BER test on the appropriate TU or VT within the SDH/SONET frame.

For in-line testing, an optical splitter is used to provide a 10% sample of the DAC 155oM transmit signal, which is connected to the SDH-in port of the PDH/SDH tester. See Figure 1-1. Within the INU, the CT Circuits screen is used to cross-connect the selected E1/DS1 trib in the SDH signal to a DAC 16x trib port.

Typically, test-set selection of the required trib is made on trib type and trib number:

- For a DAC 155oM configured for an E1 backplane bus, the trib type is 2 Mbps async. For a DS1 backplane, a 1.5 Mbps async selection is required.
- Provision for E1 or DS1 trib number selection is normally made using 'KLM' tributary mapping data, where entry tabs are provided for TUG 3/SPE, TUG 2/Group, and TU/VT. (Where such selection is not provided, consult the test-set handbook for trib-number selection).

Figure 1-1. DAC 155oM PDH/SDH In-Service Mux Testing

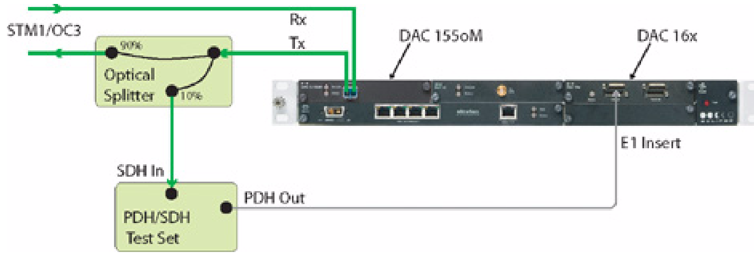


Table 1-2 lists G.707 KLM tributary mapping within an STM1/OC3 frame, which is based on the mux hierarchy used for SDH with VC4 or VC3 framing, and for SONET with STS1 framing. This data equates to the DAC 155oM bus port (bus trib) numbering, and is displayed in the DAC 155oM Plug-ins > Bus Ports screen.

Table 1-2 data applies to all framing options. For TU12/VT-2 (NxE1), bus ports 1 to 63 apply. For a TU11/VT-1.5 selection (NxDS1), bus ports 1 to 84 apply.

Table 1-2. DAC 155oM Bus Tributary Mapping

9500 MXC Port (Bus Trib)	TUG3 (K)	TUG2 (L)	TU* (M)
	SPE (K)	GROUP (L)	VT** (M)
1	1	1	1
2	2	1	1
3	3	1	1
4	1	2	1
5	2	2	1
6	3	2	1
7	1	3	1
8	2	3	1
9	3	3	1
10	1	4	1
11	2	4	1
12	3	4	1
13	1	5	1
14	2	5	1
15	3	5	1
16	1	6	1
17	2	6	1
18	3	6	1
19	1	7	1
20	2	7	1
21	3	7	1
22	1	1	2
23	2	1	2
24	3	1	2

9500 MXC Port (Bus Trib)	TUG3 (K)	TUG2 (L)	TU* (M)
	SPE (K)	GROUP (L)	VT** (M)
25	1	2	2
26	2	2	2
27	3	2	2
28	1	3	2
29	2	3	2
30	3	3	2
31	1	4	2
32	2	4	2
33	3	4	2
34	1	5	2
35	2	5	2
36	3	5	2
37	1	6	2
38	2	6	2
39	3	6	2
40	1	7	2
41	2	7	2
42	3	7	2
43	1	1	3
44	2	1	3
45	3	1	3
46	1	2	3
47	2	2	3
48	3	2	3
49	1	3	3
50	2	3	3
51	3	3	3
52	1	4	3
53	2	4	3
54	3	4	3
55	1	5	3
56	2	5	3
57	3	5	3
58	1	6	3
59	2	6	3
60	3	6	3
61	1	7	3
62	2	7	3
63 (E1)	3	7	3 (TU12/VT-2)

9500 MXC Port (Bus Trib)	TUG3 (K)	TUG2 (L)	TU* (M)
	SPE (K)	GROUP (L)	VT** (M)
64	1	1	4
65	2	1	4
66	3	1	4
67	1	2	4
68	2	2	4
69	3	2	4
70	1	3	4
71	2	3	4
72	3	3	4
73	1	4	4
74	2	4	4
75	3	4	4
76	1	5	4
77	2	5	4
78	3	5	4
79	1	6	4
80	2	6	4
81	3	6	4
82	1	7	4
83	2	7	4
84 (DS1)	3	7	4 (TU11/ VT-1.5)

Fade Margin

This test is designed to check that the expected (calculated) fade margin for a link matches actual performance.

The expected fade margin should be included in the link installation datapack together with Tx power, system losses, antenna gains, the effective radiated power, free space path loss, expected receive signal level and the calculation for link availability.

The fade margin test measures the difference in receive signal level between the normal, operational level, and the threshold level, the level at which bit errors appear. The threshold level can be specified for a bit error rate (BER) of 10^{-6} or 10^{-3}. For 9500 MXC, the difference between 10^{-3} and 10^{-6} thresholds is not more than 2dB.

Fade margin measurement should only be conducted after it has been verified that expected RSLs, as indicated in CT performance screens, are correct at both ends of the link. If an RSL is low, the reason for this must first be investigated and resolved.

When coupled with an ability to measure receive signal level at the receiver input, this procedure also provides an indication of receiver threshold, which can be checked against receiver specifications.

For 9500 MXC, a fade margin test involves reducing the Tx power at one end of the link, and checking the error performance at the other using the G.826 data presented in the CT Performance Screen. However, achieving a threshold RSL is only possible where there is sufficient adjustment available in Tx power.

- Tx power adjustment ranges apply *down* from the maximum power setting supported by the frequency and bandwidth option configured for the link.
- Therefore, in situations where the expected fade margin is greater than the Tx power-reduction range available within CT, it is not possible to reach threshold. Nevertheless, reducing Tx power to its minimum and confirming error-free operation should still provide an acceptable degree of confidence.

Measuring the Fade Margin

The CT screens used are:

- Configuration > Plug-ins > Link for Tx power and ATPC control.
- Diagnostics > Performance > Link for RSL and G.826 error data.
- Diagnostics > System Controls > Link to lock a *protected* link to one side.

To measure the fade margin:

1. Ensure ATPC is not selected, and for a protected link, force (lock) the link to one side.
2. Note the Tx power setting, and the detected Tx power reading at one end of the link.
3. Note the RSL at the other end of the link.
4. Prepare to monitor errored seconds in the receive-end Performance screen. Alternatively, use a BER test on a looped tributary.
5. Reduce the Tx power in steps until the receiver threshold is reached as indicated by the onset of errored seconds.
6. The fade margin is the difference in Tx power between the normal power and the power at Rx threshold.
7. At threshold, the indicated receiver RSL in dBm can also be compared with the receiver datasheet specifications as a direct check of receiver threshold.

Lower Than Expected Fade Margin Situation

If the measured fade margin is significantly less than the expected margin, reasons can include:

- Accuracy of measurement not taken into account. For 9500 MXC, the margin for error can be up to 3 to 4 dB, given the limitations of software-set power control, RSL measurement and G.826 error capture. Similarly, the margin for error for a receive threshold check can also be up to 4 dB given the limitations of internal RSL and BER alarm measurement. Measurement accuracy can be improved with the use of an external BER tester.
- Equipment performance outside specification.
- Path loss higher than expected.
- Antenna misalignment.
- Interference from other transmitters.

Protection Switching

This topic provides test procedures for 9500 MXC Node Links, Rings, DACs and NCC/NPC.

Refer to:

- Test Measurement on page 1-11
- Link and Ring Protection Logic on page 1-12
- Confirming Link and Ring Protection on page 1-13
- Hot-standby and Space Diversity on page 1-15
- Frequency Diversity on page 1-16
- Ring Protection on page 1-17
- DAC Protection on page 1-18
- DAC Protection Test Procedure on page 1-19
- NCC/NPC on page 1-19

No protection switch operation is permitted within a one to two minute period from power-on, which is also the time typically required before CT log-in is permitted.

Test Measurement

The procedures described are designed to confirm correct switch operation; they are not intended to provide verification of switching times to millisecond accuracy.

- The procedures provide confirmation of switch action using errored-second time resolution.
- Confirmation of switching times with millisecond accuracy is a FAT (factory acceptance test) procedure. Contact Alcatel-Lucent or your supplier for details.

The check procedures described refer to G.821 BER and G.826 link performance error measurement:

- The BER test can be established using the built-in BER test capability (on DACs), or an external hand-held tester.
  - The built-in BER test and most hand-held BER testers only provide direct measurement of errored period with a resolution to one second, as an errored-second count, which depending on where the second starts and stops in relation to the interruption may result in a count of 1 or a count of 2 for a service interruption of less than one second. However, an *estimate* of the hit period can be calculated from the Bit Error count (increment of the number of errored bits), using the circuit data rate. For example, a bit count of 50,000 indicates an outage of 24 ms on an E1 trib (E1 = 2,048,000 bits per second).
- The G.826 link performance test data is provided in the Performance screen.
  - G.826 data provides measurement of errored period with a resolution to one second, as an errored-second count, which depending on where the second starts and stops in relation to the interruption may result in a count of 1 or a count of 2 for an interruption of less than one second.
- The procedures involve disconnection of the ODU cable or withdrawal of a plug-in card, which depending on the way it is done can have a significant bearing on the observed service restoration time; a soft/slow/imprecise disconnection will result in variable switch action and switch times. It is for this reason that the procedures described herein are not appropriate for verifying 9500 MXC protection switch times.

The tests for protection switching provided in this section refer to use of the built-in G.826 link performance data, or to G.821 BER test capabilities. The built-in BER test function is used for all BER tests except for DAC testing, when an external tester is used.

Link and Ring Protection Logic

Before testing protection switching, ensure you are familiar with the following switch process and logic for hot-standby, diversity and ring configurations.

For information on Node protection options, protection operation, switching criteria, and switching times refer to Protected Operation on page 3-60,
Volume II, Chapter 3.

For information on protection operation refer to Appendix F.

Hot-standby and Diversity

For hot-standby and diversity configurations, the two RAC/ODU combinations are assigned as primary and secondary. These assignments are configured in the Protection screen.

- The default *online transmitting* RAC (and ODU) is the RAC assigned as *primary*. Applies to hot-standby and diversity. Online status can be changed in the System/ Controls screen.
- The default *online receiving* RAC (and ODU) is the RAC assigned as *secondary*. Applies to hot-standby and diversity. Online status can be changed in the System/ Controls screen.
- Management of protection switching is controlled by:
  - The online Tx RAC for Tx switching (default: primary RAC).
  - The online Rx RAC for Rx switching (default: secondary RAC).
- Transmit switching for hot-standby and space diversity is not hitless. Transmit switching for frequency diversity is hitless *providing* the online Tx RAC is not withdrawn.
  - The *online* Tx RAC manages the Tx protection switch function, and is transferred between RACs to always be with the online Tx RAC.
  - Only the online Tx is operational for hot-standby and space diversity.
  - Both online Tx and standby Tx are operational for frequency diversity. The online Tx is managing Tx traffic synchronization.
  - Switching from the online to standby transmitter will not be initiated if the standby transmitter has failed, or the standby Tx RAC has been withdrawn or replaced by an incorrect plug-in.
- Rx path switching is hitless (hot-standby and space/frequency diversity), *providing* the online Rx RAC is not withdrawn. The least errored data stream from the online and standby receivers is selected on a frame-by-frame basis within the *online* Rx RAC.
  - The Rx protection switch function is contained within the RACs and is transferred between RACs to always be with the *online* Rx RAC (bus driving RAC).

    - Changing the online status from one RAC to the other using the locks in the System/Controls screen, or withdrawing the *online* Rx RAC, transfers the online protection switch function to the partner RAC, which causes a service interruption.
- Switching is not restorative, which means that when a fault condition has been cleared there is no automatic return to the pre-fault online Rx or online Tx RACs. To change online status use the commands in System/Controls, or withdraw an online RAC to effect a switch to its partner RAC. Except for a single antenna hot-standby link where an unequal coupler has been installed, there is no operational need to always return to the default online RACs (low-loss side should be with the online Tx).
- Where testing involves disconnection and re-connection of the ODU cable at RAC front panels, such action is only recommended for protection switch testing for the reason connector mating surfaces can be damaged by arcing, and the arcing may cause errors on other traffic transiting the Node. For all other situations, either withdraw the RAC from its backplane, or disconnect the -48 Vdc power supply before ODU cable disconnection and re-connection.

Ring

A ring comprises a closed network of nodes where RACs at each node are assigned in an East and West direction in the Protection screen. Within this ring there are two traffic rings:

- One is designated primary, where traffic comes in on the West RAC and leaves on the East RAC (clockwise direction). Under normal no-fault conditions, all traffic flows just on this primary ring.
- The other is designated the secondary, where traffic comes in on the East RAC and leaves on the West RAC (anti-clockwise direction). This secondary ring is only used in the event of a fault; traffic is diverted from the primary ring onto the secondary ring at the break point, where it travels around the ring (East to West, anti-clockwise direction) to meet up with the primary ring at the other side of the break. This process is called ‘wrapping’.

Unlike hot-standby and diversity protection, ring protection is restorative; once a fault condition has cleared, the ring automatically unwraps so that only the primary ring is carrying traffic.

NMS visibility is maintained to all Nodes on a ring for a single break. Visibility is only lost where a Node or Nodes are isolated due to a double/multiple break.

Auxiliary *data traffic* is not protected on a ring.

Alarm I/O event mapping follows NMS visibility; providing NMS contact is maintained to Nodes, Alarm I/O event signalling is maintained.

Confirming Link and Ring Protection

Procedures are separately provided for:

- Hot-standby and space diversity
- Frequency diversity
- Ring

Before commencing:

- Check the protected link is operating normally:
    - No alarm icons in the CT status bar (green/0).

  - No G.826 errors in the Performance screen.
- Determine the primary/secondary or east/west RACs and their online status.
  - For hot-standby and space/frequency diversity links the default configuration has the online Tx function with the primary RAC, and the online Rx function with the secondary RAC. View online status in the System/Controls screen.
  - For ring links both east and west RACs are transmitting and receiving.
  - A RAC front panel *online* LED will be green if it is online for Tx, or Rx, or Tx and Rx. It will be unlit if it is *not online* for Tx or Rx.

Preliminary

In the procedures provided:

A BER test can be applied using the PRBS function built into E1/DS1, E3/DS3, or STM1/OC3 DACs, or an external BER tester.

Other procedures can be used. For example, the built-in PRBS functions can be activated at both ends of a protected link to provide a both-way test on a trib (both directions separately monitored).

CT screens for local and remote Nodes can be dragged to different parts of your PC screen for easier management.

The test procedures described are based on default primary and secondary RAC settings. This has the primary RAC online transmitting, and the secondary RAC online receiving.

Where the built-in PRBS Generation function is being used to check protection switching:

- For each switch event that is not designed to be hitless, the Errored Second count increments by 1, or depending on the counter time boundary relative to the event, a maximum of 2. Refer to Test Measurement on page 1-11.
- For most tests Available/Unavailable time should not change, and the Severely Errored Second count will mirror the Errored Second count.

Before You Begin

- Ensure the link is operating alarm-free, and that path conditions are normal.
- For hot-standby and diversity use the System/Controls screen to check that both have default primary and secondary RAC settings. If necessary, reset and ensure Auto / Lock Off is selected.
- For a ring test ensure the node has been switched on for not less than 5 minutes to ensure completion of internal system checks.

Before testing ring protection a node must have been switched on for not less than 5 minutes to ensure completion of internal system checks and updates. Regardless, no protection switch

operation is permitted by the Node within a one to two minute period from power-on, which is also the time typically required before CT log-in is permitted.

Hot-standby and Space Diversity

Tx switching is not hitless. Rx path switching is hitless, providing the assigned online Rx RAC is not withdrawn from its backplane.

Test procedures are provided for:

- Local alarm Tx switch: local Tx switch forced by local Tx alarm.
- Silent alarm Tx switch: local Tx switch forced from remote end by LOS (loss of signal).
- Rx switch.

Local-alarm Tx Switching Procedure

The procedure requires withdrawal, in turn, of RAC cards.

Test procedure:

1. Set a BER test on a DAC trib with a remote loopback. Confirm error-free operation.
2. Withdraw the online Tx RAC (default primary) from its backplane to initiate a Tx switch to the standby Tx (default secondary RAC).
3. Confirm that service is restored within a count of one errored second (possibly two). Refer to Test Measurement on page 1-11.

   When a card is unplugged the NCC status LED will flash orange and a major alarm and a card missing icon will appear in the status bar of all CT screens (bottom of screen).
4. Re-install the primary RAC and confirm that no switch occurs; Tx online remains with the secondary RAC, which is now online for Tx and Rx.
5. Wait for 60 seconds, confirm that NCC and RAC status LEDs are green, then withdraw the online secondary RAC and confirm that service is restored within a count of one errored second (possibly two). At this point the primary RAC is online for Tx and Rx.
6. On completion of the tests ensure the remote loopback is disabled, or will time-out.
7. Use the System/Controls screen to return to default online status (primary RAC Tx and secondary RAC Rx), and if an unequal coupler is used with a hot-standby installation, check that the online Tx is selected for the low-loss side.

Silent Tx Switching Procedure

The procedure uses the Tx mute function to simulate a path failure.

Test procedure:

1. Set a BER test on a DAC trib with a loopback at the remote Node. Confirm error-free operation.
2. Go to the System/Controls screen and select the protected link.
3. Click Tx Mute for the primary Tx online RAC, then click Send. This immediately mutes the Tx to simulate loss of signal to the remote end. The remote Node commands a local Tx switch to the standby RAC (secondary RAC Tx).

4. Confirm service is restored within 20 seconds. At this point the secondary RAC is online for Tx and Rx.

A variable guard time operates to prevent silent Tx switch oscillation. When the guard memory is at zero, a switch typically occurs within 3 seconds. If LOS remains, it switches again after a 5 second guard time. If LOS remains, switching continues but with a doubling of the guard time on each successive switch, to a maximum 320 seconds. When normal link operation is restored (no further switch events), the guard time decrements in reverse time order.

5. Remove the Tx Mute on the primary RAC, and apply to the secondary RAC.
6. Confirm service is restored within 20 seconds. At this point the primary RAC is online for Tx and Rx.
7. On completion of the tests ensure the remote loopback is disabled, or will time-out.
8. Use the System/Controls screen to return to default online status (primary RAC Tx and secondary RAC Rx), and if an unequal coupler is used with a hot-standby installation, check that the online Tx is selected for the low-loss side.

Rx Switching Procedure

The procedure requires disconnection, in turn, of the RAC ODU cables.

Test procedure:

1. Go to Diagnostics > Performance > Start All for the protected link. Ensure unavailable second and errored second counts are at zero.
2. Disconnect the primary RAC ODU cable and confirm there is no change to the zero errored-second count in the performance screen. At this point the secondary RAC is online Tx and Rx.
3. Reconnect the primary RAC ODU cable, wait 30 seconds then disconnect the secondary RAC ODU cable and confirm no change to the errored-second count. At this point the primary RAC is online Tx and Rx.

For the online Tx RAC (default primary), removing its ODU cable also forces a local switch to the standby Tx RAC. This will not affect the outcome of the local Rx switch test.

4. On completion of the tests use the System/Controls screen to return to default online status (primary RAC Tx and secondary RAC Rx), and if an unequal coupler is used with a hot-standby installation, check that the online Tx is selected for the low-loss side.

Frequency Diversity

Tx switching is hitless providing the online Tx RAC is not removed. (Both RACs transmitting but Tx traffic synchronization is controlled by the online Tx RAC).

Rx path switching is hitless.

Tx and Rx Switching Procedure

The procedure requires disconnection, in turn, of the RAC ODU cables.

Test procedure:

1. Set a BER test on a trib with a loopback at the remote Node. Confirm zero errors.
2. Disconnect the ODU cable from the primary RAC and confirm no change to the errored-second count. At this point the secondary RAC is carrying the Tx and Rx traffic.
3. Reconnect the primary RAC ODU cable, wait 30 seconds, check that its online LED is green, then disconnect the secondary RAC ODU cable and confirm no change to the errored-second count. At this point the primary RAC is carrying the Tx and Rx traffic.
4. On completion of the tests use the System/Controls screen to return to default online status (primary RAC Tx and secondary RAC Rx).

Ring Protection

Ring protection (wrapping and unwrapping) is not hitless.

Ensure the ring is not already wrapped (all Nodes operating normally and unwrapped).

- From the local node this can be determined by logging into other nodes on the ring.
- If the ring is wrapped at any point, the test procedure is not valid; full ring protection is only provided for a single break in the ring.

Ring Wrapping Procedure

The procedure uses the Tx mute function to simulate a path failure.

Test procedure:

1. Set a BER test on a looped ring circuit. Confirm zero errors.
2. Go to Diagnostics > System Controls and select the Ring link.
3. Click Tx Mute for the East RAC, then click Send. This immediately mutes the East Tx, and initiates ring wrapping.
4. Confirm that service is restored within a count of one errored second (possibly two). Refer to Test Measurement on page 1-11.
5. Reconnect the ODU cable and confirm normal ring operation returns within 5 minutes. At the instant it returns to normal, un-wrapped operation, service is restored within a count of one errored second (possibly two).
6. Repeat steps 2 to 5 for the West RAC.

For more information on commissioning a ring network, refer to Appendix A.

DAC Protection

DAC/tributary protection (DAC redundancy) is provided by operating two identical DACs as a protected pair.

The protectable DACs are:

- DAC 3xE3/DS3M
- DAC 1x155o
- DAC 2x155o
- DAC 2x155e
- DAC 155oM

Protection Logic

- The DACs are configured as primary and secondary. The primary is the default online DAC for Tx *and* Rx.
- Tx and Rx tribs are independently switched meaning it is possible for one of the DACs to be online Tx, and the other online Rx.
- When a switch occurs, all Tx and/or Rx tributaries are switched to the protection partner.
- Switching is not hitless.
- Two protection options are provided, tributary protection, or always-on:
  - Tributary Protection (TT):

“Y” cables connect the paired DACs to customer equipment.

In the Rx direction (from the customer) both DACs receive data, but only the online Rx DAC sends this data to the TDM bus.

In the Tx direction, the online Tx DAC sends data to customer equipment, the other mutes its Tx line interface.

- Tributary Always On (TA):

Separate cables connect each DAC to customer equipment.

In the Rx direction (from the customer) both DACs receive data, but only the online Rx DAC sends this data to the TDM bus.

In the transmit direction both DACs send data to customer equipment, and the customer equipment switches between these two “always on” tributaries.

TA protection must be used where two 9500 MXC INU/INUes are to be interfaced using protected DACs.

DAC Protection Test Procedure

Assumes a starting point of:

- Primary DAC is online for trib Tx and Rx, which is the configuration default.
- Tributary Protection (TT) is used.

The procedure is based on application of a trib BER test using an external tester and confirming correct protection operation by withdrawing and inserting, in turn, each DAC of the protection pairing.

The BER tester provides measurement of service interruption with an errored-second count resolution. Refer to Test Measurement on page 1-11.

Test Procedure:

1. Apply a BER test on a trib with a radio-facing loopback at the remote DAC.
   - Use an external BER tester with connection to the DAC pair via “Y” trib-cable sets.
   - Ensure the radio-facing loopback at the remote DAC pairing is applied to the online Tx and Rx, and that it is set for the correct trib. If Tx and Rx are on separate DACs, for example Tx is on primary and Rx on secondary, a radio facing loopback must be applied to both.

     This is confirmed and applied from the System/Controls screen for the remote DAC pairing. It is not necessary to apply a Tx and Rx *lock* to the online DAC(s), however application of the loopback will raise an AIS alarm.

     CT screens for local and remote Nodes can be dragged to different parts of your PC screen for easier management.
2. Withdraw the local online (default primary) DAC and confirm that service is restored within a count of one errored second (possibly two). At this point the secondary DAC is online for trib Tx and Rx.

   When a card is unplugged the NCC status LED will flash orange and a major alarm and a card missing icon will appear in the status bar of all CT screens (bottom of screen).
3. Re-install the primary DAC and confirm that no Tx or Rx trib switch occurs; tribs remain online with the secondary DAC.
4. Wait for 30 seconds, confirm that NCC and DAC status LEDs are green, then withdraw the online secondary DAC and confirm that service is restored within a count of one errored second (possibly two). At this point the primary DAC is back online for trib Tx and Rx.
5. On completion of the tests ensure the remote loopback(s) are disabled, or will time-out.

The tests can also be completed for a situation where the local DAC pairing has one DAC online for Tx and the other for Rx. Use the System/Controls screen commands to set the required online combination before commencing the tests.

NCC / NPC

The NPC provides redundancy for NCC TDM bus clock and power supply functions.

- For an NCC bus clock failure the NPC provides protection for tributary and auxiliary traffic; alarm I/O is not protected.
- Protection switching is not hitless for a TDM bus clock failure. The restoration time is 100 ms maximum, during which time all traffic on the node is affected.

- Protection is hitless for a power supply failure. If the NCC converter or one of its supply rails fails, the NPC takes over without interruption. And vice versa. (The NPC provides secondary power rails; there is no *switching* backwards and forwards).

When the TDM bus clock has switched to NPC control, it does not automatically revert to NCC control on restoration of the NCC. Return to NCC control requires either withdrawal/failure of the NPC, or use of diagnostic commands in the System/Controls screen.

Manual control of bus clock switching allows customer selection of a time when it least impacts traffic. There is no operational need to always revert to NCC for bus clocking.

If bus clocking is with the NPC, then the NCC can be removed and restored without impacting traffic. If the clock is with the NCC, the NPC can be removed and restored without impact.

NCC/NPC Protection Test Procedure

This procedure uses the built-in BER tester or an industry-standard hand-held tester that provides a one-second error count resolution. Refer to Test Measurement on page 1-11.

1. Set a BER test on a trib with a local or remote loopback. Confirm zero errors.
2. Ensure the NPC Status LED is green and its Protect LED is unlit.
3. Disconnect the NCC -48 Vdc supply connector and confirm a count of one errored second (or possibly two errored seconds). The NPC Protect LED is green, indicating the bus clock has switched to NPC control.
4. Withdraw the NCC from its backplane and confirm no further errors.

As soon as power to the NCC is disconnected, CT communication is lost and screens will be frozen as at the time of loss. Normal communication will not return until power is restored and the NCC has completed internal status checks, which typically requires up to two minutes.

5. Restore the NCC and confirm no further errors. Control of the TDM clock remains with the NPC as indicated by a green NPC Protect LED.
6. Wait at least 3 minutes *after* restoring the NCC (typically one minute beyond return of CT communications), reset the BER test, then withdraw the NPC and confirm a count of one errored second (or possibly two errored seconds).

When the NCC is restored to an operational INU/INUe, its software checks the status and verifies the configuration of each slot as recorded by the NPC. This process takes about 3 minutes. If insufficient time is allowed, then the NCC may force a hard reset on one or more slots, which interrupts traffic *on those slots*.

Always wait at least 3 minutes after power-on or restoration of an NCC before removing its NPC.

7. Restore the NPC and confirm zero errors. The NPC Status LED becomes green, and its Protect LED is unlit.

Commissioning Records

The As Built Report screen within CT provides access to an as-built report file for the Node/Terminal, for saving to a folder on your PC. The file is in a csv, Excel compatible format.

Use this report to capture configuration and other site/installation data for appending to a final commissioning report.

Support is available from Alcatel-Lucent to assist pre and post installation planning, as-built, and record keeping processes.

Chapter 2. Troubleshooting

This chapter covers the following topics:

Introduction

9500 MXC CT

When on-site, CT is the primary troubleshooting tool. For information on CT diagnostic screens refer to Diagnostics, Volume IV, Chapter 15.

User Prerequisites

This guide is for use by personnel who have attended a 9500 MXC training course.

Alcatel-Lucent Technical Support

North America	Other Countries
Alcatel-Lucent North America Wireless Transmission Division Customer Technical Assistance Center Phone: 888 252 2832 from within USA or Canada (free) +1 613 784 6100 ml.tac.support@alcatel.com	Please refer to your support agreement.

Troubleshooting Process

This section provides guidance on:

- Remote Diagnostics Using Remote Management on page 2-2
- Before Going to Site Checklist on page 2-2
- Troubleshooting Basics on page 2-3
- Troubleshooting Path Problems on page 2-5
- Troubleshooting Configuration Problems on page 2-6
- Auto Insertion of AIS or PRBS on Tribs on page 2-8

Remote Diagnostics Using Remote Management

Where a 9500 MXC is network managed under and EMS or NMS, use the features available to view indications of:

- Alarm severity
- Nature/type of alarm
- Which services are affected
- Which paths or devices should be checked in detail
- Only where it is not possible to see a network beyond a full break, and therefore not possible to see the far end of a link, does it become less certain as to which site carries the faulty equipment, or if it is an equipment fault as distinct from a full path fade. However, by looking at the event browser prior to the fault it may be possible to narrow down the options.

Before Going to Site Checklist

Where possible, before going to site obtain the following information:

- Does the fault require immediate attention?
- Determine who is the best-placed person to attend the fault.
- Confirm the nature and severity of the reported fault, its location, 9500 MXC type (Node or Terminal), frequency band, high/low end ODU, capacity, modulation and configuration (nonprotected, protected, diversity, ring). Ask:
  - Is just one 9500 MXC link affected, or a number of links in the same geographical area?
  - Is the path down completely or is traffic passing but with a BER alarm?
  - Is only one or a number of tributaries affected?
  - Could the fault be in the equipment connected to 9500 MXC, rather than in 9500 MXC? Are there alarms on other, connected equipment?
  - Is it a hard or intermittent fault?
  - Do alarms *confirm* which end of an alarmed link is faulty?
- Could the weather (rain, ice, high wind, temperature) be a factor in the reported fault?

If the fault suggests a rain fade or other weather related fade condition and it matches the prevailing weather conditions, do not take any action until the weather abates.

- Does link history suggest any fault trends?
  - Does the fault history for the link indicate a likely cause?
  - Is the 9500 MXC link newly installed?
  - Has there been any recent work done on the link?
- Ensure that you have with you:
  - Appropriate spares. Where an equipment failure is suspected, these should include replacement modules/plug-ins and ODU. If an ODU is suspected then local/national climbing safety requirements must be adhered to.
  - A laptop PC loaded with CT, and either an Ethernet or V.24 connection cable. If an Ethernet connection is to be used, you need the 9500 MXC Node/Terminal IP address and also the addresses for any remote sites to be accessed.
  - If login security has been enabled, you will need the 'engineer' password for the local and remote sites to be accessed.
  - Any special test equipment that may be needed, such as a BER tester.
  - Toolkit.
  - Key(s) for access to the site.

Troubleshooting Basics

This section provides general guidance on 9500 MXC troubleshooting:

- **Check front-panel LED indications**. These provide summary alarm indications, which can help narrow down the location and type of failure. Refer to 9500 MXC LEDs on page 2-9.
  - Where a Status LED on a plug-in is off (unlit), but power to the INU/INUe is confirmed by LEDs on other plug-ins, check the seating of the affected plug-in.
- **Check System Summary screen**. When logging into 9500 MXC with CT, the opening screen is System Summary. Use the information provided to check the alarm location, its severity, and problem type:
  - Mouse-over problem icons for a description of the problem type.
  - Double clicking a module takes you to the relevant CT Alarms screen. Refer to CT Alarms on page 2-15. Use these alarms with the information provided on probable cause and recommended actions, to help determine the real cause of a failure and the action to take.
- **Check the basics first**.
  - For example, if multiple alarms are present, and these include power supply voltage or hardware alarms, always check their cause before looking at resultant down-stream path failure or path warning alarms.

  - Similarly, if a path-related failure is indicated (no hardware or software alarms), investigate the path. Go to the CT History screen (15 minute view), and the Events screen to check supporting data, such as low RSL and incidence of intermittent pre-failure BER alarms, which if present are evidence of a path-related failure. Refer to Troubleshooting Path Problems on page 2-5 for more information.
- **Check if symptoms match the alarm**. Alarms reflect the alarm state, but in exceptional circumstances an alarm may be raised because of a failure to communicate correctly with the alarm source, or a failure in alarm management processing. Always check to see if symptoms match the alarm, using LED indications and CT Diagnostics.
- **Check if recent work may be a cause**. Recent work at the site may be a cause or contributing factor. Check for a configuration change, software upgrade, power recycling (reboot), or other site work:
  - Many hardware alarms are only initiated as a loss-of-communications alarm during a reboot, software upgrade, or reconfiguration. By not being able to communicate with the NCC/IDU, their settings cannot be loaded. The fault may be at the hardware device (most likely), communications to it, or the NCC/IDU.
  - Hardware/software compatibility alarms will be raised when a new plug-in is installed that needs a later version of 9500 MXC software.
  - A configuration not supported alarm will be raised if the installed license is incompatible with the configured RAC/radio capacity.
  - NCC slot management alarms will be raised when a plug-in is installed in a slot that has been configured for a different plug-in, or a configured plug-in is missing.
- **RAC before an ODU**. If there is doubt about whether a fault is in a RAC/IDU, or ODU, always replace the RAC/IDU first; it is quicker and easier.
- **Hot-pluggable**. INU/INUe modules are hot-pluggable. There is no need to power-down before replacing, but traffic will be lost unless the plug-in is protected. Unplugging the NCC will cause all traffic to be lost, unless protected by an NPC.
- **Plug-in restoration time**. Ensure adequate time is allowed for services to resume when a plug-in is replaced:
  - When an option-slot plug-in is replaced it should resume operation within 60 seconds. Check for a green Status LED, and for a RAC, a green Online LED. An exception is where the replaced RAC is one of a protected pair, and its partner is online for Tx and Rx. In this situation the online LED of the replaced RAC will become unlit, indicating it is ready to protect for Tx and/or Rx.
  - Unless protected by an NPC, when an NCC is replaced it is the same as booting from cold, meaning up to two minutes may be needed for all LED indications to stabilize, and for CT communications to re-establish.
  - If an NCC is protected by an NPC, and the TDM bus clock is with the NCC, there is a momentary traffic hit (less than one errored second) as the clock switches to NPC control. When an NCC is re-inserted, there is no traffic hit, as the clock remains with the NPC until forced to return to the NCC using the CT Systems/Control screen, or by unplugging the NPC.

There is no operational requirement to return a clock from NPC to NCC; should the NPC fail it auto-switches the clock to the NCC.

- **Additional NCC-specific restoration times**. While traffic should return to normal within two minutes for a rebooted node, there are two situations requiring additional time:
  - NCC software requires approximately three minutes to verify the status and configuration of all plug-ins and ODUs. When an NCC is withdrawn and re-inserted during an NCC/NPC protection test, the NCC must be allowed not less than 3 minutes to complete this task before subsequent NCC removal. For more information refer to Commissioning, Chapter 1.
  - Where dynamic NMS routing is configured, allow not less than 5 minutes for the 9500 MXC router address-table auto-update to complete.

Troubleshooting Path Problems

A path-related problem, with the exception of interference, is characterized by traffic being similarly affected in both directions. Generally, if you are experiencing only a one-way problem, it is not a path problem.

A path extends from ODU antenna port, to ODU antenna port.

- Normally a path problem is signalled by a reduced RSL, and depending on its severity, a high BER.
- Only in worst case situations, such as an antenna knocked out of alignment, will a path fail completely, and stay that way.
- For weather-related problems, such as rain or ducting, the path problem will disappear as the weather returns to normal.

Refer to:

- Path Problems on a Commissioned Link on page 2-5
- Path Problems on a New Link on page 2-6

Path Problems on a Commissioned Link

A path problem on an existing link, one that has been operating satisfactorily may be caused by:

- **Weather-related path degradation**

  If BER alarms are fleeting / not permanent and RSL returns to its normal, commissioned level after the alarm is cleared, rain, diffraction, or multipath fading is indicated. Rain fade is the likely cause of fade for links 13 GHz and higher. Diffraction and multipath/ducting for links 11 GHz and lower. If these alarms are persistent, there could be a problem with the link design or original installation.

- **Changed antenna alignment or antenna feed problem**

  If RSLs do not return to commissioned levels after a period of exceptionally strong winds, suspect antenna alignment.

  Also, check the antenna for physical damage, such as may occur with ice-fall. For a remote-mounted ODU, check its antenna feeder.

- **New path obstruction**

Where all other parameters check as normal, *and* the path has potential for it to be obstructed by construction works, view/survey the path for possible new obstructions.

- **Interference from other signal sources**

  Interference usually affects traffic in just one direction. *Unlike other path problems, RSL is not affected*. If suspected, check for new link installations at the same site or in the same geographical area. Ultimately a spectrum analyzer may have to be used to confirm interference, which is not an easy task given the need to connect directly to the antenna port, after removing the ODU.

Path Problems on a New Link

For a new link, potential problems can extend to *also include*:

- **Incorrect antenna alignment**

  One or both antennas incorrectly aligned. For an alignment procedure, refer to Volume III, Chapter 5.

- **Mismatching antenna polarizations**

  Given a typical polarization discrimination of 30 dB, for most links a mismatched polarization setting means it would not be possible to capture a signal to begin the antenna alignment process.

- **Incorrect path calculations**

  If the RSLs are too low or too high, antenna alignment is correct, and Tx power settings are correct, check the path calculations used to determine the link performance. A good calculation match is +/- 2 dB. Disagreements in excess of 3 dB should be investigated.

- **Reflections**

  Reflection (path cancellation) problems may not have been picked up at the path planning stage, particularly if the survey was a simple line-of-sight. If suspected, resurvey the path.

Troubleshooting Configuration Problems

Configuration problems should only occur during the set up of a new link, or reconfiguration of an existing link. The more common problems may be broadly categorized as:

- **General compatibility problems**

  The two alarms that may activate are Configuration Not Supported, and SW/HW Incompatible:

  - **Configuration Not Supported and/or NCC Slot Management**: The plug-in installed is incorrect for the configuration, such as DAC 16x, AUX, or a RAC installed in a slot configured for a DAC 155o. Check the configuration required against the plug-in installed. Change either the configuration, or use the CT Layout screen to select/accept the installed plug-in. Similarly, check that the RAC/ODU pairing is correct. A RAC 30 or RAC 40 must be paired with an ODU 300. A RAC 10 must be paired with an ODU 100.

  - **SW/HW Incompatible**: Typically raised when new hardware is plugged into an existing INU that has software from an earlier release. To remove the alarm, compatible 9500 MXC software is required; install the latest software.

- **RAC compatibility**

The RAC 30v3:

- Is not over-air compatible with a RAC 30v1.
- Is compatible with RAC 30v2 providing SW release 3.4 or later is installed on the INU/INUe.

For more information refer to RAC 30 and RAC 3X on page 3-19 of Volume II, Chapter 3.

(RAC 30v3 requires SW release 3.3 or later)

- **Incorrect circuit connections**

No alarms are activated for incorrect circuit connections. An incorrect assignment means the expected end-to-end circuit connectivity will not happen. Re-check circuit assignments for all nodes carrying the lost circuit(s).

CT only allows valid cross-connections within a node; circuit conflicts within a node are prevented.

Take extra care when configuring ring circuits. For guidance refer to Appendix A.

Where the problem is not obvious, use a bus-loopback BER test to track a single circuit through a 9500 MXC network, beginning at the node closest to the node applying the BER test.

- **Incorrect circuit naming and commissioning**

All traffic-carrying circuits must be named, within the Circuits screen, for the bus loopback capability to operate:

- Circuits on the bus are identified by their circuit name, as applied in the CT Circuits screen.
- The name applied to a circuit must be identical at each node carrying that circuit. If not, circuit identification for bus loopback purposes is very difficult.

The commissioning tick boxes in DAC and AUX plug-in screens must be set correctly:

- If not ticked, when valid traffic is detected on a configured circuit, a warning alarm is displayed: Trib (n) Uncommissioned Traffic.
- Similarly, if a box is ticked but no traffic is to be carried, an alarm is displayed: Trib (n) LOS.

- **Incorrect / incompatible trib settings**

Trib line interface settings incorrect, or line levels incompatible. While no alarm activates for an incorrect setting, its effect may result in line levels being too low (LOS alarm), or too high, resulting in a high BER:

- DAC 16x and DAC 4x. Impedance options must be set correctly for an E1 selection. Encoding and line length must be set for a DS1 selection. For a DS1 selection on the DAC 16x, the first 8 tribs must be set for AMI **or** B8ZS; the subsequent 8 tribs can be set for a different selection, but must all be set for the same selection, AMI **or** B8ZS.
- Line levels to/from connected equipment must be compatible. While not usually a problem for PDH connections, it is not uncommon on optical tribs.

- **ATPC settings**

  Ensure ATPC settings are correct, specifically that the target fade margin allows adequate headroom for local Tx power, while ensuring an adequate fade margin. Refer to ATPC Guidelines, Volume IV, Node and Terminal Plug-ins, for set up information.

  - ATPC must not be enabled for RAC 40/4X XPIC configurations.

  ATPC must not be enabled where, with the remote-end Tx muted, the RSL indicates the presence of interfering signals (RSL will be at or below threshold with no interferer present).

There is no alarm action to indicate an incorrect/illogical set up.

- **Incorrect plug-in specific configuration**

  This comment applies more to the highly configurable plug-ins, such as DAC ES, DAC 155oM, and AUX. The flexibility of setup options means more care is needed in their configuration.

- **Configuration Locked**

  In the unlikely event a 9500 MXC device does not respond to normal CT commands the reset options include:

  - Power recycle: remove power to the radio off, pause for 10 seconds, and power-on.
  - Software reset. Refer to Software Management, Volume IV, Chapter 13.
  - Factory reset. This is an option for IDUs fitted with a recessed front panel switch, such as IDUsp. Refer to For information on the software reset function, refer to Advanced Management on page 15-61 of Volume IV., Volume II, Chapter 2.

Auto Insertion of AIS or PRBS on Tribs

Refer to Auto Insertion of AIS or PRBS on Tribs on page 15-48, Volume IV, Chapter 15.

9500 MXC LEDs

This section provides information on 9500 MXC front-panel LEDs.

- Each INU/INUe plug-in has one or more tri-color LEDs.
- The IDU has two tri-color status LEDs.
- LED states are resolved using the following descending priority order:
  - Red
  - Orange flashing
  - Green
- Status LEDs indicate green for normal operation, orange flashing for a configuration problem or diagnostic-mode selection, and red for a critical/major problem.
- 9500 MXC software updates LED states at least once every second.
- Fleeting LED states are extended by software to ensure that a user has time to recognize a change in status. A red LED state will remain active for a minimum of 500 ms.
- A green RAC On-Line LED indicates it cannot be removed without impacting customer traffic. An Online LED should only be off (unlit) for an *offline* RAC in a protected configuration *where both Tx and Rx online have been assigned to the other RAC*. (The default configuration has the primary RAC online transmitting and the secondary online receiving, in which case *both* RACs will have a green Online LED).
- At start up, NCC Test and Status LEDs will initially be red, then flashing orange, until the software can apply the correct states.
- When a plug-in is inserted into a powered INU/INUe, its Status LED will remain red until software can apply the correct state. Any other LEDs on the plug-in will remain off until the software can apply the correct states.
- All RAC, DAC and AUX LEDs will remain unchanged during a *soft reset* until the software can apply the correct states.

A normal INU/INUe or IDU will have all LEDs green or unlit. All Status LEDs must be green.

Refer to:

- INU/INUe LEDs on page 2-10
- IDU LEDs on page 2-14

INU/INUe LEDs

Table 2-1 summarizes INU/INUe LED behavior. Empty cells in this table indicate that the associated LED state is not used.

Table 2-1. INU/INUe LED Alarm Table

LED State	LED							
	NCC Status	NCC Test	DAC Status AUX Status	RAC Status	RAC Online	NPC Status	NPC Protect	FAN
Off (unlit)	INU/INUe power off	INU/INUe power off	INU/INUe power off	INU/INUe power off	INU power off, or ODU is muted and RAC is not driving the TDM bus, or RAC is wrapped	INU/ INUe power off	Off-line	Normal operation
Green	Normal operation		Normal operation	Normal operation	Transmitter is online, or RAC is driving (Rx) the TDM bus	Ready to protect	On-line (driving TDM bus clock)	
Orange Flashing	Configuration corrupt or not supported, or incompatible software	Diagnostic (test) mode active	Configuration corrupt or not supported, or incompatible software	Configuration corrupt or not supported, or incompatible software				
Red	Critical alarm		Critical alarm	RAC or ODU critical alarm	No Rx signal from ODU	Critical alarm		Critical alarm

The event used to trigger an LED is generally at a higher (summary) hierarchy level than that available within the CT Alarms screen. For example, an NCC status alarm can be triggered by a component failure, but to get detail on what component failed, recourse to CT is required.

One or multiple alarms may trigger an LED. For example, an NCC status alarm can be triggered by a component failure, *or* power supply failure, *or* TDM clock failure.

Table 2-2 maps LED *alarm* indications for INU/INUe plug-ins against possible causes and recommended actions.

- Where recommended actions states CT should be used to see alarm details, refer to CT Alarms on page 2-15.

Table 2-2. INU/INUe LED Alarm Triggers

LED	Indication	Possible Causes	Recommended Action
NCC Status	Orange flashing:	Either: • Configuration corrupt • Configuration not supported • Slot management alarm • Software loading (new 9500 MXC software is being loaded) • TDM clock *locked* to NPC • Incompatible license	Where the cause is not obvious, use CT to see detail at a lower alarm level.
	Red:	Either: • Component failure • Power supply failure • NCC TDM clock failure	Repair action is required. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.
NCC Test	Orange flashing:	Diagnostic mode selected/ active.	Check/remove mode using CT System Controls screen.
DAC Status	Orange flashing:	Either: • Configuration corrupt • Configuration not supported • Hardware / software incompatible	9500 MXC software does not support the (new) DAC. Install latest 9500 MXC software.
	Red:	Either: • Trib LOS • FPGA software load failure • EEPROM failure • Line Interface Unit failure • Clock generator failure	For a loss of signal on a commissioned trib check the trib cable connection and the status of the signal from the attached equipment. Repair action is required for a SW/HW failure. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.
RAC Status	Orange flashing:	Either: • Configuration corrupt • Configuration not supported • Hardware / software incompatible • Software loading	9500 MXC software does not support the (new) DAC, *or* 9500 MXC software is currently being installed via CT. Where new software is not being installed, new (latest) software must be installed to remove the incompatibility.

LED	Indication	Possible Causes	Recommended Action
	Red:	Either: • Component failure • Power supply failure • ODU comms failure • Tx path failure • Rx synthesizer not locked • Rx IF synthesizer not locked • Tuner not locked	Repair action is required. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.
RAC Online	Off (unlit):	RAC is one of a protected pair, and is currently offline. A ring-wrapped RAC that is operating error-free but waiting for the error-free timer or time-of-day timer to time out before unwrapping, displays an unlit Online LED.	Providing its Status LED is green and its paired RAC is not alarmed (both Status and Online LEDs are green), no action is required. Check online configuration in System Controls screen. For a ring-wrapped RAC you can check the time to go before unwrap by checking the countdown timer in the System/Controls screen.
	Red:	Either: • Demodulator not locked • RAC cable demodulator not locked • ODU cable modulator not locked	Unlocked demodulators indicate a receive path failure, which may or may not be equipment related. Use CT to see detail at a lower alarm level.
AUX Status	Orange flashing:	Either: • Configuration corrupt • Configuration not supported • Hardware / software incompatible	9500 MXC software does not support the (new) AUX. Install latest 9500 MXC software.
	Red:	• Component failure	Repair action is required. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.
NPC Status	Orange flashing:	TDM clock is *locked* to NPC	Lock set in CT System Controls screen. Unlock using the same screen.

LED	Indication	Possible Causes	Recommended Action
	Red:	Either: • FPGA software load failure • EEPROM failure • Clock generator failure • Redundant power supply failed or one or more rail voltages outside limits. • NPC TDM clock error or failure	Repair action is required. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.
FAN	Red:	Fan failure (one or both axial fans)	Replace the FAN.

IDU LEDs

Table 2-3 maps IDU LED alarm indications against possible causes and recommended actions.

For a normal IDU, both LEDs will be green.

At startup, Status LEDs will initially be red, then flashing orange, until the software can apply the correct states.

LEDs will remain unchanged during a soft reset until the software can apply the correct states

Table 2-3. IDU LED Alarm Triggers

LED	Indication	Possible Causes	Recommended Action
IDU Status	Orange flashing:	Either: • Configuration corrupt • Configuration not supported • Software loading • Diagnostic mode selected	Where the cause is not obvious, use CT to see detail at a lower alarm level.
	Red:	Either: • Trib LOS • IDU component failure • Power supply failure • Modulator not locked • Demodulator not locked • IDU cable demodulator not locked • Aux channel clock failure	For a loss of signal on a commissioned trib check the trib cable connection and the status of the signal from the attached equipment. An unlocked demodulator indicates a receive path failure, which may or may not be equipment related. Repair action is required for a SW/HW failure. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.
ODU Status	Orange flashing:	Either: • Diagnostic mode selected/ active • Software loading (new 9500 MXC software is being loaded)	Where cause is not obvious, use CT to see detail at a lower alarm level.

LED	Indication	Possible Causes	Recommended Action
	Red:	Either: • ODU component failure • ODU power supply failure or current/voltages outside limits • ODU communications failure • Tx synthesizer not locked • Transceiver Tx failure • Tx power failure • Tx If synthesizer not locked • Tuner not locked • ODU cable demodulator not locked	Repair action is required. The failure may or may not be causing traffic disruption. Use CT to see detail at a lower alarm level.

CT Alarms

This section introduces CT alarms, and provides links to CT Alarm Descriptions, which include a description, probable cause, recommended actions, and where appropriate, additional information.

Refer to:

- 9500 MXC Node Alarms on page 2-16
- 9500 MXC Terminal Alarms on page 2-25

Procedure for Viewing Alarms

Alarm descriptions are generally provided for tree-end alarms only.

Viewing from within CT. Click on the Help for Alarm tab in the Diagnostics > Alarms screen.

Viewing from within this user manual. Click on an alarm to view its description.

- If you are viewing from Online Help, you can return to this page by clicking the left arrow at the top of the page.
- If you are viewing within an online pdf copy of the User Manual, you can return to this page by clicking the left *arrowhead* in the toolbar (ensure 'view history' is selected in the toolbar options).

- **Viewing from a print copy of the 9500 MXC User Manual**. Refer to Appendix B.

Several alarms are common to a number of the plug-ins. Within Appendix B. they are only shown once, in order of first appearance, and their heading is suffixed by '(All)'.

All alarms listed within a heirachy may not be activated. The CT Alarms screen only presents those alarms that are applicable to the selected module.

9500 MXC Node Alarms

The following listing shows 9500 MXC Node alarm-tree hierarchies.

Only alarms relevant to the selected plug-in are displayed in its Alarms screen hierarchy. However the following listings list all alarms pertinent to all RAC and DAC versions. For example the RAC listing includes all alarms for RAC 10, and RAC 30v1/v2/v3, but not all alarms apply to all RAC variants.

Refer to:

- NCC Alarm Hierarchy on page 2-16
- RAC Alarm Hierarchy on page 2-18
- DAC Alarm Hierarchy on page 2-20
- AUX Alarm Hierarchy on page 2-21
- NPC Alarm Hierarchy on page 2-21
- DAC ES Alarm Hierarchy on page 2-22
- DAC GE Alarm Hierarchy on page 2-23
- DAC 155oM Alarm Hierarchy on page 2-24
- FAN Alarm Hierarchy on page 2-25

NCC Alarm Hierarchy

NCC

Hardware

Component failure

- FPGA Software Load Failure (All)
- RAM Failure
- Flash Card Failure
- Fixed Flash Failure
- ADC Failure (NCC/IDU)
- RTC Failure
- Clock Generator Failure (NCC/IDU)

Power supply

- +5V Digital Supply (NCC/IDU)
- -5V Digital Supply (NCC/IDU)
- +3.3V Digital Supply (NCC/IDU)
- +2.5V Digital Supply (NCC)
- -48V Supply (NCC/IDU)
- +1.8V Digital Supply (NCC/IDU)
- +1.2V Digital Supply (NCC)
- Temperature
- Expansion NCC Communications Failure
- Fan Failure (NCC)
- Fan Plug-in Missing
- NCC TDM Clock Failure

Software

- Configuration Corrupt
- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)
- Date and Time Not Set

Slot Management

Slot n

- Slot Plug-in Missing
- Slot Plug-in Incorrect

Diagnostic

- TDM Clock Locked to NCC
- Circuit Loopback

NMS

- NMS Configuration Error

NMS over AUX comms failure

- NMS Over AUX Channel n Failure

NMS over E1 comms failure

- NMS Over E1 Channel n Failure

NMS over E1 sync failure

- Source E1 Frame Sync Loss
- NMS Extraction Failure

RAC Alarm Hierarchy

RAC

Hardware

Component failure

- RAC component failure
- Fuse Blown
- FPGA Software Load Failure (All)
- EEPROM Failure (All)
- Clock Generator Failure (RAC)
- Modulator Failure
- Demodulator Failure (RAC)
- Cable Demodulator Failure (RAC10/IDU)

ODU component failure

- ADC Failure (ODU)
- FPGA Software Load Failure (All)
- Clock Generator Failure (ODU 100)
- Demodulator Failure (ODU100)
- Tx NCO Failure (ODU100)
- Cable Demodulator Failure (ODU100)
- Cable NCO Failure (ODU100)

Power supply

- RAC -48V Supply
- ODU -48V Supply
- Temperature
- IF Temperature
- Power Detector Temperature
- Transceiver RX Temperature

ODU Communications Failure

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)
- Remote Communications Failure

ODU

- Software/Hardware Incompatible (All)

Diagnostic

- Bus Facing IF Loopback
- TX Power Mute

- ATPC Disabled
- TX Manual Lock
- RX Manual Lock
- Bus Facing Digital Loopback
- ODU XPD Measurement Mode
- TDM Bus Write Override

Radio link

Traffic Path Down

Path failure

Tx path failure

- TX Synthesiser Not Locked
- Transceiver TX Failure
- TX IF Synthesiser Not Locked
- Modulator Not Locked
- RAC TX Cable IF Synth Not Locked
- ODU TX Cable IF Synth Not Locked
- ODU TX Cable Unplugged

Rx path failure

- ODU TX Cable Unplugged
- RX IF Synthesiser Not Locked
- Demodulator Not Locked
- RAC/IDU Cable Demodulator Not Locked
- Tuner Not Locked
- ODU Cable Unplugged
- RAC RX Cable IF Synthesiser Not Locked

Path warning

Rx path warning

Error warning

- ESR Threshold Exceeded
- SESR Threshold Exceeded
- 10-3 BER Threshold Exceeded
- 10-6 BER threshold exceeded
- XPIC Cable Unplugged

DAC Alarm Hierarchy

DAC

Hardware

- Component failure
- FPGA Software Load Failure (All)
- EEPROM Failure (All)
- LIU Failure
- Clock Generator Failure (DAC)

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)

Diagnostic

Traffic

Tributary

Tributary n

- Trib n Output AIS Enabled
- Trib n Radio Facing Loopback
- Trib n Line Facing Loopback
- Trib n Link Test Enabled

Protection

- TX Manual Lock
- RX Manual Lock

TDM Bus Write Override

Tributary

Tributary failure

Tributary n

- TX Manual Lock

Tributary warning

Tributary n

- Trib n Output Failure
- Trib n AIS

AUX Alarm Hierarchy

AUX

Hardware

Alarm inputs

- Alarm Input (n)

Component failure

- FPGA Software Load Failure (All)

Auxiliary clock fail

- Auxiliary Channel (n) Clock Failure

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)

Diagnostic

Auxiliary

Auxiliary 1

- AUX (n) Bus Facing Loopback
- AUX (n) Line Facing Loopback

Auxiliary 2

- AUX (n) Bus Facing Loopback
- AUX (n) Line Facing Loopback

Auxiliary 3

- AUX (n) Bus Facing Loopback
- AUX (n) Line Facing Loopback

TDM Bus Write Override

NPC Alarm Hierarchy

NPC

Hardware

Component failure

- FPGA Software Load Failure (All)
- EEPROM Failure (All)
- Clock Generator Failure (NPC)

Redundant power supply

- +5V Digital Supply (NPC)
- +3.3V Digital Supply (NPC)
- -5V Digital Supply (NPC)

- -48 Vdc Supply (NPC)
- NPC TDM Clock Failure

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)

Diagnostic

- TDM Clock Locked to NPC

DAC ES Alarm Hierarchy

DAC ES

Hardware

Component failure

- FPGA Software Load Failure (All)
- EEPROM Failure (All)
- Switch Access Failure

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)

Diagnostic

Traffic

Channel - Channel n

- Channel PRBS Test Active
- Channel Loopback Active

Port-Port n

- Port Loopback Active
- Port Monitoring Active

- *.Direct Link Active*

TDM Bus Write Override

Traffic

Transport channel failure

Channel

- Transport Channel (n) Switch Packet Errors

Port failure

Port n

- Link Failure (DAC ES, DAC GE)

Dropped frames

- Dropped Frames Ratio (DAC ES, DAC GE)

DAC GE Alarm Hierarchy

DAC GE

Hardware

Component failure

- FPGA Software Load Failure (All)
- EEPROM Failure (All)
- LIU Failure
- ICPU Failure

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)
- ICPU Software Failure

Diagnostic

Traffic

Channel - Channel n

- Channel PRBS Test Active
- Channel Loopback Active

Port - Port n

- Port Loopback Active
- Port Monitoring Active

- .Direct Link Active

TDM Bus Write Override

Traffic

Transport channel failure

Channel n

- Transport Channel (n) Switch Packet Errors
- Link Down
- Link Degraded

Port failure

Port n

- Link Failure (DAC ES, DAC GE)

Dropped frames

- Dropped Frames Ratio (DAC ES, DAC GE)

DAC 155oM Alarm Hierarchy

DAC 155oM

Hardware

Component failure

- FPGA Software Load Failure (All)
- EEPROM Failure (All)
- LIU Failure
- Clock Generator Failure (DAC)
- PMC TEMAP Access Failure
- PMC OHT Access Failure

Software

- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)
- Remote Communications Failure

Diagnostic

Traffic

Line Tributary n (1.5)

- Trib n Output AIS Enabled
- Trib n Radio Facing Loopback
- Trib n Line Facing Loopback

- Bus Trib z Loop-Back Enabled
- Ring Manual Lock

TDM Bus Write Override

Traffic

Line Tributary n (1.5)

- Trib n LOS
- Trib n Uncommissioned Traffic

SONET/SDH Frame

Line / Multiplex Section

- RDI In
- AIS In
- Signal Degrade BER
- Signal Fail BER

Regenerator Section

- LOS
- LOF

- OOF

Path Section

High Order Path, Container x (VC3/STS-1,VC4)

- Container x AIS
- Container x LOP
- Container x LOM
- Container x RDI
- Container x RPSLM

• Low Order Path, Container/Trib y in Alarm

FAN Alarm Hierarchy

FAN

Hardware

• Fan Failure (FAN)

9500 MXC Terminal Alarms

The following listing shows 9500 MXC Terminal alarm-tree hierarchy. Click only on tree-ends, *in italics*, to view alarm details.

Refer to:

• IDU Alarm Hierarchy on page 2-25
• Radio Alarm Hierarchy on page 2-26
• Tributary Alarm Hierarchy on page 2-28
• AUX Alarm Hierarchy on page 2-28
• Ethernet Alarm Hierarchy on page 2-29
• Terminal FAN Alarm Hierarchy on page 2-29

IDU Alarm Hierarchy

IDU

Hardware

Component failure

• FPGA Software Load Failure (All)
• RAM Failure
• Flash Card Failure
• Fixed Flash Failure
• ADC Failure (NCC/IDU)
• RTC Failure
• Clock Generator Failure (NCC/IDU)

Power supply

- +5V Digital Supply (NCC/IDU)
- -5V Digital Supply (NCC/IDU)
- +3.3V Digital Supply (NCC/IDU)
- +2.5V Digital Supply (NCC)
- -48V Supply (NCC/IDU)
- +1.8V Digital Supply (NCC/IDU)
- +1.2V Digital Supply (NCC)

Software

- Configuration Corrupt
- Configuration Not Supported (All)
- Software/Hardware Incompatible (All)
- Date and Time Not Set

Radio Alarm Hierarchy

Radio

Hardware

Component failure

IDU component failure

- Modulator Failure
- Demodulator Failure (RAC)
- ODU component failure
- ADC Failure (ODU)

Power supply

- ODU PA Current
- ODU -48V Supply

Temperature

- IF Temperature
- Power Detector Temperature
- Transceiver RX Temperature

ODU Communications Failure

Software

- Configuration Not Supported (All)
- Remote Communications Failure

ODU

- Software/Hardware Incompatible (All)

Diagnostic

- TX Power Mute

- ATPC Disabled
- Bus Facing Digital Loopback
- Bus Facing IF Loopback
- TX Manual Lock
- RX Manual Lock

Radio link

- Traffic Path Down

Path failure

Tx path failure

- TX Synthesiser Not Locked
- Transceiver TX Failure
- TX IF Synthesiser Not Locked
- Modulator Not Locked
- RAC TX Cable IF Synth Not Locked
- ODU TX Cable IF Synth Not Locked
- ODU TX Cable Unplugged

Rx path failure

- RX Synthesiser Not Locked
- Demodulator Not Locked
- RAC/IDU Cable Demodulator Not Locked
- Tuner Not Locked
- RX IF Synthesiser Not Locked
- ODU Cable Unplugged

Path warning

Rx path warning

Error warning

- ESR Threshold Exceeded
- SESR Threshold Exceeded
- 10-3 BER Threshold Exceeded
- 10-6 BER threshold exceeded
- Protection Cable Unplugged
- Protection Partner Comms Failure
- Ethernet Bridge Cable Unplugged

Tributary Alarm Hierarchy

Tributary

Hardware

Component failure

- LIU Failure

Software

- Configuration Not Supported (All)

Diagnostic

Traffic

Tributary

Tributary n

- Trib n Output AIS Enabled
- Trib n Radio Facing Loopback
- Trib n Line Facing Loopback
- Trib n Link Test Enabled

Tributary

Tributary failure

Tributary n

- Trib n LOS
- Trib n Output Failure

Tributary warning

Tributary n

- Trib n Uncommissioned Traffic
- Trib n AIS

AUX Alarm Hierarchy

AUX

Hardware

Alarm inputs

- Alarm Input (n)
- Auxiliary Channel (n) Clock Failure

Software

- Configuration Not Supported (All)

Diagnostic

Auxiliary

Auxiliary 1

- AUX (n) Bus Facing Loopback
- AUX (n) Line Facing Loopback

Ethernet Alarm Hierarchy

Ethernet

Hardware

Component failure

- Switch Access Failure

Software

- Configuration Not Supported (All)

Diagnostic

Traffic

Channel

- Channel n
- Channel PRBS Test Active
- Channel Loopback Active

Port

Port n

- Port Loopback Active
- Port Monitoring Active
- .Direct Link Active

Traffic

Transport channel failure

Channel

- Transport Channel (n) Switch Packet Errors

Port failure

- Port n
- Link Failure (DAC ES, DAC GE)

Dropped frames

- Dropped Frames Ratio (DAC ES, DAC GE)

Terminal FAN Alarm Hierarchy

FAN

Hardware

- Fan Failure (FAN)

Using CT Diagnostics Screens

CT Diagnostics screens provide tools for locating and diagnosing 9500 MXC problems. Table 2-4 provides a summary of essential functions.

Click on screen type in the Screen column to open a full description.

Getting the best from these screens requires familiarity. Time spent on their layout, features, options and applications, will be time well spent.

With exception of diagnostic options provided in the System Controls screen, such as locks and loopbacks, all screens can be fully exercised without impacting traffic.

Table 2-4. Diagnostic Screen Function Summary

Screen	Function	Tips
System Summary	System Summary is the opening CT screen. Provides a high-level summary, by module, of all detected problems, using alarm severity and problem icons. Includes a system layout function for an INU/ INUe.	• Mouse-over a problem icon to view its description. • Right-click in a module to open an options menu. Left click on an option to select. Menu includes direct links to the Alarms and Plug-ins screens for the module. • Right-click in the circuit-interconnection area to view options of Circuits screen or Circuit Loopbacks. Left-click to select. (Applies to Nodes, IDU ES and IDU 300 20xV2)

Screen	Function	Tips
Alarms	Presents an alarm-tree hierarchy for the selected module. • Active alarms are opened out to show the trunk to tree-end path. • Active alarm points have a colored center. • Viewed alarms which have been active but since cleared, will have an up/down arrow on the right side of their alarm circle. A Help for Alarm tab supports context-sensitive alarm help for a selected (highlighted) alarm. Provides a description of the alarm, probable cause, recommended actions, and where applicable additional information. The HSX Helpset must first be loaded on your CT PC. Otherwise, view this alarm information from within the 9500 MXC Alarms section of this chapter (for PC-based access), or from Appendix B	• If a hardware alarm is active, this should be investigated before others. Hardware alarms occur when communications with a device fail. Generally hardware status is only checked during a power-on, software reload, or in some instances, a reconfiguration. The exceptions are RTC and ADC hardware alarms, which are continuously communicated. • When multiple alarms are active, most are likely to be downstream from the real fault. For instance, with an active Demodulator Not Locked alarm, the downstream Rx path warning alarms will also be active. A Demodulator alarm may be caused by a loss of path, (path degradation or a problem with the remote Tx), or a fault within the Demodulator, or its upstream hardware or software. As a rule, follow the guidance provided within the alarm description for each alarm.

<table>
<tr><th>Screen</th><th>Function</th><th>Tips</th></tr>
<tr><td>Event Browser</td><td>View active and cleared alarms in date/time order. Goes back in time for a maximum 5000 events (first on, first off).

The views provided are particularly helpful in situations where it is unclear what caused an alarm; what was the event that first lead to an alarm being raised. The chronological ordering and event filtering options allow easy review of repeated events of the same type, such as may occur during path fade situations, or other intermittent fault events.

Each event also captures its event source by slot location or type.

A Help for Event tab supports context-sensitive alarm help for a selected (highlighted) alarm event. Provides a description of the alarm, probable cause, recommended actions, and where applicable additional information. The HSX Helpset must first be loaded on your CT PC.</td><td>• Use the filtering options to select only active alarms, and/or to separately view all events of the same type.</td></tr>
<tr><td>History</td><td>Adds extra dimension to Events Browser and Alarms screens, by presenting a histogram of performance and events.

A 15 minute resolution option provides viewing of seven days worth of 15 minute data bins; a 24 hour option provides one months worth of 1 data bins.

Within the total history period, a user can also select a report range to capture more detailed data.

The history screens are particularly useful where there is a need to analyze link operation over time when investigating recurrent events.

Two History screens are provided, Link and Ethernet:

Link (1+0 and 1+1 RACs):

The link history screen captures G.806 link performance data, together with RSL, events detected, and configuration changes.

Ethernet (DAC ES, DAC GE, IDU ES):

The Ethernet history screen captures Rx and Tx statistics for each port and channel, events detected and configuration changes.</td><td>Link: Use the report range options to select a time period within the complete history view to provide summary reports for:

• G.826 history
• G.821 BER history
• RSL history
• Event history
• Configuration history

Ethernet: Use the Ethernet Statistics report option to view an extended errors listing.</td></tr>
</table>

Screen	Function	Tips
Performance	View current G.826 link data, plus RSL, detected forward power, current BER, remote fade margin, ODU temperature, and -48 Vdc power to the ODU.	Particularly useful for cross-checking alarm events, when there is a need to confirm if the reported event is affecting the path, or not.
System Controls	Provides menus to view and set link, trib, and AUX diagnostics.	Use to: • Apply IF and digital loopbacks • Apply trib and AUX loopbacks • Apply BER tests • Apply AIS on tribs • View online status for protected links • Force protection switching • Apply protection locks • Apply a Tx mute
Parts	Provides access to serial numbers, part numbers, and time-in-service data.	

Informational Events

This section introduces informational events and provides links to the descriptions for each informational event.

Procedure for Viewing Events

Informational event descriptions are listed in hierarchical format where each event is *in italics*.

- Click on an *informational event* to view its description.
  - If you are viewing within the HSX Helpset, you can return to this page by clicking the left arrow at the top of the page.
  - If you are viewing within an online pdf copy of the 9500 MXC user Manual, you can return to this page by clicking the left *arrowhead* in the toolbar (ensure 'view history' is selected in the toolbar options).
- If you are using a print copy of the 9500 MXC User Manual, refer to Appendix B. .

Several informational events are common to more than one device. Within Appendix B. they are only shown once and in alphabetical order.

Refer to:

- INU Informational Events on page 2-34
- IDU Informational Events on page 2-38

INU Informational Events

The following is a listing of the informational events for the INU device.

Terminal

Event System Restart

CT User Logged On

CT User Logged Off

Traffic Alignment Error

Terminal Accessed By Stratex Key

License Entered

Incorrect License Entered

Software Reset

Software File Received

Software Changed

Automatic Learning Disabled

Configuration User Reverted

Configuration Changed

Watch Dog Expired

Power On

POST Failed

Generic Trap

Date / Time Changed

Protection Switch

Protection Switch Failure

Low Memory

Event Action Created

Event Action Accepted

User Authentication Successful

User Authentication Failed

User Password Admin Reset

User Authentication Enabled

User Authentication Disabled

Ring Manual Mode Enabled

Ring Manual Mode Disabled

Date/Time Changed By SNTP

INU

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

RAC

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

ATPC Active

ATPC Inactive

AIS Transmitted

AIS Transmission Ceased

Rx Performance Monitoring Reset

ATPC Max Power for 15 Minutes

Set Power Out of Range

ATPC Max Power Out of Range

ATPC Min Power Out of Range

Ring Configuration Mismatch

Module Reset Triggered

DAC

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

AIS Transmitted

AIS Transmission Ceased

AUX

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

Alarm Output 1 Activated

Alarm Output 1 Deactivated

Alarm Output 2 Activated

Alarm Output 2 Deactivated

Alarm Output 3 Activated

Alarm Output 3 Deactivated

Alarm Output 4 Activated

Alarm Output 4 Deactivated

NPC

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

DAC ES

Event System Restart

Event Log Activitiy Suspended

Event Log Activitiy Resumed

DAC GE

DAC 155oM

FAN

IDU Informational Events

The following is a listing of the informational events for the IDU.

IDU Terminal

Event System Restart

CT User Logged On

CT User Logged Off

Traffic Alignment Error

Terminal Accessed By Stratex Key

Software Reset

Software File Received

Software Changed

Automatic Learning Disabled

Configuration User Reverted

Configuration Changed

Watch Dog Expired

Power On

POST Failed

Generic Trap

Date / Time Changed

Low Memory

Event Action Created

Event Action Accepted

User Authentication Successful

User Authentication Failed

User Password Admin Reset

User Authentication Enabled

User Authentication Disabled

Protected Partner Mismatched Software Version

Protection Switch

Protection Switch Failure

License Entered

Incorrect License Entered

Date/Time Changed By SNTP

IDU

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

Radio

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

ATPC Active

ATPC Inactive

AIS Transmitted

AIS Transmission Ceased

Rx Performance Monitoring Reset

ATPC Max Power for 15 Minutes

Set Power Out of Range

ATPC Max Power Out of Range

ATPC Min Power Out of Range

Tributary

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

AIS Transmitted

AIS Transmission Ceased

AUX

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

Alarm Output 1 Activated

Alarm Output 1 Deactivated

Alarm Output 2 Activated

Alarm Output 2 Deactivated

Alarm Output 3 Activated

Alarm Output 3 Deactivated

Alarm Output 4 Activated

Alarm Output 4 Deactivated

FAN

Event System Restart

Unsupported Configuration

Event Log Activitiy Suspended

Event Log Activitiy Resumed

Volume VI

Appendices

Appendix A. Ring Network Planning and Implementation

This appendix provides guidance on planning and implementing a 9500 MXC NxE1/DS1 'super PDH' ring network.

Topics addressed are:

Information is provided on basic ring planning and implementation. A later release will include instruction specific to:

- Transport of Ethernet data on a ring

- Use of the DAC 155oM for fiber closures

- Inclusion of non-ring-protected point-to-point traffic on a ring

Until this time, refer to instruction provided in the 9500 MXC User Manual under:

- Volume II,Chapter 3. Protected Operation Description

- Volume IV, Chapter 7, Plug-ins

- Volume IV, Chapter 8, Protection

Ring Operation

Ring protection is provided by auto-routing traffic in a reverse direction around a ring to bypass a break in the ring. For NxE1 or NxDS1 (Super PDH) rings the failure detection and circuit re-routing is managed by the 9500 MXC Node, no external switching device is required. Refer to Essential Ring Nomenclature and Rules.

9500 MXC PDH rings, support capacities to 75xE1 or 84xDS1.

Auxiliary Data circuits will be interrupted beyond a break-point, and will not be restored until the ring unwraps. Alarm I/O actions are not affected.

Essential Ring Nomenclature and Rules

A ring comprises a closed network of nodes where the protection partner RACs *at each node* are assigned in an East and West direction, within the CT Protection screen.

Within a ring there are two traffic rings:

- One is designated primary, where *at each node* traffic is received by the West RAC and transmitted by the East RAC (clockwise direction). Under normal no-fault conditions, all traffic flows only on this primary ring.
- The other is designated secondary, where traffic at each node is received by the East RAC and transmitted by the West RAC (anti-clockwise direction). This secondary ring is only used in the event of a fault; traffic is switched from the primary ring onto the secondary ring just prior to a break point, then travels on the secondary ring (East to West, anti-clockwise direction) to connect back to the primary ring at the other side of the break.

This process of switching traffic from primary to secondary at one side of the break, and from secondary to primary at the other side, is termed 'circuit wrapping', or just 'wrapping'.

Each E1 or DS1 ring-protected circuit is unique on the ring; it cannot be reused within the ring.

At each node, traffic may be passed-through, or dropped-and-inserted:

- Pass-through circuits are directly analogous to a repeater circuit; they are carried through a node.
- Drop-insert circuits are local traffic circuits. On the primary ring, Rx traffic is routed from the West RAC to a DAC (or RAC) where it will be available on the trib as DAC-out to a user connection. Data from the user is provided on the DAC-in trib, which is routed to the East RAC for transmission around the ring to its destination node/DAC.

Unlike hot-standby and diversity protection, ring protection switching is restorative; once a fault condition has cleared, the ring will automatically unwrap at a time determined by the Error-Free Timer and the optional Delay Ring Unwrap Timer, so that only the primary ring is carrying traffic.

The east, west, clockwise and anti-clockwise descriptors are conventions used to describe and configure 9500 MXC ring operation. The physical layout of a ring may be quite different but the descriptors still apply.

North Gateway or Any-to-Any Operation

Super-PDH ring architecture supports configurations for *North Gateway* or *Any-To-Any* operation.

- With North Gateway, one of the nodes operates as the gateway, through which all traffic on the ring is sourced and sent.
- For any-to-any operation, traffic can be routed from any node in the ring to any other node.

Operation of a 9500 MXC ring is described in 9500 MXC User Manual, Volume II, Chapter 3. Protected Operation.

The wrapping action within a 9500 MXC Node is described in 9500 MXC User Manual, Appendix F.

Planning a Ring Network

Circuit allocation is a key requirement in implementing a ring network. Within a protected PDH ring, each E1 or DS1 circuit can be used only once. It is therefore vital to have at the outset a clear picture of where each circuit enters and leaves the ring. In particular, the information must provide:

- Number of nodes on the ring, and node type (INU or INUe).
- Ring capacity.
- Ring type (north-south, or any-to-any).
- Location of the required plug-ins within each INU/INUe.
- An overview of the number of circuits entering and leaving the ring at each node.
- A list for each node detailing:
  - The ring circuit numbers to be drop-inserted, and
  - The ring circuit numbers to be passed-through.

Figure A-1 shows an example of a ring topology planning sheet for a North-South ring.

Figure A-2 shows an excerpt from the circuit allocation planning sheet for the example provided in Figure A-1.

Figure A-1. North-South Ring Topology Planning Sheet Example

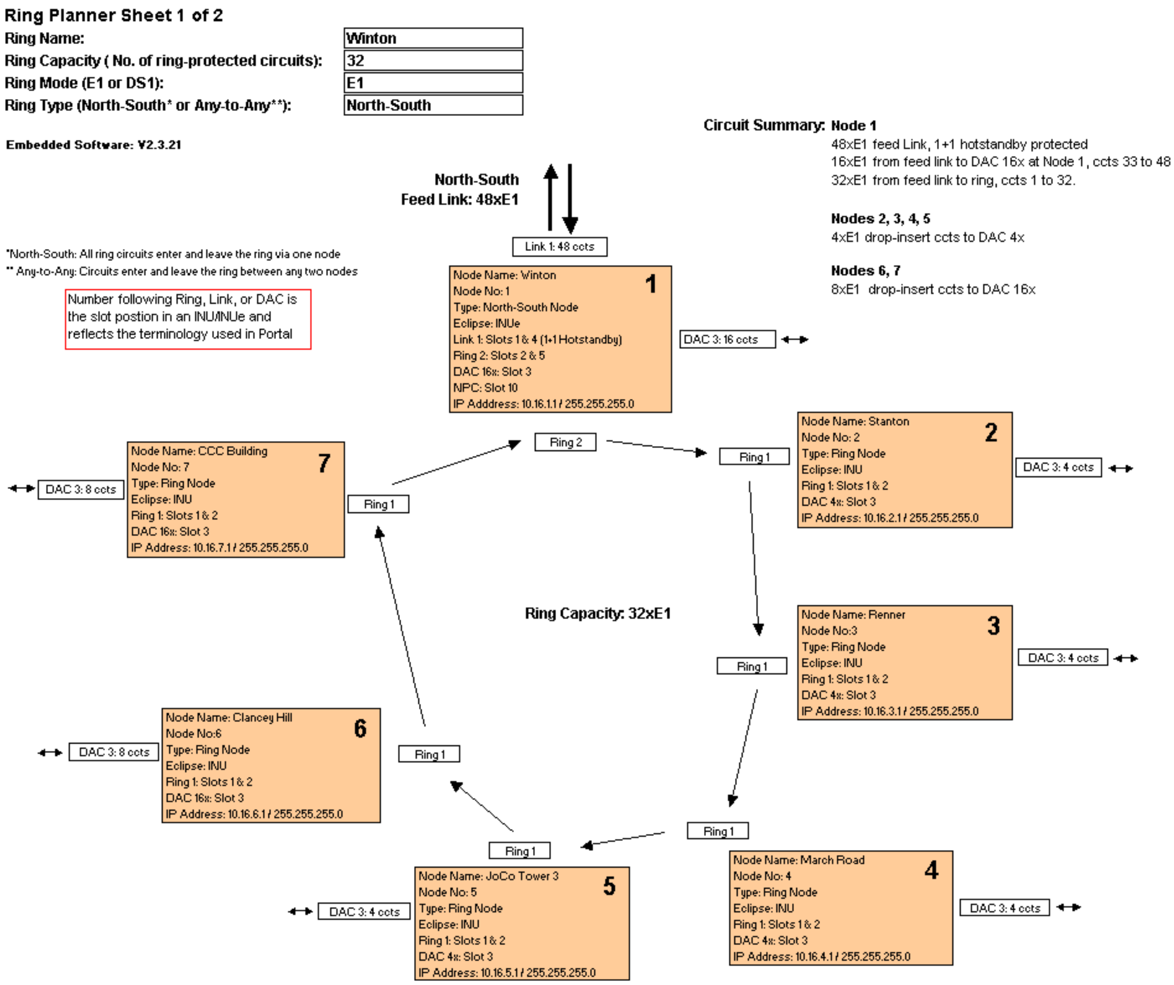


Figure A-2. Excerpt from a Circuit Allocation Sheet for the Example Ring in Figure A-1

Ring Planner Sheet 2 of 2

Ring Name:	Winton
Ring Capacity (No. of ring-protected circuits):	32
Ring Mode (E1 or DS1):	E1
Ring Type (North-South or Any-to-Any):	North-South

NOTE: It is only necessary to configure drop-insert connections. Pass through ring connections are default connected.

Ring Circuit No.	Node No: 1 Node Name: Vinton Node Type: North-South Ring Node					Node No: 2 Node Name: Stanton Node Type: Ring Node					Node No: 3 Node Name: Renner Node Type: Ring Node				
	Drop-Insert Circuit Connections				Pass-through Ring Connections	Drop-Insert Circuit Connections				Pass-through Ring Connections	Drop-Insert Circuit Connections				Pass-through Ring Connections
	Link 1	TO	Ring 2	Destination on Ring		Ring 1	TO	DAC 3	Destination on Ring		Ring 1	TO	DAC 3	Destination on Ring	
Circuit	Port		Port	Node	Circuit	Port		Port	Node	Circuit	Port		Port	Node	Circuit
1	1		1	2		1		1	1						1
2	2		2	2		2		2	1						2
3	3		3	2		3		3	1						3
4	4		4	2		4		4	1						4
5	5		5	3						5	5		1	1	
6	6		6	3						6	6		2	1	
6	7		7	3						6	7		3	1	
8	8		8	3						8	8		4	1	
9	9		9	4						9					9
10	10		10	4						10					10
11	11		11	4						11					11
12	12		12	4						12					12
13	13		13	5						13					13
14	14		14	5						14					14
15	15		15	5						15					15
16	16		16	5						16					16
17	17		17	6						17					17
18	18		18	6						18					18
19	19		19	6						19					19
20	20		20	6						20					20
21	21		21	6						21					21
22	22		22	6						22					22
23	23		23	6						23					23
24	24		24	6						24					24
25	25		25	7						25					25
26	26		26	7						26					26
27	27		27	7						27					27
28	28		28	7						28					28
29	29		29	7						29					29
30	30		30	7						30					30
31	31		31	7						31					31
32	32		32	7						32					32
33															
34															
35															
36															
37															
38															
39															
40															
41															
42															
43															

Installing a Ring Network

There are no special hardware installation requirements for a ring network. The main points to note are:

- Each radio link in a ring must be functioning correctly to attain normal, unwrapped ring operation.
- The RAC plug-ins must be located according to standard INU/INUe protection rules:
    - For an INU, the partner RACs can be installed in any slot. Slots 1 and 2 are recommended slots for standardization purposes.
    - For an INUe, the partner RACs must be installed in slots 1 and 4, or 2 and 5, or 3 and 6.
    - Where a DAC 16x is required, it should be installed in a slot on the right side of an INU/INUe to facilitate easy trib cable management (cable exits its connector to the right side).
- The protection mechanism is selected in the CT Configuration > Protection screen.
- Individual links within a ring will be installed and put into operation before the link is closed. *Until all links are operational*, circuits configured on the network will remain wrapped at nodes either side of ring sections still to be completed.

For information on 9500 MXC Installation, including antenna alignment, refer to 9500 MXC User Manual, Volume III, Installation.

Configuring a Ring Network

CT, the 9500 MXC craft terminal, is used to configure a network. The configuration process is presented in the following order:

- Layout on page -8
- Licensing on page -8
- Protection on page -9
- Plug-ins on page -13
- Circuits on page -15
- Networking on page -19
- Date/Time on page -20

CT screens which provide features and functions specific to Ring operation, as distinct from hot-standby or diversity protection, are Plug-ins, Protection, and Circuits.

Layout

The Configuration > System Summary screen shows the plug-ins installed. It indicates the plug-in type ***detected*** for each slot against the plug-in type ***expected***, the configuration for which is held in the CompactFlash card in the NCC.

Before proceeding with a configuration, verify that the required plug-ins are installed correctly.

For System Summary Screen operation, refer to System Summary, Volume IV, Chapter 15.

Licensing

A license determines the capacity maximums for the RACs, of which there can be up to three installed in an INU, or six in an INUe.

The DAC 155oM is not subject to licensing.

A license is held within the CompactFlash card, which is identified by a unique license number.

The base (default) license allows installation of up to six RACs, each with a maximum capacity of 40xE1, or 16xDS1. Beyond this level, licenses must be purchased, which provide an up-to capacity on a per-RAC basis.

For a typical RAC/RAC ring node the node license must support:

- The two RAC positions and their required (configured) capacity.
- Capacity for any additional RAC or RACs that connect to/from the ring.

For information on Licensing screen operation and the licensing process, refer to 9500 MXC User Manual, Volume IV, Chapter 4.

Protection

For a ring configuration two RACs may be paired for east-west operation, or a RAC and a DAC 155oM. The RAC/DAC 155oM pairing is used where fiber linking is required to close a ring.

Ring-specific configuration data for a DAC 155oM will be provided in a later release of this appendix. Comprehensive configuration data, including ring applications, is included in CT > Node and Terminal Plug-ins, and in CT > Protection.

The Configuration > Protection screen is used to set the RAC partnering required for east-west ring operation.

The Protection screen provides:

- Location (slot number) of installed RAC and DAC 155oM plug-ins
- Identification and selection of allowable RAC/RAC or RAC/DAC 155oM partnering for protected operation.
- Selection of the protection type; Ring.
- Selection of East and West designations.

Refer to:

- Ring Protection Configuration and Operation Rules on page -9
- The Protection Screen on page -10
- Configuring Ring Protection on page -11

Ring Protection Configuration and Operation Rules

- Selecting two RACs, or a RAC and a DAC 155oM, is the starting point for configuring a protected link. It is not possible to configure a protected link without both partner plug-ins installed.
- Partner plug-ins will only be permitted within the slot conventions for the INU and INUe. For details refer to 9500 MXC Node Slot Numbering Conventions, Volume IV, Chapter 1.
- Once a protected link is configured and saved (Sent), one or both RACs may be withdrawn without affecting the saved configuration.
- A protected link will only be returned to non-protected:
  - On selection of Non-Protected in the Partners column, or

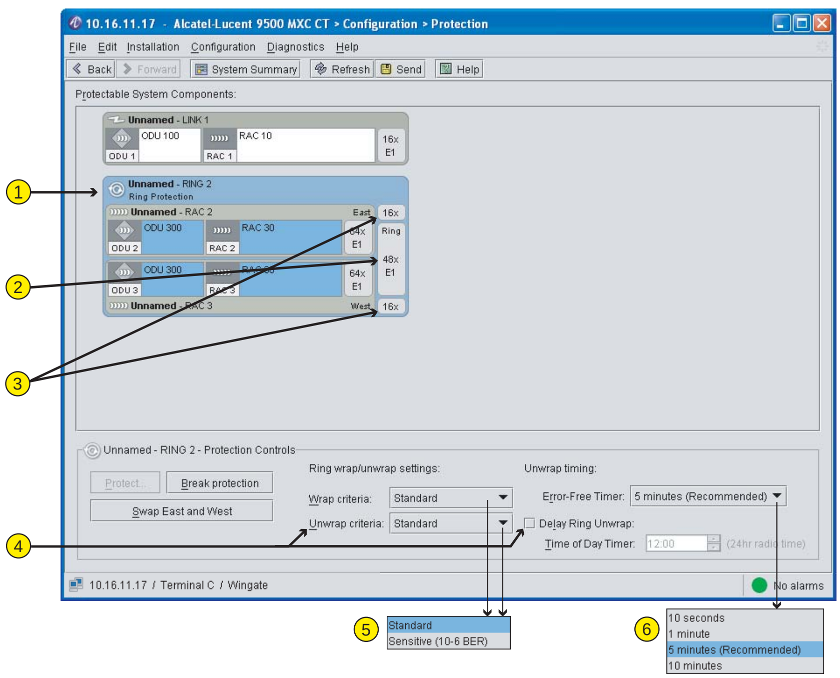
- If one of the protected plug-ins is replaced by an incompatible plug-in type (such as a DAC 16x), *and* the replacement DAC is installed as the *accepted* plug-in the System Summary screen.

The Protection Screen

- The protection screen identifies all *installed* RAC and DAC 155oM plug-ins (the protectable plug-ins).
- The Type and ID columns show the link type:
  - RING for a ring protected pairing of back-to-back *radio* links (RACs), or a back-to-back pairing of a radio link (RAC) with a fiber link (DAC 155oM).
  - LINK for non-protected *radio* links, and for hot-standby and diversity *radio* links.
  - DATA for a non-protected DAC 155oM *fiber* link.

Figure A-3 shows typical protection screen for a ring selection.

Figure A-3. Protection Screen Showing a Ring Selection for an INUe



Item	Description
1	Shows a ring pairing with its configured ring capacity and balance of available LINK capacities.
2	Ring capacity has been set for 16xE1 (A 1xE1/DS1 capacity is auto-configured when ring protection is first set).
3	Shows balance of circuits available for use as ring-protected circuits, or as point-to-point circuits.
4	Ring *wrap* settings are set for standard or sensitive. Ring *unwrap* is set for standard, sensitive or delayed. If set to delayed both wrap and unwrap criteria default to standard.

Item	Description
5	Select standard or 10^{-6} BER wrap and unwrap criteria.
6	Select an unwrap timer option. An unwrap will occur upon error-free completion of the selected period.

Configuring Ring Protection

Use the following procedure to view and configure ring protection options:

1. Identify the partners required for ring protected operation.
2. Identify which plug-in (RAC / DAC 155oM) is to be the East link:
   - The East plug-in will be transmitting on the primary ring, and receiving on the secondary ring. The West RAC will be receiving on the primary ring and transmitting on the secondary ring.
   - The plug-in assigned as east will retain any existing connections, and circuit assignments for the west will automatically be assigned to match the east. (Any prior circuit connections for the west will be dropped - view 'Consequences' for on-screen advice).
   - The slot number in which the east plug-in is installed will be the Ring ID number (slot number)
3. Click first on the component *which is to become east* then click Protect to view the Protection Selection window. Only valid partners are shown.
4. Select ring-wrap and unwrap criteria. See Figure A-3. Options are provided for Standard and Sensitive, with additional unwrap selections of an Error-free Timer, and a Delayed Ring Unwrap timer:
   - Standard is default for wrap and unwrap. For information on ring wrap and unwrap criteria, refer to Protection Switching Criteria on page 3-77, Volume II, Chapter 3.
   - Sensitive *adds* a 10^{-6} BER event to the wrap and/or unwrap criteria. A *wrap* will occur on occurrence of a standard wrap event and/or a 10^{-6} BER event. Similarly an *unwrap* will not occur until after completion of an error-free period that is clear of any standard or 10^{-6} BER events.
   - The Error-free Timer sets the period of error-free operation needed prior to initiation of an unwrap. (When a wrap has occurred the timer counts down towards an unwrap as soon as all wrap conditions are cleared. The count begins anew should a wrap condition re-occur during the countdown). Default is 5 minutes (recommended).
   - The Delay Ring Unwrap option allows setting of a time of day when an unwrap will occur providing all wrap conditions have been cleared for a period not less than that set in the Error-free Timer.
     - With this option selected the Wrap and Unwrap criteria default to Standard.
     - The Delay Ring Unwrap has a 1-hour window. If the conditions which caused the wrap are not cleared by the Error-free Timer during this window, then Delay Ring Unwrap resets for the same time the following day.
   - The System/Controls screen provides a countdown timer to indicate the time to go before the ring will unwrap. Applies to both the Error-free Timer and Delay Ring Unwrap Timer. (Counts down to zero).
5. To reverse the East and West roles, click on the 'Swap East with West' tab.

6. Click Send to save the configuration.

Plug-ins

The Configuration > Plug-ins screen provides view/change settings for:

- Capacity
- Bandwidth/modulation
- Tx and Rx frequencies
- ATPC
- Protection (view only)

Figure A-4 shows a typical Plug-ins screen for a ring.

For information on assigning settings, refer to Plug-ins in 9500 MXC User Manual, Volume IV, Chapter 4.

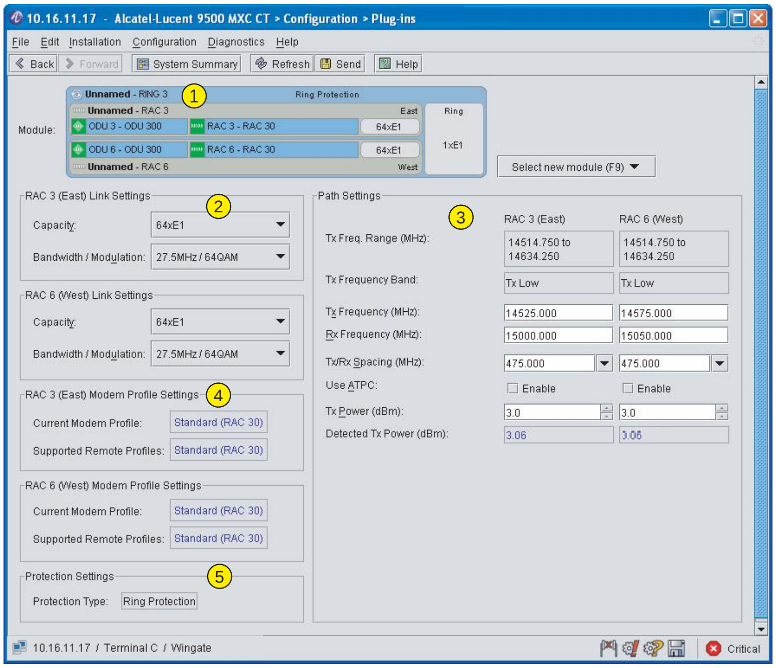
Points to note for a ring:

- Unless there are point-to-point overlay circuits on the ring, all RINGs (RACs) would normally be configured for the same capacity.

Point-to-point overlay circuits are not ring-protected. They sit side-by-side with ring-protected circuits and can be assigned between any two nodes on the ring. For more information, refer to 9500 MXC User Manual, Volume II, Chapter 3.

- Where east and west ring links at one node are operating *in the same frequency band*, good frequency planning dictates they should both be Tx high, or Tx low.
- Links on a ring will be installed and commissioned at different times. Confirming correct operation of each individual link in a ring is a pre-requisite for normal, unwrapped, ring operation. Until all ring links are operational, partial ring links, which may be one link are or multiple links, will operate in a wrapped state (circuits will be ring-wrapped).
- Correct operation for individual links is most easily confirmed by checking the Online and Status LEDs for the relevant RACs. Both must be green, and there should be no alarm icons present in the CT status bar. (Status bar appears at the bottom of all CT screens)
- To avoid confusion over which RAC is East, and which is West, and the remote node to which they each connect, the RACs should be labelled (front panel sticker).

Figure A-4. Typical Plug-In Screen for a Ring



Item	Description
1	Module shows ring-protected STM1 links with RACs in slots 1 & 4.
2	East and West links are independently set for capacity and bandwidth/modulation. For a normal ring (no pt-to-pt overlay) the east and west capacity settings should be set for same capacity.
3	Path settings are independently set for the East and West links.
4	Modem profile settings are confirmed for both RACs.
5	The Protection Settings Panel simply confirms that ring protection has been set.

Circuits

The Configuration > Circuits screen supports two windows, one for Traffic Circuits, the other for Auxiliary Circuits.

Ring-specific data for Auxiliary circuits will be included in a latter release of this appendix. Comprehensive data on Auxiliary configuration is included in CT > Node and Terminal Plug-ins.

Traffic Circuits

In the Circuits window, circuits on the ring are either:

- Connected (dropped and inserted) from a ring circuit to a plug-in installed in the node, which may be a DAC, or a RAC that is linking to/from the ring.
- Passed through the node.

A circuit connected at this node must also be connected (dropped and inserted) at another node on the ring to complete the circuit.

Each node/node *circuit* on the ring is dedicated; a circuit cannot be reused to provide connection between other nodes on the ring.

The circuit connection process involves:

1. Selecting circuits on the ring to be dropped and inserted at the node.
2. Applying port-port cross-connects between these circuits and DAC and/or RAC plug-ins, which feed traffic to/from the ring.
3. Leaving all other ring circuits (those which are not drop-inserted at the node) as pass-through circuits.

Key to a successful circuits configuration is a ring circuits planner, showing all circuits on the ring, and the nodes at which they are to be dropped/inserted.

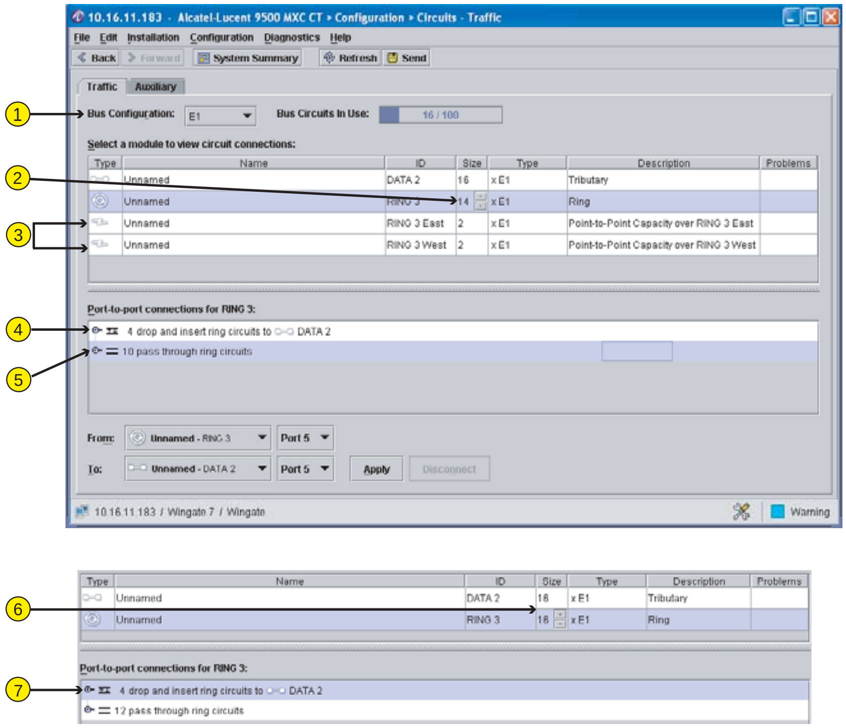
This same planner must provide circuit configuration data for each node, with identification, by circuit number, of the circuits to be drop-inserted, or passed through.

Information on a recommended planner is provided in Planning a Ring Network on page -4.

Ring-Node Traffic Circuits Connection

Figure A-5 shows an example ring-node circuits screen.

Figure A-5. Example Circuits Screen for 16xE1 East and West Links



Item	Description
1	Backplane bus is set to match the rate type selected in the Plug-ins screen.
2	Protected ring capacity is set here.
3	Balance of available capacity on ring (2xE1) is automatically assigned as available Pt-to-Pt capacity.
4	Four of the protected ring circuits are connected to DATA 2.
5	Balance of protected ring circuits (10xE1) are passed-through.
6	Alternative view shows all 16xE1 circuits assigned to the Ring; there are no circuits available for Pt-to-Pt.
7	Local connections to DATA 2 remain at 4xE1, resulting in pass-through circuits incrementing to 12xE1

The important points to note in the example Traffic Circuits window (main view) are:

- The East and West RACs have both been configured for a capacity of 16xE1.
- The ring has been configured with a capacity of 14xE1, leaving 2xE1 available as point-to-point capacity in the East and West directions.

- 4 of the protected ring circuits have been drop-insert connected to the DAC 16x (DATA 2). The balance of 10xE1 circuits, are automatically assigned as pass-through circuits.
- In the alternative view, all 16 of the available ring circuits have been assigned to protected ring operation, which has automatically deleted available capacity for point-to-point use.
- Alternative view also shows drop-insert connections to DAC 2 remaining at 4xE1, to result in the number of pass-through circuits automatically incrementing to 12xE1.

Ring circuits are default connected as pass-through. Specific configuration of pass through circuits is not required.

New connections can be set from any module to any other module, for example a circuit can be set from a RAC to a DAC, *or* from a DAC to a RAC.

Configuring Ring Traffic Circuits

For a new/non-configured module this connections panel will show all RING circuits as 'pass-through ring circuits'.

To set new connections:

1. Use the *From* and *To* buttons, and the *pass through ring circuits* line in the port-to-port connections box. The toggle(s) in the port-to-port connections box should be kept in the up (horizontal) position for easy viewing. Refer to Figure A-5.
   - Populate the **From** tab by clicking on the module (RING) you wish to connect from in the **Select a module to view circuit connections** panel.
   - Use the **From** > **Port** tab to set (in numerical order) the first From port connection.
   - Populate the **To** tab by selecting from its drop-down menu (menu only applies where there are two or more possible To options).
   - Use the **To** > **Port** tab to set (in numerical order) the first To port connection.

If there are *no* allocated circuits, the From and To buttons will prompt for bulk allocation of circuits between the first pair of modules, with the number of connections based on the lowest capacity end of the selected pair. For instance, if a 32xE1 link has been selected as the From module and a 16xE1 DAC selected as the To module, the From and To port buttons will prompt for a 16xE1 bulk allocation. If such a bulk allocation is not intended, then select the 1st port-to-port circuit using the Port drop-down menus, and proceed as above.

2. Click **Apply**.

   The newly connected circuit is shown in the port-to-port connections box, and the number of pass-through circuits is reduced accordingly.

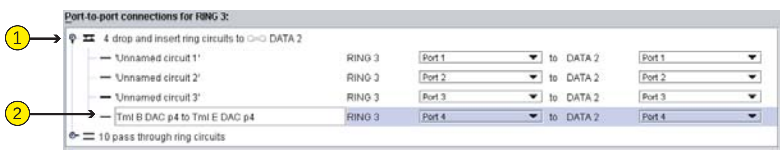
   - Continue to click **Apply** to establish subsequent new circuit connections *between the same modules*. This connection is made in ascending numerical order on the port numbers first established.
   - To establish new connections between a *different* pair of modules, use the **From** and **To** module and port settings to define the first connection, and then click Apply. Continue to click **Apply** to advance the connections.

3. When all connections have been set, click **Send** to save.

To view and name individual circuits:

1. Highlight the relevant RING, LINK or DAC module in the **Select a module to view circuit connections** panel to show its ‘to’ connections in the **Port-to-port connections** panel.
2. In the **Port-to-port connections** panel, click the toggle down for the required ‘to’ module to view its port-to-port connection details. Refer to the Ring 3 to DATA 2 example in Figure A-5 and Figure A-6.
3. To add or change a circuit name, highlight the existing name entry and type.

Figure A-6. View of a Connection in the Port-to-Port Connections Box



Item	Description
1	Toggle down to view individual circuit details.
2	Highlight and type-over to enter a circuit name.

To change existing circuits:

1. Within the **Port-port connections** panel, click the relevant toggle to display individual circuit details.
2. Click on a row to populate the **From** and **To** buttons with its connection details. Use the **Port** drop-down menus to select a new port-to-port connection, and click **Apply**. Alternately, click on the Port buttons within each circuit row, and use the drop-down menu. *Existing port connections are red. Unallocated ports are black.*
3. Click **Send** to commit.

If an existing port connection is selected, then its partner port will be returned to ‘pass through ring circuits’, and its original port-to-port connection line will disappear.

Networking

The Configuration > Networking screen provides view and change settings for NMS IP addressing and routing.

For a ring network dynamic routing must be selected, RIP or OSPF. *Static routing is not an option*.

Single IP addressing should be used at all nodes, except those where there is a ‘north-bound’ interface to another network, *which is static routed*. In this instance, *just the interfacing node(s)* on the ring must be partitioned using interface IP addressing:

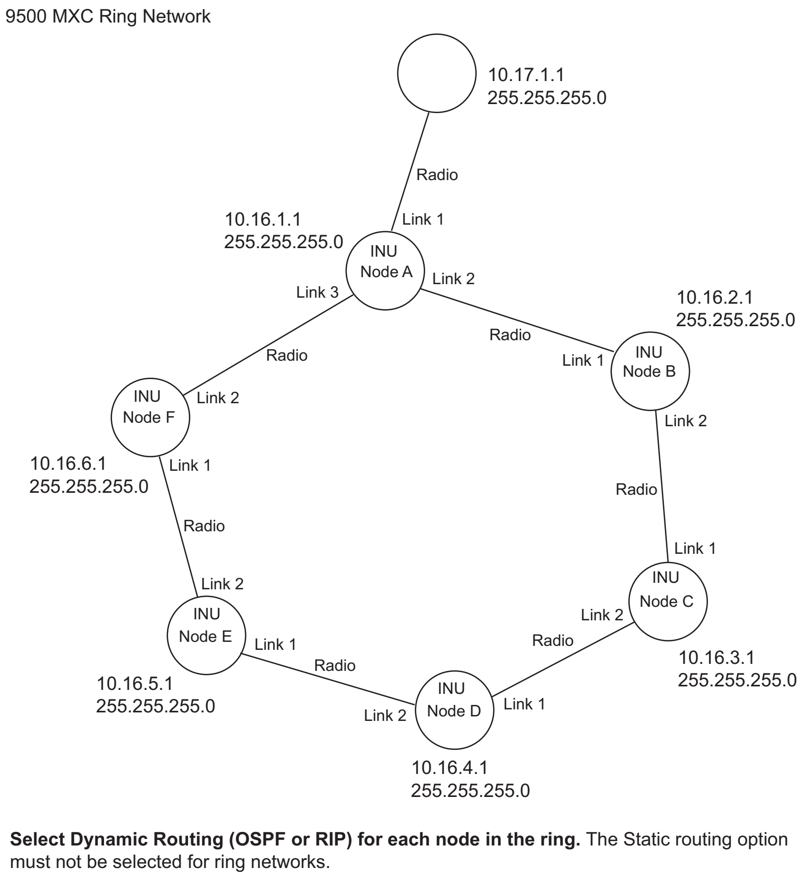
- In the IP Addressing window, select ‘Use Interface Addressing (Advanced)’ and assign each used port a unique IP address and routing option:
  - The RING ports must be set for dynamic routing. OSPF is recommended, in which case all other nodes on the ring must be set for OSPF.
  - The ring-interfacing LINK port must be set for static routing.

For information on the Networking screen, refer to 9500 MXC User Manual, Volume IV, Chapter 4.

For information on 9500 MXC NMS networking and example networks, refer to Appendix D.

Figure A-7 shows a ring network example.

Figure A-7. Example Ring Network NMS IP Addressing



Date/Time

The Configuration > Date/Time screen is standard for all 9500 MXC network configurations. For details, refer to Volume IV, Chapter 12.

Commissioning and Troubleshooting a Ring Network

Guidelines are provided to confirm correct ring network operation.

A pre-requisite is to confirm that all links on the ring are:

- Operating error-free
- Correctly configured for NMS networking
- Correctly configured for traffic circuits

During installation each link should be installed and configured using data prepared at the ring planning stage. A master reference must be prepared, as recommended in Planning a Ring Network on page -4

Once *all links in the ring* have been installed and configured, correct ring operation can confirmed using the following procedures, which are based on a CT connection (Ethernet NMS cable connection) at one node on the ring.

Refer to:

- Ring Node Visibility on page -21
- Integrity of Individual Ring Links on page -22
- Integrity of the Ring and Ring Circuits on page -22
- Confirming Ring Wrapping and Unwrapping on page -23

Ring Node Visibility

Use CT to log on to all nodes in the ring. (You will need the IP address for each node)

Maintain connection to all nodes.

Screens may be layered, and brought to the front by clicking, or two or more screens may be set side-by-side for viewing. Where necessary, drag a corner of a screen to resize.

- If all nodes are visible, it indicates:
  - NMS IP addressing and routing is OK.
  - A normal unwrapped ring, *or* a wrapped ring with only one link inoperative. To confirm normal ring operation, check the System Summary screen for each node.
- If some nodes are not visible:
  - NMS addressing and routing may be set incorrectly. If no nodes other than the local node are visible, check the gateway setting on your CT PC. Refer to 9500 MXC User Manual, Volume 4, Chapter 2.
  - One or more links on the ring are down, and ring wrapping has not occurred.

- Two or more links are down, ring wrapping has occurred, but the missing node or nodes are isolated.

Use CT to view the status of the node and the RING RACs up to the point of discontinuity in a ring. If RING status is OK at this point (no alarms and performance OK), it suggests a problem with IP addressing at the missing node(s).

Integrity of Individual Ring Links

Check each node on the ring for correct, error-free operation:

1. Confirm the System Summary screen shows no alarms.
2. Within Diagnostics > Performance, click Start All, to initiate monitoring. This must be separately selected for east or west RACs, by clicking on the required RAC line in the Plug-ins panel.
   - Check that Detected Tx Power and RSL agree with the values stated in the installation datapack.
   - Check that the -48v supply is within expected limits.
   - For the selected RAC, G.826 stats should be reviewed at intervals to confirm continued error-free operation.

If alarms are present, or performance data is outside expected values, the reasons must be checked and any required remedial action completed before a ring is commissioned.

Integrity of the Ring and Ring Circuits

Check each node on the ring for correct circuits configuration, and confirm circuits using a BER test on selected tribs.

1. Open Configuration > Circuits > Traffic Circuits, and in the Port to Port Connections panel check all connections against the master ring circuits listing.
2. Select a local DAC trib for a BER test. Apply a radio-facing loopback at the remote end of the trib, and set a BER test.
   - If a BER test cannot be set, check the circuit configuration, and the loopback selection.
   - If a BER test can be set, it confirms correct end-to-end circuit assignment.

3. Leave a BER test on overnight (or other specified period) to confirm error-free ring operation.
   - If a BER test shows errors, cross-check against the G.826 stats in the Performance screens for all nodes in the ring.

     In all but exceptional circumstances, such as a DAC failure, BER test errors will correlate with radio link errors in G.826 performance stats. Check the affected link to determine the cause of errors. Checks should include reference to path conditions, which may indicate a path-fade problem.

     Where G.826 performance data is error-free on all ring links, the presence of BER test errors indicates a problem within one of the DACs and/or its interfacing to the RAC via the TDM bus. Check other tribs and use local digital and IF loopbacks to help isolate the problem.

Confirming Ring Wrapping and Unwrapping

Ring wrapping will occur when one or more links in the ring fail.

For ring-wrapping criteria for radio (RAC/ODU) and fiber (DAC 155oM) ring refer to:

- Radio Links on page -23
- Fiber (DAC 155oM) Links on page -23
- Wrap and Unwrap Times on page -24
- Checking Wrap and Unwrap Operation on page -24

Radio Links

Conditions for ring wrapping:

- Tx path failure:
  - Tx synthesizer not locked
  - Tx transceiver failure
  - Tx power failure
  - Tx ODU IF synthesizer not locked
  - Tx RAC IF synthesizer not locked
  - Modulator not locked
- Rx path failure:
  - Rx synthesizer not locked
  - Rx IF synthesizer not locked
  - Demodulator not locked
  - ODU Tx cable IF synthesizer not locked
  - 10^{-6} BER (user selectable wrap and unwrap options)
- RAC plug-in is missing
- RAC software load failure

Fiber (DAC 155oM) Links

Conditions for ring wrapping:

- Loss of SDH/SONET frame
- DAC 155oM plug-in is missing
- DAC 155oM software load failure

Wrap and Unwrap Times

The wrapping process is performed without any participation of the alarmed RAC or DAC 155oM (or potentially failed RAC/DAC in the instance of a silent transmitter failure).

Ring wrapping and unwrapping is not hitless:

- The service restoration times (detection, switching and recovery) for a ring wrap is not more than100 ms.
- The revertive switch *command* for return to normal service is initiated after the relevant alarms on the failed link have been cleared for a period set by the Error-Free Timer (default 5 minutes), or by the optional Delay Ring Unwrap Timer, which sets a time of day for an unwrap. Full restoration of normal traffic (unwrapped) on the ring occurs within 100 ms of receipt of the revertive switch command.

Unwrap Timers

An **Error-free Timer** in the Protection configuration screen sets the period of error-free operation needed prior to initiation of an unwrap. When a wrap has occurred this timer counts down towards an unwrap as soon as all wrap conditions are cleared. The count begins anew should a wrap condition re-occur during the countdown. The time options are 10 seconds, or 1, 5, or 10 minutes. 5 minutes is default (recommended).

A **Delay Ring Unwrap** timer in the Protection configuration screen allows setting of a time of day when an unwrap will occur providing all wrap conditions have been cleared for a period not less than that set in the Error-free Timer. This timer has a 1-hour window; if the conditions which caused the wrap are not cleared by the Error-free Timer during this window, then Delay Ring Unwrap resets for the same time the following day.

The System/Controls screen provides a countdown timer to indicate the time to go before the ring will unwrap. Applies to both the Error-free Timer and Delay Ring Unwrap Timer. (Counts down to zero)

Checking Wrap and Unwrap Operation

To simulate a ring radio-link failure:

- A Tx mute can be invoked in Diagnostics > System Controls, for the east or west RAC.
- The east or west RAC can be withdrawn from its backplane.

To avoid a power spike causing momentary errors on all node traffic, the ODU cable must not be disconnected or reconnected on an operational RAC. Before connection/disconnection, first withdraw a RAC from its backplane.

To check for correct wrap operation:

1. First ensure the ring is operating normally, specifically that it is not already in a wrapped state. This can be checked by quick inspection of the CT status bar.
2. Apply a BER test on a looped trib circuit, and confirm error-free operation.
3. Apply a Tx mute on the East RAC, or withdraw the RAC from its backplane, and check for:
   - Continuing error-free BER indication, after a momentary error blink.
   - An errored second count of not more than two seconds (it will be one or two, depending on the where errors begin and stop within the errored-second count.
4. Remove the Tx mute (or return RAC to its backplane). Within several seconds, normal *link* operation will be confirmed by a green RAC status LED and an unlit RAC online LED. At this point the error-free timer is initiated, and providing no further errors are detected on the link, the ring will revert to normal unwrapped operation on time-out of the error-free timer setting.
   - While the link is subject to the timer the online LED remains unlit.
   - The online LED becomes green as soon as the ring link is unwrapped (traffic is restored on the link).
   - The time to go before an unwrap occurs is displayed by the RING unwrap timer in the System/Controls screen.

   Check that:
   - Revertive switching occurs at time-out of the unwrap timer setting, once normal link operation is restored.
   - An error-free BER indication is maintained throughout, except for a momentary error blink during the revertive switch (unwrap).
   - The errored second count is not more than two seconds (it will be one or two, depending on the where errors begin and stop within the errored-second count.
5. Repeat steps 1 to 4 for the West RAC.

Applying a Tx mute to a West RAC will cause a wrap even when the secondary ring is not in use, for the reason all nodes need to be transparent to the possibility of a wrap occurring at another node on the ring.

Appendix B. 9500 MXC Alarms

9500 MXC alarms are presented under eight headings. Within each, the order of alarms is as they appear in the CT Alarms screen hierachy.

The alarms include information on probable cause, recommended actions, and where appropriate, additional information.

- Several alarms are common to a number of the plug-ins. They are only shown once (in order of first appearance), and their heading is suffixed by '(All)'. These alarms are:
  - FPGA Software Load Failure (All)
  - EEPROM Failure (All)
  - Configuration Not Supported (All)
  - Software/Hardware Incompatible (All)
- Alarm descriptions are common to 9500 MXC Node and Terminal (Terminal alarms are a subset of Node alarms). Table B-1 shows the commonality and the order in which alarms are presented in this appendix.

Table B-1. 9500 MXC Node and Terminal Alarm Commonality

Alarm Tree	Applies to 9500 MXC:
NCC/IDU	Node and Terminal
RAC/Radio	Node and Terminal
DAC/Trib	Node and Terminal
AUX	Node and Terminal
NPC	Node
FAN	Node
DAC ES	Node
DAC 155oM	Node

- All alarms for a particular selection type are displayed in its hierachy, but for the Node, not all will be available for activation for all plug-ins of the same type. For instance, under a RAC selection, RAC 30 and RAC 10 alarms share 80% commonality, the remainder are specific to each.

NCC/IDU Alarms

This section lists the NCC/IDU alarms.

FPGA Software Load Failure (All)

The software loading of the Field Programmable Gate Array has failed. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

- If the alarm is raised on initial power-on, retry (reboot); power off, pause, power on.
- If the alarm is raised after a new SW load, reload the previous SW version and re-check the alarm. If cleared, retry the SW load.
- If the alarm is raised after a capacity or backplane reconfiguration, revert to the previous settings. If the alarm has cleared, retry the new configuration.
- If the alarm is permanent, replace the plug-in/IDU.

Additional Information

FPGA loading occurs:

- During power-up.
- When a new software version is loaded that includes an update to the FPGA.
- When a RAC, DAC or AUX is installed in a powered Node.
- Depending on the plug-in, FPGA loading may occur during a reconfiguration of Node backplane and/or RAC/DAC capacity.

RAM Failure

The RAM test has failed. This is a warning alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the test failure is. Depending on the malfunction, the node may otherwise operate satisfactorily.
2. Reboot (power off, pause, power on).
3. If the alarm remains, replace the NCC/IDU.

Additional Information

RAM function is checked during power-up and software reloads.

Flash Card Failure

Loss of communications with the flash card. This is a warning alarm.

Probable Cause

Flash card or process malfunction.

Recommended Actions

Reboot (power off, pause, power on). If the alarm remains, first replace the NCC/IDU, reboot, and if the alarm persists, the flashcard.

Additional Information

- The flash card memory function is checked during power-up and software reloads.
- Loss of communications means the configuration for the node cannot be accessed.
- Replacing a flashcard requires complete re-configuration of the Node/Terminal.
- A Node/Terminal will not start without a flashcard installed.

Fixed Flash Failure

Loss of communications with fixed flash memory. This is a warning alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

Reboot (power off, pause, power on). If the alarm remains, replace the NCC/IDU.

Additional Information

Fixed flash memory is checked during power-up and software reloads.

ADC Failure (NCC/IDU)

There is no communication with the ADC (analog to digital converter). This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

4. Check other alarms and performance indicators to determine how critical the failure is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
5. Reboot (power off, pause and power-on). If the alarm persists, replace the NCC/IDU.

Additional Information

The ADC on the NCC is used to monitor voltage and temperature levels presented on, or to the NCC/IDU.

RTC Failure

Loss of communication with the RTC (realtime clock). This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
2. If there are no other alarms to indicate a general NCC/IDU failure, check configuration of the clock in the CT Date/Time screen. Also check if events in the CT Events Browser screen are still being date/time stamped. If normal, an RTC specific communications problem is indicated.
3. Depending on the location of the problem, it may clear when the Node/Terminal is rebooted.

If the problem remains, replace the NCC/IDU.

Additional Information

The RTC holds the date/time reference.

Clock Generator Failure (NCC/IDU)

Cannot communicate with the clock generator. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Reboot (power-off, pause, power on). If the alarm remains, replace the NCC/IDU.

Additional Information

- This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the clock generator means its configuration cannot be loaded. The Node/Terminal will not operate.
- The clock generator sets primary timing for the NCC/IDU, including TDM clock and FPGA functions.
- For a Node, an associated NCC TDM Clock Failure alarm will only appear if an NPC is installed. When the NCC clock fails, the NPC will assume clocking for the TDM bus, and the NPC will activate the NCC TDM Clock Failure alarm.

+5V Digital Supply (NCC/IDU)

+5 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

- Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
- Replace the NCC/IDU.

-5V Digital Supply (NCC/IDU)

-5 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
2. Replace the NCC/IDU.

+3.3V Digital Supply (NCC/IDU)

+3.3 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
2. Replace the NCC/IDU.

+2.5V Digital Supply (NCC)

+2.5 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical alarm is. Depending on the malfunction, the node may otherwise operate satisfactorily.
2. Replace the NCC.

-48V Supply (NCC/IDU)

-48 volt supply out of tolerance. This is a warning alarm.

Probable Cause

Main 48 Vdc power supply is outside limits of -40.5 to -60 Vdc.

Recommended Actions

1. Measure the 48 Vdc supply with a voltmeter. If the supply voltage is correct, suspect the voltage sensor circuit in the NCC/IDU. Confirm by checking the -48V supply voltage in the CT Performance screen.
2. If it is an NCC/IDU problem, check for other alarms to determine how critical the alarm is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
3. If the fault is with the NCC/IDU (not the supply), replace the NCC/IDU.

Additional Information

The node will operate to specification with a supply voltage between -40.5 and -60 Vdc.

+1.8V Digital Supply (NCC/IDU)

+1.8 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
2. Replace the NCC/IDU.

+1.2V Digital Supply (NCC)

+1.2 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical alarm is. Depending on the malfunction, the node may otherwise operate satisfactorily.
2. Replace the NCC.

Temperature

NCC/IDU temperature is out of tolerance. This is a warning alarm.

Probable Cause

The FAN is faulty (Node only).

The indoor ambient temperature is excessive.

The temperature sensing circuit is faulty.

Recommended Actions

1. Check Node FAN LED.
2. If alarmed, the problem is likely to be caused by inadequate cooling due to an inoperative or defective FAN.
3. If not alarmed, the problem is likely to be caused by high ambient temperature, restricted airflow, or a defective temperature sensing circuit.
4. Check the ambient temperature at the INU/INUe/IDU, which must be no higher than +55 degrees Celsius (131 F). Bear in mind the ambient temperature in an enclosed rack may be much higher than the ambient within the equipment room.
5. Check that airflow is not restricted. The INU/INUe requires unimpeded airflow to each side for the fan cooling to be fully effective, which means that there should be not less than 50mm (2”) clearance on both sides.
6. If there are no other alarms, the ambient temperature is OK and the airflow is not restricted, then suspect the temperature sensing circuit. Replace the NCC/IDU.

Expansion NCC Communications Failure

Can’t cooperate with expansion NCC. This is a major alarm.

Probable Cause

Expansion cable unplugged or equipment malfunction.

Recommended Actions

Check the cable.

Replace the affected NCC.

Fan Failure (NCC)

FAN plug-in alarm. This is a warning alarm.

Probable Cause

FAN plug-in malfunction, most likely a failure of one of its two axial fans.

Recommended Actions

Replace the FAN.

Additional Information

The two axial fans operate in protected mode. In the event the operational fan fails, the standby fan will come on line. While both fans will run if the INU temperature exceeds a preset threshold, normally just one will run, and operation will be cycled between the two.

The FAN is field replaceable and can be hot-swapped; removal will not affect traffic.

Fan Plug-in Missing

FAN missing from fan slot. This is a major alarm.

Probable Cause

The FAN plug-in is misssing or incorrectly seated.

Recommended Actions

Install a FAN, or reseat the FAN in its backplane.

NCC TDM Clock Failure

NCC TDM clock has failed. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Reboot the NCC by withdrawing it from its backplane, pausing, and re-inserting. If the alarm remains, replace the NCC.

Additional Information

- This alarm will only appear if an NPC is installed, *and* NCC clocking of the TDM bus has failed. The event activating this alarm also initiates the switching of the TDM bus clock from the NCC to the NPC.
- During the switch of bus clocks, there will be traffic hit of not more than one errored second. Switch time is typically less than 10 ms.
- When the NCC has been replaced and alarm has cleared, clock management of the TDM bus will remain with the NPC. It may be left with the NPC, or returned to the NCC using the switch command in the CT System Controls screen. During the switch there will be a traffic hit of not more than one errored second.

- Should the NPC TDM bus clock fail control of the clock switches to the NCC.If the NCC bus clock has also failed, control will be returned to the NPC. To avoid switch oscillation between NPC and NCC clock sources, a switch oscillation guard time is used.

Configuration Corrupt

User configuration data checksum failure. This is a critical alarm.

Probable Cause

Configuration corrupted or process malfunction.

Recommended Actions

1. If the alarm is present at power-on, reboot (power off, pause, power on).
2. If the alarm is raised after a new software load, revert to the previous SW version and check to see that the alarm has cleared. If cleared, retry the SW load.
3. If the alarm is permanent, and the Flash Card Failure alarm is not active, replace the NCC/IDU.

Additional Information

A checksum is used to determine configuration status during power-up and software reloads. It may also be prompted during a reconfiguration.

Configuration Not Supported (All)

Configuration is not compatible with the hardware. This is a major alarm.

Probable Cause

- Incorrect Node plug-in installed for the configuration, such as DAC 16x, AUX, or a RAC installed in a slot configured for a DAC 155o.
- Incorrect RAC/ODU, or IDU/ODU pairing.
- License violation.

Recommended Actions

1. For a Node, check the configuration required against the plug-in installed. Change either the configuration or the plug-in using the CT Layout screen.
2. Check that the RAC/ODU or IDU.ODU pairing is correct. A RAC 30 or RAC 40 must be paired with an ODU 300. A RAC 10 or IDU must be paired with an ODU 100.
3. Update (increase) license level.

Software/Hardware Incompatible (All)

Hardware is not supported by the installed software. This is a major alarm.

Probable Cause

- There is a software/hardware version mismatch, which may occur when:
  - A new plug-ins is installed, which requires a later version of software than that currently running on the Node.
  - An ODU is installed which requires a later version of software than that currently running on the Node/IDU.

Recommended Actions

To remove the alarm, compatible 9500 MXC software is required; install the latest software.

Additional Information

A check for possible mismatch occurs during the following events:

- Power on
- Software reset
- Plug-in inserted

Date and Time Not Set

Date and time have not been set. This is a warning alarm.

Probable Cause

Configuration incomplete.

Recommended Actions

Use the CT Date/Time screen to configure the settings.

Slot Plug-in Missing

Cannot detect a plug-in in a configured slot. This is a major alarm.

Probable Cause

Plug-in is not installed in a configured slot.

Recommended Actions

1. If the slot is correctly configured, insert the required plug-in.
2. If the slot should be empty, accept the empty status in the CT Layout screen.

Slot Plug-in Incorrect

Plug-in incorrect for the slot configuration. This is a major alarm.

Probable Cause

Wrong plug-in in slot, or slot configuration incorrect for the plug-in.

Recommended Actions

1. If the slot configuration is correct, install the correct plug-in.
2. If the installed plug-in is correct, accept the plug-in in the CT Layout screen, then configure the plug-in.

TDM Clock Locked to NCC

TDM clock is locked to the NCC. This is a warning alarm.

Probable Cause

TDM bus clock has been locked to the NCC using the lock command in CT System Controls.

Recommended Actions

To remove the alarm, remove the lock.

Additional Information

This alarm will only present when an NPC has been installed *and* the lock is applied.

Circuit Loopback

Circuit loopback has been applied. This is a warning alarm.

Probable Cause

A loopback is active - set in the Circuit Loopbacks screen.

Recommended Actions

Remove the loopback.

NMS Configuration Error

Error in the NMS configuration. This is a major alarm.

Probable Cause

Error in the NMS configuration.

Recommended Actions

Check NMS configuration.

NMS Over AUX Channel n Failure

No communication via the NMS over the AUX channel. This is a major alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check the integrity of the connected equipment.
2. Check the AUX card operation and setup.

NMS Over E1 Channel n Failure

No communication via the NMS over the E1 channel. This is a major alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check the integrity of the connected equipment.
2. Check the setup and operation of the relevant DAC plug-in.

Source E1 Frame Sync Loss

No framing pattern in the source E1 signal. This is a major alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Check the integrity of the source signal / equipment.

NMS Extraction Failure

Unable to extract NMS from E1 signal. This is a major alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check the integrity of the connected equipment.
2. Check the setup and operation of the relevant DAC plug-in.

RAC/Radio Alarms

This section lists the RAC/Radio alarms.

Fuse Blown

RAC fuse supplying -48 Vdc to ODU has blown. This is a critical alarm.

Probable Cause

Short circuit on the ODU cable.

Component failure (short circuit) within the ODU.

Recommended Actions

1. Disconnect the ODU cable at the RAC front panel and use a multimeter to check the resistance between inner and outer conductors of the ODU cable. It should measure approximately 0.3 Megohms.
2. If the reading is low, indicating a short circuit, disconnect the ODU cable at the ODU and measure cable resistance, and resistance looking into the ODU.
3. Once the fault has been identified and cleared, the RAC must be replaced; the PCB-mounted fuse is not field replaceable.

Additional Information

ODU input resistance at its Type N connector is nominally 0.3 Megohms.

EEPROM Failure (All)

No communications with the EEPROM. This is a warning alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the terminal may otherwise operate satisfactorily.
2. Reboot the plug-in by withdrawing it from its backplane, pausing, and re-inserting. If the alarm remains, replace it.

Additional Information

The EEPROM supports plug-in identity and internal calibration functions.

Clock Generator Failure (RAC)

Unable to communicate with the clock generator. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

- Check for other alarms:
  - If there are no other alarms, reboot the node (power-off, pause, power on). If the alarm remains, replace the RAC.
  - If there are other alarms which indicate a general loss of communications, an NCC problem is indicated. Reboot the node, and if the alarms remain, replace the NCC.

Additional Information

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the clock generator means its configuration cannot be loaded.

Modulator Failure

No communications with the modulator. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

- Check Modulator Not Locked alarm.
  - If alarmed, replace the RAC.
  - If not alarmed, Detected Tx Power in the CT Performance screen is normal, and there are no remote radio alarms, the failure may not be critical (traffic affecting). Withdraw the RAC from its backplane, pause, and re-insert. If the alarm persists, replace the RAC.

Additional Information

Normally a modulator failure will result in a Modulator Not Locked alarm, which in turn will mute the Tx. Tx muting can be checked in the CT Performance screen.

Demodulator Failure (RAC)

No communications with the demodulator. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

- Check for other alarms:
  - If there are no other alarms except downstream Demodulator Not Locked, and path warning alarms, reboot (power-off, pause, power on).

- If other hardware alarms are present, check for a common cause, such as an NCC power supply or process failure. Reboot, and if the alarms remain, replace the NCC.

Additional Information

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the demodulator means its configuration cannot be loaded.

Cable Demodulator Failure (RAC10/IDU)

Loss of communications with the demodulator. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

- Check for other alarms:
  - If there are no other alarms, reboot the node (power-off, pause, power on). If the alarm remains, replace the RAC10/IDU.
  - If there are other alarms which indicate a general loss of communications, an NCC/IDU problem is indicated. Reboot, and if the alarms remains, replace the NCC/IDU.

Additional Information

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the cable demodulator means its configuration cannot be loaded.

ADC Failure (ODU)

No communications with the analog to digital converter. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the failure is. Depending on the malfunction, the Node/Terminal may otherwise operate satisfactorily.
2. Reboot (power off, pause and power-on). If the alarm persists, replace the ODU.

Additional Information

The ADC in the ODU is used to monitor voltages for presentation to the NCC/IDU. A failure will affect RSL, Detected TX Power, and ODU voltage and temperature readings.

FPGA Software Load Failure (ODU 100)

The software loading of the Field Programmable Gate Array has failed. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

1. If the alarm is raised on initial power-on, retry (reboot) the terminal by switching the 48 Vdc power off, pausing, and then powering on.

2. If the alarm is raised after a new SW load, reload the previous SW version and re-check the alarm. If cleared, retry the SW load.
3. If the alarm is raised after a capacity or backplane reconfiguration, revert to the previous settings. If the alarm has cleared, retry the new configuration.
4. If the alarm is permanent, replace the ODU.

Additional Information

FPGA loading occurs:

- During INU/INUe power-up.
- When a RAC, DAC or AUX is installed in a powered INU/INUe.
- When a new software version is loaded that includes an update to the FPGA.
- ODU FPGA loading *may* occur during a reconfiguration of backplane and/or capacity.

Clock Generator Failure (ODU 100)

Unable to program the clock generator. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Check for other alarms:

- If there are no other alarms, reboot (power-off, pause, power on). If the alarm remains, replace the ODU.
- If there are other ODU alarms which indicate a general loss of communications with the ODU, the problem may be due to loss of power at the ODU, or an NCC/IDU-to-ODU telemetry failure.
- If there are similar alarms on other ODUs, an NCC/IDU problem is indicated. Replace the NCC/IDU.

Where there is doubt, always replace the NCC/IDU before an ODU.

Additional Information

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the synthesiser means its configuration cannot be loaded. The ODU will not operate.

Demodulator Failure (ODU100)

Loss of communications with the demodulator. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

Check for other alarms:

- If there are no other alarms except downstream Rx path failure and path warning alarms, reboot (power-off, pause, power on). If the alarm remains, replace the ODU.

- If there are other ODU alarms, which indicate a general loss of communications with the ODU, the problem may be due to loss of power at the ODU, an ODU cable fault, or an NCC/IDU-to-ODU telemetry failure. Where there is doubt, always replace the NCC/IDU before an ODU.

Additional Information

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the demodulator means its configuration cannot be loaded.

Tx NCO Failure (ODU100)

Loss of communications with the NCO (Numerically Controlled Oscillator). This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

Check for other alarms:

- If there are no other alarms, except upstream Tx path failure alarms, reboot (power-off, pause, power on). If the alarm remains, replace the ODU.
- If there are other ODU alarms which indicate a general loss of communications with the ODU, the problem may be due to loss of power at the ODU, an ODU cable fault, or an NCC/IDU-to-ODU telemetry failure.
- If there are similar alarms on other ODUs, an NCC/IDU problem is indicated. Reboot, and if the alarms remain, replace the NCC/IDU.

Where there is doubt, always replace the NCC/IDU before an ODU.

Additional Information

The NCO supports the modulator.

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the NCO means its configuration cannot be loaded.

Cable Demodulator Failure (ODU100)

Loss of communications with the demodulator. This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

Check for other alarms:

- If there are no other alarms, except upstream Tx path failure and warning alarms, reboot (power-off, pause, power on). If the alarm remains, replace the ODU.
- If there are other ODU alarms which indicate a general loss of communications with the ODU, the problem may be due to loss of power at the ODU, an ODU cable fault, or an NCC/IDU-to-ODU telemetry failure.
- If there are similar alarms on other ODUs, an NCC/IDU problem is indicated. Reboot, and if the alarms remain, replace the NCC/IDU.

Where there is doubt, always replace the NCC/IDU before an ODU.

Additional Information

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the demodulator means its configuration cannot be loaded.

Cable NCO Failure (ODU100)

Loss of communications with the NCO (numerically controlled oscillator). This is a critical alarm.

Probable Cause

Equipment or process malfunction.

Recommended Actions

Check for other alarms:

- If there are no other alarms, except downstream Rx path failure and path warning alarms, reboot (power-off, pause, power on). If the alarm remains, replace the ODU.
- If there are other ODU alarms which indicate a general loss of communications with the ODU, the problem may be due to loss of power at the ODU, an ODU cable fault, or an NCC/IDU-to-ODU telemetry failure.
- If there are similar alarms on other ODUs, an NCC/IDU problem is indicated. Reboot, and if the alarms remain, replace the NCC/IDU.

Where there is doubt, always replace the NCC/IDU before an ODU.

Additional Information

The NCO supports the Rx cable modulator (ODU 100-to-RAC 10).

This alarm is only checked at power-on, reconfiguration, or software reload. Loss of communications to the NCO means its configuration cannot be loaded.

RAC -48V Supply

RAC -48 volt supply out of tolerance. This is a warning alarm.

Probable Cause

Main 48 Vdc power supply to ODU is outside alarm limits of -40.5 to -60 Vdc.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. In particular check the NCC -48V alarm and the ODU -48V Supply alarm. Depending on the malfunction, the link may otherwise operate satisfactorily.
2. Check the -48V ODU supply voltage in the CT Performance screen. This, and NCC and ODU -48 Vdc alarms indicate an out-of-tolerence -48 Vdc supply to the node. Confirm by measuring the -48 Vdc supply with a voltmeter.
3. If the alarm is not supported by other indications and measurement, the voltage sensing circuit is faulty. Replace the RAC.

ODU -48V Supply

ODU -48 volt supply out of tolerance. This is a warning alarm.

Probable Cause

Main 48 Vdc power supply is outside limits of -40.5 to -60 Vdc, or the voltage drop on the ODU cable is excessive due to poor connections or a combination of poor connections and a low -48Vdc power supply.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. In particular, check the NCC/IDU -48V alarm, and for a Node check the RAC -48V Supply alarm. Depending on the malfunction, the node may otherwise operate satisfactorily.
2. Check the -48V ODU Supply voltage in the CT Performance screen, and use a voltmeter to measure the -48V supply at the front panel power connector.
3. If the -48V supply to 9500 MXC is normal, (and for a 9500 MXC Node there is no RAC -48V Supply alarm), suspect excessive voltage drop on the ODU cable, or the voltage sensor circuit in the ODU.
4. If a cable related problem is suspected check the ODU cable, connectors, and connector weatherproofing. Disconnnect the cable at the ODU and apply a short-circuit between inner and outer conductors. Measure the resistance at the node end. For 9913 coax, resistance should be not more than 0.01 ohms per meter (0.003 ohms per ft). Bear in mind that for a 100m run, a resistance of about 1 ohm is expected so care must be taken to ensure correct measurement.
5. If there are no other alarms, the node is operating normally, and the ODU cable is OK, then the voltage sensor circuit and/or its processing in the ODU is the likely cause. Replace the ODU.

Additional Information

CAUTION: use extreme care if attempting to measure voltage at the RAC/IDU front panel ODU connector, or at the ODU end of the cable. Inadvertently shorting the inner to outer will blow the surface-mounted PCB fuse on the RAC, which is not a field replaceble item. HSX repair will not be covered by warranty.

IF Temperature

Modem / IF temperature out of tolerance. This is a warning alarm.

Probable Cause

The ODU is faulty, either with an overheating problem or with a faulty temperature sensor.

Environmental temperature excessive. The ambient must not exceed 55^{o}C (131^{o}F), which is a shaded temperature limit (no solar gain).

Recommended Actions

1. Check for other ODU related over-temperature alarms: Power Detector Temperature, and Transceiver RX Temperature. Also check the PA Current alarm.
2. Use the CT Performance screen to check ODU Temperature and Detected Tx Power. ODU Temperature should not exceed 90°C, and then only in extreme ambient and maximum Tx power conditions. If Detected Tx Power is not normal, this may be as a result of general overheating, or a component failure.
3. If there is correlation between other temperature alarms and/or the ODU Temperature reading, a general overheating of the ODU is indicated. If this cannot be associated with very high ambients, a faulty ODU is indicated. The ODU must be replaced.

4. If there are no other alarms, the ODU Temperature is normal, Detected Tx Power is normal, and the ambient is not high, then a localized alarm measurement fault is indicated. The ODU should be replaced.
5. Where an environmental temperature problem is suspected, use the CT Events Browser and History screens to see if there is an alarm pattern associated with ambient temperature and sun position. If confirmed, a sun shield should be installed for the ODU.

Additional Information

This temperature output is used to maintain correct Modem/IF calibration over temperature. The Modem/IF is located in the ODU.

Solar gain on the ODU can add 10°C or more to the internal ODU temperature, therefore in ambients in excess of 45°C (113°F), solar gain can result in over-temperature situations.

Detected Tx Power should be within 2 dB (typically within 1 dB) of the Tx power setting in a RAC/Radio Plug-ins screen *when ATPC is disabled*. In situations where ATPC is selected, refer to the commissioning record for guidance on a normal Tx power indication.

Power Detector Temperature

Power detector temperature out of range. This is a warning alarm.

Probable Cause

The ODU is faulty due to an overheating problem, or a faulty temperature sensor.

Excessive environmental temperature. The ambient must not exceed 55°C (131°F), which is a shaded temperature limit (no solar gain).

Recommended Actions

1. Check for other ODU related over-temperature alarms: IF Temperature and Transceiver RX Temperature. Also check the PA Current alarm.
2. Use the CT Performance screen to check ODU Temperature and Detected Tx Power. ODU Temperature should not more than 90°C, and then only in extreme ambient and maximum Tx power conditions. If Detected Tx Power is not normal, this may be as a result of general overheating, or a component failure.
3. If there is correlation between other temperature alarms and/or the ODU Temperature reading, a general overheating of the ODU is indicated. If this cannot be associated with very high ambient temperatures, a faulty ODU is indicated. The ODU must be replaced.
4. If there are no other alarms, the ODU Temperature is normal, Detected Tx Power is normal, and the ambient is not high, then a localized alarm measurement fault is indicated. The ODU should be replaced.
5. Where an environmental temperature problem is suspected, use the CT Events Browser and History screens to see if there is an alarm pattern associated with ambient temperature and sun position. If confirmed, a sun shield should be installed for the ODU.

Additional Information

This temperature output is used to maintain correct PA calibration over temperature. It is also presented in the CT Performance screen as ODU temperature.

Solar gain on the ODU can add 10°C or more to the internal ODU temperature, therefore in ambients in excess of 45°C (113°F), solar gain can result in over-temperature situations.

Detected Tx Power should be within 2 dB (typically within 1 dB) of the Tx power setting in a RAC Plug-ins screen *when ATPC is disabled*. In situations where ATPC is selected, refer to the commissioning record for guidance on a normal Tx power indication.

Transceiver RX Temperature

Transceiver RX temperature is out of range. This is a warning alarm.

Probable Cause

The ODU is faulty with an overheating problem or a faulty temperature sensor.

ODU temperature excessive.

Recommended Actions

1. Check for other ODU related over-temperature alarms: Power Detector and IF.
2. Use the CT Performance screen to check ODU Temperature and Detected Tx Power. ODU Temperature should not more than 90°C, and then only in extreme ambient and maximum Tx power conditions. If Detected Tx Power is not normal, this may be as a result of general overheating, or a component failure.
3. If there is correlation between other temperature alarms and/or the ODU Temperature reading, a general overheating of the ODU is indicated. If this cannot be associated with very high ambient temperatures, a faulty ODU is indicated. The ODU must be replaced.
4. If there are no other alarms, the ODU Temperature is normal, Detected Tx Power is normal, and the ambient is not high, then a localized alarm measurement fault is indicated. The ODU should be replaced.
5. Where an environmental temperature problem is suspected, use the CT Events Browser and History screens to see if there is an alarm pattern associated with ambient temperature and sun position. If confirmed, a sun shield should be installed for the ODU.

Additional Information

This temperature output is used to maintain correct transceiver calibration over temperature.

The ambient must not exceed 55°C (131°F), which is a shaded temperature limit (no solar gain).

Detected Tx Power should be within 2 dB (typically within 1 dB) of the Tx power setting in a RAC Plug-ins screen *when ATPC is disabled*. In situations where ATPC is selected, refer to the commissioning record for guidance on a normal Tx power indication.

ODU Communications Failure

Cannot establish communications with the ODU. This is a major alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms, which may indicate a general loss of communications with

the ODU, in which case check the -48V supply to the ODU, and ODU cable.

2. If this is the only alarm, and it has been active for at least 5 minutes, reboot (power off, pause, power on). If the alarm remains, replace the ODU.

Additional Information

Alarm is triggered by a loss of the PPP (point-to-point protocol) link between the NCC and ODU.

It indicates a failure within the ODU microprocessor, or an active watchdog event, which should time-out within 5 minutes.

Remote Communications Failure

Cannot establish communications with the remote terminal. This is a major alarm.

Probable Cause

Path loss or equipment malfunction.

Recommended Actions

Check for other alarms:

- If Demodulator Not Locked and Rx path failure and path warning alarms are active, an Rx path or remote Tx failure is indicated.
- If Demodulator Not Locked is *not* active (traffic is not affected), a process or component failure in the radio overhead is indicated, which may be at the local or remote end, and may also be causing loss of NMS, Auxiliary channels, and Alarm I/O over the link. The problem may be one-way or both-way affecting.
- If there are no traffic affecting path alarms, check NMS operation and ODU alarms:
- If NMS is lost to the remote end, loss of the overhead channel is indicated.
- If an AUX plug-in is configured for the link, check the Auxiliary Channel Clock Fail alarm(s). If active, it also indicates loss of the overhead channel.
- If there are no RAC/Radio or ODU alarms to indicate a local process or component failure, check alarms at the remote site.
- Check to see if the communications failure is a both-way or one-way problem. If both-way, the problem is more likely to be within an NCC/IDU. If one-way the problem is more likely to be within one of the ODUs or RAC/Radios at the mux (Tx) or demux (Rx) stages.

Additional Information

The Remote Communications Failure alarm signals that internal communication between link ends is lost. This communication is carried in the overhead channel, which also carries NMS, Auxiliary channels and Alarm I/O. The alarm is triggered from the NCC/IDU.

Bus Facing IF Loopback

Bus facing IF loopback is active. This is a warning alarm.

Probable Cause

IF Loopback has been selected in the CT System Controls screen.

Recommended Actions

To remove the alarm, remove the loopback.

TX Power Mute

Transmitter power amplifier is muted. This is a warning alarm.

Probable Cause

Tx mute has been selected in CT System Controls.

Recommended Actions

To remove the alarm, delete the selection.

Additional Information

Tx mute may be used to mute the online Tx of a protected pair to test the forcing of a transmitter switch from the remote radio (silent Tx switch command).

ATPC Disabled

The ATPC function has been disabled. This is a warning alarm.

Probable Cause

ATPC has been disabled through a CT command in the System Controls screen.

Recommended Actions

Re-enable ATPC in the CT System Controls screen.

TX Manual Lock

Transmit manual switch mode is active. This is a warning alarm.

Probable Cause

One of the transmitters of a hot-standby or diversity pair has been forced (locked) as Tx online.

Recommended Actions

To remove the alarm, remove the lock.

RX Manual Lock

Receive manual switch mode is active. This is a warning alarm.

Probable Cause

The primary or secondary designated RAC of a hot-standby or diversity pair has been forced online from the CT System Controls screen (forced to deliver Rx data to the TDM bus).

Recommended Actions

To remove the alarm, remove the lock.

Bus Facing Digital Loopback

Bus facing digital loopback is active. This is a warning alarm.

Probable Cause

Digital Loopback has been selected in CT System Controls.

Recommended Actions

To remove the alarm, remove the loopback.

ODU XPD Measurement Mode

ODU XPD measurement mode is active. This is a warning alarm.

Probable Cause

The XPD measurement mode has been selected in the System/Controls screen for a RAC 40 or RAC 4X. When selected, the normal RSSI voltage on the ODU RSSI connector is replaced by a voltage representative of the received-signal cross-polarization discrimination.

Recommended Actions

To remove the alarm, deselect the mode.

TDM Bus Write Override

Bus write override is active. This is a warning alarm.

Probable Cause

Bus write override is activated when Disable for Removal is selected on a module. This option is used to ensure that removal of a module will not affect other traffic traversing an INU/INUe.

- Some modules, when withdrawn, may cause a momentary hit on other traffic.
- Disable for removal ensures that when a module is withdrawn, no hit on other traffic will occur.
- Unless withdrawn, a module will be automatically re-enabled within 60 seconds.

Recommended Actions

To remove the alarm, select re-enable on the relevant module, or wait for the 60 second time-out.

TX Synthesiser Not Locked

Transmitter is not on frequency. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Confirm that transmitter power has been muted using the Detected Tx Power measurement in the CT Performance screen. Replace the ODU.

Additional Information

This alarm will mute the transmitter to prevent spurious transmission.

The Tx synthesiser controls the link transmit frequency.

Transceiver TX Failure

Failed transceiver module. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Confirm loss of transmitter using Detected Tx Power in the CT Performance screen. Replace the ODU.

TX IF Synthesiser Not Locked

Transmitter IF not on frequency. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Confirm that transmitter power has been muted using the Detected Tx Power measurement in the CT Performance screen. Replace the ODU.

This alarm will mute the transmitter to prevent spurious transmission.

Modulator Not Locked

Modulator is not locked. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check Detected Tx Power in the CT Performance screen to confirm failed operation. A Modulator Not Locked alarm, should mute the ODU Tx.
2. Reboot (power off, pause, power on). If the alarm remains:
3. For a RAC 30 or RAC 40, replace the RAC.
4. For a RAC10/IDU, replace the ODU (ODU 100).
5. After rebooting, also check Modulator Failure (RAC 30/40) and Cable Demodulator Failure (ODU 100) alarms, which if active, confirm a hardware failure.

Additional Information

A Tx mute is applied to prevent transmission of spurious signals.

For a RAC10/Radio, an ODU Cable Demodulator Not Locked Alarm, if active, will force a Modulator Not locked Alarm.

RAC TX Cable IF Synth Not Locked

RAC TX cable IF synthesiser not locked. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Replace the RAC.

Additional Information

Alarm indicates the ODU cable Tx IF frequency is not locked. It is possible for traffic to pass over a link with IF synthesisers not locked, but it will be errored with a high BER. This may be checked using the Performance screen parameters for the remote radio.

RAC and ODU Tx Cable IF synthesisers use a common 10 MHz clock in the RAC. If the ODU Tx Synth Not Locked alarm is also active it confirms a fault with the RAC 10 MHz clock.

ODU TX Cable IF Synth Not Locked

ODU TX cable IF synthesiser not locked. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Replace the ODU.

Additional Information

An ODU TX cable IF synthesiser failure affects all communications to the remote-end terminal. Remote end path alarms (BER, ES, SES, ESR, and SESR) will also be on.

Cable Demodulator Not Locked (ODU 100)

ODU cable demodulator not locked . This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms. As a consequence of this alarm, the Modulator Not Locked alarm should be active, which in turn will mute the Tx to prevent possible spurious transmission.
2. Reboot (power off, pause, power on).
3. After rebooting check for a Cable Demodulator Failure alarm. If active it indicates a loss of communications with the demodulator, which comfirms a hardware failure. Replace the ODU.
4. Regardless, if the alarm remains, replace the ODU.

ODU TX Cable Unplugged

Cannot detect ODU cable. This is a critical alarm.

Probable Cause

Cable is disconnected or faulty.

Recommended Actions

Check the cable and its connectors.

RX Synthesiser Not Locked

Receiver not on frequency. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Replace the ODU.

Additional Information

The Rx synthesiser sets the link receive frequency. Failure will affect all communications from the remote radio. Downstream path failure and path warning alarms will also be activated.

RX IF Synthesiser Not Locked

Receiver IF not on frequency. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Replace the ODU.

Additional Information

Alarm indicates the ODU cable Rx IF frequency is not locked. It is possible for traffic to pass over a link with IF synthesisers not locked, but it will be errored with a high BER. This may be checked using local Performance screen parameters.

Demodulator Not Locked

Demodulator cannot synchronise to Rx data. This is a critical alarm.

Probable Cause

Path loss, or equipment malfunction.

Recommended Actions

Check other local Link (RAC/Radio) alarms.

- A *path or remote Tx failure* is indicated by the absence of upstream Rx alarms.
    - For a RAC 30/40 possible upstream alarms include Rx Synthesiser and Rx IF Synthesiser alarms.
    - For a RAC 10 / IDU possible upstream ODU alarms include Rx Synthesiser and Tuner alarms.
- A *component failure* is indicated by the *additional* presence of:
    - For a RAC 30/40, one or more of the upstream alarms indicated in 1) above, or alarms indicating a loss of communications with the ODU, such as an ODU Cable Unplugged alarm.
    - For a RAC 10 / IDU, one or more of the alarms indicated in 1) above.
- A *remote Tx failure* is indicated in the absence of upstream Rx alarms, and weather conditions not supporting reasons for a full path fade.

Additional Information

Demodulator unlocked is the primary receive-signal path and equipment alarm. Always check upstream, towards the ODU, path and remote radio, to ascertain the cause.

For a RAC 30/40, the demodulator is located in the RAC. For a RAC 10 / IDU, the demodulator is located in the ODU.

An unlocked demodulator will activate downstream path failure and path warning alarms.

RAC/IDU Cable Demodulator Not Locked

RAC 10 / IDU cable demodulator not locked . This is a critical alarm.

Probable Cause

Equipment malfunction or path loss.

Recommended Actions

1. Check upstream alarms:
   - ODU Cable Modulator Not Locked
   - Demodulator Not Locked
   - Tuner Not Locked
   - RX Synthesiser Not Locked
2. If the only active alarms *from this list* are Demodulator Not Locked *and* ODU Cable Modulator Not Locked, a path or remote Tx problem is indicated. Confirm a lack of receive signal using the RSL measurement in the CT Performance screen.
3. If RX Synthesiser Not Locked, *or* Tuner Not Locked, *or* just ODU Cable Modulator Not Locked are active, an ODU problem is indicated.
4. If RAC/IDU Cable Deomodulator Not Locked *is the only active alarm*, a RAC 10 / IDU problem is indicated.
5. *If not a path or remote Tx problem*, reboot (power off, pause, power on):
6. If the RAC/IDU Cable Demodulator Not Locked alarm remains, *and is the only active alarm* (excluding any path warning alarms), replace the RAC/IDU.
7. Where active alarms include ODU Component Failure or RX Synthesiser Not Locked, *or* Tuner Not Locked, *or* just ODU Cable Modulator Not Locked, replace the ODU.

Additional Information

This cable demodulator is locked to the signal from the ODU cable modulator, which in turn is locked to the demodulator.

Tuner Not Locked

Receive path tuner has failed. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Reboot (power off, pause, power on). If the alarm remains, replace the ODU.

Additional Information

The Tuner supports I/Q demodulation. Failure will affect all receive traffic.

Downstream alarms will be active: Demodulator Not Locked, ODU Cable Modulator Not Locked, RAC Cable Demodulator Not Locked, and Rx path failure and warning alarms.

ODU Cable Modulator Not Locked (ODU 100)

ODU 100 cable modulator not locked . This is a critical alarm.

Probable Cause

Equipment malfunction or path loss.

Recommended Actions

1. Check upstream alarms:
   - Demodulator Not Locked
   - Tuner Not Locked
   - RX Synthesiser Not Locked
2. If the only active alarms *from this list* are Demodulator Not Locked *and* ODU Cable Modulator Not Locked, a path or remote Tx problem is indicated. Confirm a lack of receive signal using the RSL measurement in the CT Performance screen.
3. If RX Synthesiser Not Locked, *or* Tuner Not Locked, *or* just ODU Cable Modulator Not Locked are active, an ODU problem is indicated, reboot (power off, pause, power on). If alarms remain, replace the ODU.

Additional Information

The cable modulator is locked to the signal from the demodulator.

ODU Cable Unplugged

ODU cable unplugged alarm is active. This is a critical alarm.

Probable Cause

The ODU cable is disconnected or faulty.

Recommended Actions

- Check The RAC OnLine LEDs for the affected link.
  - If alarmed (red), it confirms a problem on the ODU cable, or the -48 Vdc supply failure to the ODU. Check the ODU cable and connectors, and RAC -48V Supply alarm.
  - If not alarmed (green), it indicates a telemetry problem at the ODU; traffic is not being affected. Check Detected Tx Power and RSL in the CT Performance screen. If not readable, it confirms a telmetry problem. Replace the ODU.

Additional Information

The ODU Cable Unplugged alarm is activated by a failure to detect telemetry data from the ODU. A failure may be due to the cable, the -48Vdc supply to the ODU, or a problem within the ODU telemetry hardware.

A telemetry failure means all management communication to the ODU is lost. If the power supply is interrupted, or a soft reset applied, it cannot be configured; the ODU will not operate.

RAC RX Cable IF Synthesiser Not Locked

The RAC RX cable IF synthesiser is not locked. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Withdraw the RAC, pause, then reinsert.

Replace the RAC.

ESR Threshold Exceeded

G.826 ESR threshold exceeded. This is a path warning alarm.

Probable Cause

Path conditions, interference, or equipment malfunction.

Recommended Actions

- Check for other alarms, particularly those that indicate a total LOS due to a component failure, or a complete path failure:

  - Component failure or Rx path failure alarms must be checked before investigating an RSL Below Threshold alarm.

  - If the only other alarms are Demodulator Not Locked, and its downstream path failure and path warning alarms, a path failure is indicated, which may be caused by a complete path fade or a remote Tx failure.

  - If ESR Threshold Exceeded is the only alarm, or the only other alarms *are also path warning alarms*, check G.826 and RSL measurements at both ends using the CT Performance screen:

  - If low RSL and G.826 alarms are present *at both ends of the link*, a path problem is indicated, which most likely will be caused by a degraded path due to rain, diffraction or mulipath fading. Check recommended actions for BER alarms.

  - If an ESR alarm is present *at just the local end and RSL is normal*, interference from another link should be suspected. Use the CT History and Event Browser screens to track the onset of ESR alarms, which for a newly installed interferring link should show a repetition of G.826 alarm occurences as the new link is installed and commissioned.

Additional Information

An ES (errored second) is a one-second period with one or more errored blocks or at least one defect.

ESR (errored second ratio) is the ratio of ES to total seconds in available time during a fixed measurement interval. For 9500 MXC the measurement interval is 60 seconds, and the ESR alarm threshold is set at 20%.

SESR Threshold Exceeded

G.826 severely errored seconds ratio exceeded. This is a warning alarm.

Probable Cause

Path conditions, interference or equipment malfunction.

Recommended Actions

- Check for other alarms, particularly those that indicate a total LOS due to a component failure, or a complete path failure:

  - Component failure or Rx path failure alarms must be checked before investigating an SESR Threshold alarm.

- If the only other alarms are Demodulator Not Locked, and its downstream path failure and path warning alarms, a path failure is indicated, which may be caused by a complete path fade or a remote Tx failure.

- If SESR Threshold Exceeded and other G.826 path warning alarms *are the only alarms active*, check G.826 and RSL measurements at both ends using the CT Performance screen:

- If low RSL and G.826 alarms are present *at both ends of the link*, a path problem is indicated, which most likely will be caused by a degraded path due to rain, diffraction or mulipath fading. Check recommended actions for BER alarms.

- If ESR and SESR alarms are present *at just the local end and RSL is normal*, interference from another link should be suspected. Use the CT History and Event Browser screens to track the onset of ESR alarms, which for a newly installed interferring link should show a repetition of G.826 alarm occurences as the new link is installed and commissioned.

Additional Information

An SESR threshold alarm will be preceeded by an ESR threshold alarm, and BER alarms.

A severely errored second is one-second period, which contains at least 30% errored blocks or at least one defect. After 10 consecutive SESs a link is considered to be unavailable.

SESR is the ratio of SES to total seconds in available time during a fixed measurement interval. For 9500 MXC the measurement interval is 60 seconds, and the alarm threshold is 10 percent.

10^{-3} BER Threshold Exceeded

Received data has exceeded a threshold of 1 error bit in a data stream of 10^3 bits (0.1% error rate). This is a path warning alarm.

Probable Cause

The most common cause is path degradation through rain fade, diffraction, or multipath. Other causes are equipment malfunction or interference.

Recommended Actions

- Check for other alarms, particularly those that indicate a component failure, or a complete path failure:

  - Component failure or Rx path failure alarms must be checked before investigating a BER Threshold alarm.

  - If the only other alarms are Demodulator Not Locked, and its downstream path failure and path warning alarms, a path failure is indicated, which may be caused by a complete path fade or a remote Tx failure.

  - If BER Threshold Exceeded *is the only active alarm, apart from other G.826 path warning alarms*, check G.826 and RSL measurements at both ends using the CT Performance screen:

- If low RSL and G.826 alarms are present *at both ends of the link*, a path problem is indicated, which is most likely caused by a degraded path due to rain, diffraction or mulipath fading. Prevailing weather conditions should provide clues to support such conditions. If low RSLs remain (*permanent at both ends*) a change in path parameters is indicated, such as an antenna out of alignment, or an obstacle in the signal path. If there have been abnormal weather conditions such as exceptionally strong winds, suspect antenna alignment.
- If BER Threshold alarms are present *at just the local end and RSL is normal*, a failure in the modulation process at the remote end, or interference from another link should be suspected:

  - - Check remote-end LINK/RAC Tx alarms. An equipment problem is not normally fleeting, meaning the Event Browser screen should show a permanent alarm with a definite starting point.

  - - A newly installed interferring link should show a repetition of G.826 alarm occurences as it is installed and commissioned. Use the CT History and Event Browser screens to track the onset of BER alarms.

  - If BER alarms coincide with low RSL *and just one end of the link is affected*, a remote RAC or ODU equipment problem is indicated. Check remote Detected Forward Power and Tx alarms.

Additional Information

A 10^{-3} BER threshold alarm is preceded by 10^{-6} BER threshold alarm.

Rain fade is the likely cause of fade for links 13 GHz and higher. Diffraction and multipath/ducting for links 11 GHz and lower. If these alarms are persistent, there could be a problem with the link design or original installation.

Check that all other link health indicators are normal before investigating an interference problem. Then check for any new link installations in the same geographical area, on the same frequency band, which coincide with the onset of BER alarms. Confirming interference may require use of a spectrum analyzer.

10^{-6} BER threshold exceeded

Received data has exceeded a threshold of 1 error bit in a data stream of 10^6 bits (0.0001% error rate). This is a warning alarm.

Probable Cause

The most common cause is path degradation through rain fade, diffraction, or multipath. Other causes are equipment malfunction or interference.

Recommended Actions

- Check for other alarms, particularly those that indicate a component failure, or a complete path failure:
  - Component failure or Rx path failure alarms must be checked before investigating a BER Threshold alarm.
  - If the only other alarms are Demodulator Not Locked, and its downstream path failure and path warning alarms, a path failure is indicated, which may be caused by a complete path fade or a remote Tx failure.
  - If BER Threshold Exceeded *is the only active alarm, apart from other G.826 path warning alarms*, check G.826 and RSL measurements at both ends using the CT Performance screen:

- If low RSL and G.826 alarms are present *at both ends of the link*, a path problem is indicated, which is most likely caused by a degraded path due to rain, diffraction or mulipath fading. Prevailing weather conditions should provide clues to support such conditions. If low RSLs remain (*permanent at both ends*) a change in path parameters is indicated, such as an antenna out of alignment, or an obstacle in the signal path. If there have been abnormal weather conditions such as exceptionally strong winds, suspect antenna alignment.
- If BER Threshold alarms are present *at just the local end and RSL is normal*, a failure in the modulation process at the remote end, or interference from another link should be suspected:

  - - Check remote-end LINK/RAC Tx alarms. An equipment problem is not normally fleeting, meaning the Event Browser screen should show a permanent alarm with a definite starting point.

  - - A newly installed interferring link should show a repetition of G.826 alarm occurences as it is installed and commissioned. Use the CT History and Event Browser screens to track the onset of BER alarms.
- If BER alarms coincide with low RSL *and just one end of the link is affected*, a remote RAC or ODU equipment problem is indicated. Check remote Detected Forward Power and Tx alarms.

Additional Information

Rain fade is the likely cause of fade for links 13 GHz and higher. Diffraction and multipath/ducting for links 11 GHz and lower. If these alarms are persistent, there could be a problem with the link design or original installation.

Check that all other link health indicators are normal before investigating an interference problem. Then check for any new link installations in the same geographical area, on the same frequency band, which coincide with the onset of BER alarms. Confirming interference may require use of a spectrum analyzer.

XPIC Cable Unplugged

No signal is detected at the XPIC input connector. This is a warning alarm.

Probable Cause

Cable unplugged or equipment malfunction.

Recommended Actions

1. Check the cables.
2. Replace the RAC 40.

ODU PA Current

ODU PA current out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

Replace the ODU.

Additional Information

A fault condition is more likely to be raised on the PA current-high alarm limit rather than current-low, in which case correlation may be found with one or more of the ODU temperature alarms and/or an abnormal Forward Power measurement. Noise and errors may also be introduced on the transmitted signal, which may show as abnormal BER and ES figures at the remote end.

Traffic Path Down

The radio path is down. True for non-protected and for protected/diversity configurations. This is a critical alarm.

Probable Cause

Path loss or equipment malfunction.

Recommended Actions

1. Check for path loss.

   Traffic will be affected in both directions.

   A complete path loss will almost invariably be preceded by a low RSL and BER alarms; check CT History and Event Browser screens and associated event help.

2. Check equipment.
3. An equipment related path loss should be signalled by alarms from the ODU, RAC, or NCC.
4. Such alarms may be at the local or remote end and may be one-way or both-way traffic affecting.

Protection Cable Unplugged

Unable to detect the protection cable. This is a warning alarm.

Probable Cause

Cable not present/disconnected.

Recommended Actions

Check/install the protection cable.

Protection Partner Comms Failure

Unable to establish communications with the partner IDU in a protected configuration. This is a warning alarm.

Probable Cause

The partner IDU is powered off, there is an equipment failure, or there is non-matching system software installed on the IDUs.

Recommended Actions

Check that both IDUs are powered on and have matching system SW loaded.

Check to see if the alarm is present on one or both IDUs.

Check the Protection screen on both IDUs to see if the partner IP address is displayed. No partner IP address confirms a comms failure.

Replace one IDU. If this does not clear the alarm, return the replaced IDU to service, and replace its partner IDU.

DAC Alarms

This section lists the DAC alarms.

LIU Failure

No communications with the LIU (line interface unit). This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

For a 9500 MXC Node, withdraw the DAC from its backplane, pause, and re-insert. If the alarm persists, replace the DAC.

For a 9500 MXC Terminal, reboot (power off, pause, power on). If the alarm persists, replace the IDU.

Additional Information

Depending on the DAC/Trib, the LIU function includes selection of E/DS rate, balanced/unbalanced, and line impedance.

Clock Generator Failure (DAC)

Unable to program the clock generator. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the terminal may otherwise operate satisfactorily.
2. Replace the DAC.

Additional Information

The clock generator sets the timing for the FPGA.

Trib n Output AIS Enabled

Alarm indication signal transmitted on trib(s). This is a warning alarm.

Probable Cause

AIS has been enabled (forced) on the alarmed trib or tribs using commands in the CT System Controls screen. AIS can be forced on E1, DS1, E3, DS3, or STM1/OC3 tribs.

Recommended Actions

To remove the alarm, de-select AIS.

Additional Information

AIS may be selected to replace the normal signal to indicate to the receiving equipment that there is a transmission interruption at the equipment originating the AIS signal, or upstream of that equipment. In this user-enabled instance, AIS can be used to test traffic or alarm continuity on uncommissioned (non-traffic carrying) tribs, or to send a signal downstream to indicate traffic has been interrupted (for example, a service check is being performed).

For E1, DS1, E3, DS3 tribs, AIS is generated as an unframed, all-ones signal.

For an STM1/OC3 trib, AIS selection inserts a PRBS15 pattern (15 bit pseudo-random bit sequence).

The AIS enabled alarm is activated on a per trib basis.

Trib n Radio Facing Loopback

Trib data looped back to radio path. This is a warning alarm.

Probable Cause

A radio facing (TDM bus facing) loopback has been established on a trib using commands in the CT System Controls screen.

Recommended Actions

To remove the alarm, deselect the loopback.

Additional Information

When a radio-facing loopback is placed on an E1/DS1 trib, AIS is inserted on the line/customer facing direction of that trib.

Trib n Line Facing Loopback

Trib data looped back to line. This is a warning alarm.

Probable Cause

A line-facing loopback has been established on a trib STM1 using commands in the CT System Controls screen.

Recommended Actions

To remove the alarm, deselect the loopback.

Additional Information

When a line-facing loopback is placed on a trib, the trib-in data is also allowed to pass through to the TDM bus / radio.

Trib n Line Bus Loopback - NEW

Trib data looped back to bus line. This is a warning alarm.

Probable Cause

A line-facing loopback has been established on a trib bus using commands in the CT System Controls screen.

Recommended Actions

To remove the alarm, deselect the loopback.

Additional Information

When a line-facing loopback is placed on a trib, the trib-in data is also allowed to pass through to the TDM bus / radio.

Trib n Link Test Enabled

Trib built in link test applied. This is a warning alarm.

Probable Cause

The built-in BER test has been applied to a trib.

Recommended Actions

To remove the alarm, deselect the test.

Additional Information

In the link test mode traffic on the selected tributary is replaced by a standard 2^{15-1} pseudo random bit sequence (PRBS) test pattern. Link BER from the received pattern can then be estimated. The test is normally run with the remote radio in loopback. Counters are provided for:

a) The number of errored bits while synchronized to the PRBS

b) The number of error free bits while synchronized to the PRBS

This test can only be applied to one tributary at a time.

TX Manual Lock

A RAC diagnostic is active. This is a warning alarm.

Probable Cause

RAC is in diagnostic mode. Lock(s) set in the System/Controls screen.

Recommended Actions

Remove the lock(s).

RX Manual Lock

A receive diagnostic is active. This is a warning alarm.

Probable Cause

RAC is in diagnostic mode. Lock(s) set in the System/Controls screen.

Recommended Actions

Remove the lock(s).

Trib n LOS

Loss of signal on a commissioned tributary. This is a critical alarm.

Probable Cause

The failure may be within the attached equipment, the trib cable, or the radio.

Recommended Actions

1. Check for alarms on trib-attached equipment, which may indicate loss of signal input from this source.

2. Check the trib cable and connectors.
3. Check the configuration of the affected trib. Ensure correct line options are selected.
4. Run a loop-back test on the affected trib using an external BER tester.
5. If the test is OK, the problem is in the attached equipment or cabling.
6. If the test fails, replace the DAC/IDU.

Additional Information

This alarm is raised at the affected end of the link only.

For an E1/DS1 trib, AIS will be inserted towards the TDM bus/radio, provided the trib is ticked as commissioned in its CT plug-ins screen.

Trib n Output Failure

The output to the customer equipment has failed. This is a critical alarm.

Probable Cause

Output device or card error.

Recommended Actions

1. Withdraw the DAC, pause, then reinsert.
2. Replace the DAC.

Trib n Uncommissioned Traffic

Signal received on an uncommissioned tributary. This is a warning alarm.

Probable Cause

Traffic has been detected on an uncommissioned tributary. This indicates that the circuit has been configured but not classified as commissioned.

Recommended Actions

1. Go to the CT circuits screen and tick the commissioned/uncommissioned box to show commissioned.
2. When a trib is commissioned, it and its associated circuit should be named. Trib naming is done in the Plug-ins screen; circuit naming in the Circuits screen.

Trib n AIS

AIS received on tributary. This is a warning alarm.

Probable Cause

AIS has been detected on a trib input due to an alarm condition within the connected equipment, or upstream from the directly connected equipment.

Recommended Actions

Investigate the AIS source, first in the directly connected equipment, and then in its upstream connections.

AUX Alarms

This section lists the AUX alarms.

Alarm Input (n)

AUX alarm input is active, where ‘n’ can be 1 to 6 for a 9500 MXC Node, or 1 to 2 for a Terminal. This is a warning alarm.

Probable Cause

AUX alarm input is active.

Recommended Actions

Investigate the cause of the activating event.

Additional Information

This alarm draws attention to a changed, active state on a configured AUX alarm input.

Auxiliary Channel (n) Clock Failure

Auxiliary channel clock failure, where ‘n’ may be 1 to 3 for a 9500 MXC Node, or 1 for a Terminal. This is a warning alarm.

Probable Cause

No clock has been detected on an auxiliary port configured for synchronous data.

Recommended Actions

This alarm will only be activated when an AUX port has been configured for an *external clock and no clock is detected on the customer interface*.

The loss of external clock normally indicates a failed connection to external equipment, which is providing the clock.

Alternatively, if it is a new configuration, the external clock selection in the AUX plug-ins screen may be incorrect.

Additional Information

The AUX acts as a DCE (data communication equipment). A general rule is that DCE devices provide the clock (internal clocking) and that the DTE (data termination equipment), such as a PC, synchronizes on the provided clock (external clocking).

Normally, on any given synchronous data circuit *one* DCE device is configured as the master device, and has internal clock selected. This master DCE ensures all other DCE devices, which have external clock selected, and DTEs, are maintained in synchronization.

Where the 9500 MXC AUX sync circuit is providing connection between two DTEs (such as two PCs) one AUX must be set for internal clock, the other external.

Where a 9500 MXC AUX sync circuit is used to extend a circuit which includes other (external) DCEs, again, just one DCE must be configured to provide an internal clock. This DCE may be one of the 9500 MXC AUX plug-ins, or an external DCE device, such as a modem.

If more than one DCE is selected to provide an internal clock, data slippage will occur.

When *internal* clocking is used, the Tx clock is phase locked to an internal oscillator. When *external* clocking is used the phase of the outgoing Tx clock is locked to the clock signal provided from the received (external) clock.

When connecting from a DCE to a DTE, a straight cable is used. When connecting from a DCE to another DCE, a cross-over cable must be used.

The AUX Rx and Tx clock phase selection options are normally not critical for correct operation. It is recommended that they are left as default.

AUX (n) Bus Facing Loopback

A bus-facing loopback exists on an auxiliary data port, where ‘n’ may be port 1, 2, or 3 for a 9500 MXC Node, or 1 for a Terminal. This is a warning alarm.

Probable Cause

A bus-facing loopback has been set in the CT System Controls screen for the alarmed auxiliary.

Recommended Actions

To remove the alarm, deselect the loopback.

AUX (n) Line Facing Loopback

A line-facing loopback exists on an auxiliary data port, where ‘n’ may be port 1, 2, or 3 for a 9500 MXC Node, or 1 for a Terminal. This is a warning alarm.

Probable Cause

A line-facing loopback has been set in the CT System Controls screen for the alarmed auxiliary.

Recommended Actions

To remove the alarm, deselect the loopback.

NPC Alarms

This section lists the NPC alarms.

Clock Generator Failure (NPC)

Unable to program the clock generator. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Check for other alarms to determine how critical the alarm is. Depending on the malfunction, the link may otherwise operate satisfactorily.
2. Replace the NPC.

Additional Information

The clock generator sets the timing for the FPGA.

+5V Digital Supply (NPC)

+5 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Providing the NCC is maintaining supply to the node (is not alarmed), replace the NPC. Traffic will not be affected.
2. If the NCC is faulty or has been removed, first check for other alarms to determine how critical the alarm is. Depending on the malfunction, the node may otherwise operate satisfactorily.
3. If node operation is not affected (traffic is not affected) ensure the NCC is installed and indicating no alarms before replacing the NPC.

Additional Information

A node will not restart (boot up) without an NCC.

Before replacing an NPC, the NCC must have been installed for not less than 3 minutes to ensure it has a full node status update. Prior replacement of an NPC, which is driving the TDM bus clock, may result in traffic loss.

+3.3V Digital Supply (NPC)

3.3 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Providing the NCC is maintaining supply to the node (is not alarmed), replace the NPC. Traffic will not be affected.
2. If the NCC is faulty or has been removed, first check for other alarms to determine how critical the alarm is. Depending on the malfunction, the node may otherwise operate satisfactorily.
3. If node operation is not affected (traffic is not affected) ensure the NCC is installed and indicating no alarms before replacing the NPC.

Additional Information

A node will not restart (boot up) without an NCC.

Before replacing an NPC, the NCC must have been installed for not less than 3 minutes to ensure it has a full node status update. Prior replacement of an NPC, which is driving the TDM bus clock, may result in traffic loss.

-5V Digital Supply (NPC)

-5 volt digital supply out of tolerance. This is a warning alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Providing the NCC is maintaining supply to the node (is not alarmed), replace the NPC. Traffic will not be affected.
2. If the NCC is faulty or has been removed, first check for other alarms to determine how critical the alarm is. Depending on the malfunction, the node may otherwise operate satisfactorily.
3. If node operation is not affected (traffic is not affected) ensure the NCC is installed and indicating no alarms before replacing the NPC.

Additional Information

A node will not restart (boot up) without an NCC.

Before replacing an NPC, the NCC must have been installed for not less than 3 minutes to ensure it has a full node status update. Prior replacement of an NPC, which is driving the TDM bus clock, may result in traffic loss.

-48 Vdc Supply (NPC)

48 volt supply out of tolerance. This is a warning alarm.

Probable Cause

48 Vdc power supply to NPC is outside limits of -40.5 to -60 Vdc.

Recommended Actions

1. Check the NCC -48 Vdc alarm, and the ODU -48 V supply in the CT Performance screen.
2. If all indications match, the power supply for the node is at fault. Confirm with a voltmeter check.
3. If the supply voltage is correct, suspect the voltage sensor circuit in the NPC. Replace the NPC.

Additional Information

A node will operate to specification with a supply voltage between -40.5 and -60 Vdc.

Providing the NCC is maintaining power supply to the node, an NPC may be replaced without affecting traffic.

NPC TDM Clock Failure

The NPC TDM clock has failed.

Probable Cause

Equipment malfunction.

Recommended Actions

Reboot the NPC by withdrawing it from its backplane, pausing, and re-inserting. If the alarm remains, replace the NPC.

Additional Information

Providing the NCC is maintaining the clock, replacing the NPC will not affect traffic.

TDM Clock Locked to NPC

TDM clock is locked to the NPC. This is a warning alarm.

Probable Cause

TDM bus clock has been locked to the NPC using the lock command in CT System Controls.

Recommended Actions

To remove the alarm, remove the lock.

DAC ES Alarms

This section lists the DAC ES alarms.

Switch Access Failure

No communications with Ethernet switch. This is a critical alarm.

Probable Cause

Equipment malafunction.

Recommended Actions

- Check Transport Channel Failure and Port Failure alarms.
  - If active, replace the DAC.
  - If not active (traffic is not affected) DAC replacement is not urgent. *Providing* a replacement DAC ES is to hand, try re-booting the alarmed DAC by withdrawing it from its backplane, pausing, and re-inserting.

Additional Information

The switch provides the port-to-channel bridging and switching functions.

Channel PRBS Test Active

PRBS test applied. This is a warning alarm.

Probable Cause

The built-in BER test has been applied to a channel.

Recommended Actions

To remove the alarm, deselect the test.

Additional Information

In the link test mode traffic on the selected channel is replaced by a pseudo random bit sequence (PRBS) test pattern. Channel BER from the received pattern can then be estimated. The test is normally run with the remote DAC ES or DAC GE in channel loopback. Counters are provided for:

a) The number of errored bits while synchronized to the PRBS

b) The number of error free bits while synchronized to the PRBS

Channel Loopback Active

DAC ES / DAC GE channel data looped back to radio path. This is a warning alarm.

Probable Cause

A radio facing (bus facing) loopback has been established on a DAC ES / DAC GE channel using commands in the CT System/Controls screen.

Recommended Actions

To remove the alarm, deselect the loopback.

Port Loopback Active

DAC ES / DAC GE port data looped back to channel/radio path. This is a warning alarm.

Probable Cause

A channel/radio facing (bus facing) loopback has been established on a DAC ES / DAC GE port using commands in the CT System/Controls screen.

Recommended Actions

To remove the alarm, deselect the loopback.

Port Monitoring Active

A DAC ES / DAC GE port has been set to monitor another port. This is a warning alarm.

Probable Cause

Port monitoring has been established on a DAC ES / DAC GE port using commands in the CT System/Controls screen.

Recommended Actions

To remove the alarm, deselect the monitoring.

Additional Information

Port monitoring allows an unused port to connect across a selected port to facilitate transparent attachment of test equipment for traffic monitoring purposes.

Port Shutdown Active

A DAC ES / DAC GE port has been shut down. This is a warning alarm.

Probable Cause

The port has shut down.

Recommended Actions

Reactivate the port.

.Direct Link Active

A direct port-to-channel link has been set. This is a warning alarm.

Probable Cause

A port-to-channel link has been established on a DAC ES / DAC GE using commands in the CT System/Controls screen.

Recommended Actions

To remove the alarm, deselect the option.

Additional Information

Direct Link options provide:

a) Port 1 to Channel 1 direct connection or,

b) Port 1 to Channel 1, *and* Port 2 to Channel 2.

When active, port to channel associations configuerd in the DAC ES / DAC GE plug-ins screen are replaced by the selected option.

Transport Channel (n) Switch Packet Errors

High FCS (frame check sequence) errors where 'n' is channel 1 or 2. This is a warning alarm.

Probable Cause

Traffic received on the alarmed channel is errored. The errors may be caused by equipment/circuit malfunction or radio path degradation.

Recommended Actions

1. Check alarms on the remote DAC ES / DAC GE.
2. If the same alarm is present, it indicates a both-way problem, which is likely to be caused by radio path degradation. Confirm by checking path alarms and alarm history on the radio links connecting the DAC ES / DAC GE plug-ins.
3. If the same alarm is not present, it indicates an equipment or process malfunction, which may be in the local or remote DAC ES / DAC GE, or within associated RAC/ODUs providing the connection. Check node alarms at the local and remote sites, and at any intermediate sites, for possible problems.
4. The DAC ES / DAC GE PRBS generator and loopback diagnostic options may be used to verify DAC ES / DAC GE channel-to-channel operation.
5. Use the channel loopback setting for a go-and-return test.
6. Without a loopback a one-way test is supported, using the PRBS Tx function at one end, and Rx at the other.
7. If there are no other alarms or performance issues to indicate the likely source of the problem, replace first one DAC ES / DAC GE, and then the other. They are hot-pluggable.

Additional Information

Switch packet errors are determined over a DAC ES / DAC GE link, which may exist across multiple radio paths; error checking is between local and remote DAC ES / DAC GE plug-ins.

High switch packet errors will reduce Ethernet traffic throughput, which in turn may raise Dropped Frame alarms, particulary so where the available bandwidth was already limited.

Link Failure (DAC ES, DAC GE)

The DAC ES / DAC GE Ethernet port is down. This is a warning alarm.

Probable Cause

No valid Ethernet framing data received on the port.

Recommended Actions

1. Check the Ethernet connector activity LEDs for the alarmed port.
2. If activity is absent, unplug the RJ-45 port cable and plug it into one of the NCC Ethernet NMS connectors.
3. If LED activity on the plugged NMS connector is absent, check connected equipment and cabling.
4. If activity is present (green LED indicates a valid Ethernet connection; orange flashing indicates Ethernet receive traffic), replace the DAC ES / DAC GE.

Additional Information

The port Enabled check box in the DAC ES / DAC GE plug-ins screen must be checked to enable traffic on the port. Only when checked, *and* no valid framing data is detected, will this alarm be raised.

Dropped Frames Ratio (DAC ES, DAC GE)

Ratio of dropped frames to total frames has exceeded threshold. Separate alarms indicate thresholds exceeded for 10%, 20%, 40% or 80%. This is a warning alarm.

Probable Cause

Inadequate bandwidth on one or both channels.

Recommended Actions

1. Provide increased bandwidth on the affected channel (increase the number of E1/DS1 circuits used to transport the channel).
2. Use the Rx and Tx count registers in CT System/Controls to determine which ports are carrying most traffic, and from this, based on the operational mode selected in the DAC ES or DAC GE plug-ins screen, determine which channel is primarily affected (requires additional bandwidth).
3. If traffic requirements have changed since the DAC ES or DAC GE was first configured, also review port priority selections. When frames are being dropped, it is likely that traffic assigned on lowest priority ports will be most affected.

Additional Information

When buffer space runs out, frames will be dropped, and a dropped-frame counter increments to provide the ratio count of dropped frames to total frames.

DAC GE Alarms

This section lists the DAC GE alarms.

ICPU Failure

No communications with the electrical or optical transceiver module. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Withdraw the DAC GE, pause, then reinsert.
2. Replace the DAC GE.

ICPU Software Failure

The DAC GE processor software is unavailable or unstable. This is a major alarm.

Probable Cause

There is a version mismatch in the CPU software.

Recommended Actions

1. DAC GE requires SW release 3.1 or later. SW must be upgraded to to 3.4 or later to secure access to RWPR and to advanced link aggregation.
2. Replace the DAC GE.

ICPU Memory Failure

During a software vesion change, the DAC GE has failed to load the flash application. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Withdraw the DAC GE, pause, then reinsert.
2. Replace the DAC GE.

Link Down

A channel link in the DAC GE is down. This is a major alarm.

Probable Cause

Traffic received on the alarmed channel is errored. The errors may be caused by equipment/circuit malfunction or radio path degradation.

Recommended Actions

1. Check for other link alarms (RAC, DAC 155oM), which may indicate a failed link, a degraded path or an equipment malafunction.
2. Replace the DAC GE.

Link Degraded

A channel link in the DAC GE is degraded in capacity. This is a warning alarm.

Probable Cause

Traffic received on the alarmed channel is degraded in capacity. The errors may be caused by equipment/circuit malfunction or radio path degradation.

Recommended Actions

1. Check for other link alarms (RAC, DAC 155oM), which may indicate a degraded path or an equipment malafunction.
2. Replace the DAC GE.

Link Forced Shutdown Shutdown

A channel link in the DAC GE has been shut down. This is a warning alarm.

Probable Cause

The link has shut down.

Recommended Actions

3. Reactivate the link.

Ethernet Bridge Cable Unplugged

The Ethernet bridging cable required between port 2 of protected IDU partners is missing, or is unplugged at one end. This is a warning alarm.

Probable Cause

Cable not present/disconnected.

- An Ethernet cable (Mdi/straight cable) is required between port 2 of the protected IDUs.
- This is called the Ethernet Bridge cable, and is in addition to the IDU-IDU protection and NMS cables

Recommended Actions

Check/install the cable.

DAC 155oM Alarms

This section lists the DAC 155oM alarms.

PMC TEMAP Access Failure

No communications with the mapper IC. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Withdraw the DAC 155oM, pause, then reinsert.
2. Replace the DAC 155oM.

PMC OHT Access Failure

No communications with the overhead processor. This is a critical alarm.

Probable Cause

Equipment malfunction.

Recommended Actions

1. Withdraw the DAC 155oM, pause, then reinsert.
2. Replace the DAC 155oM.

Bus Trib z Loop-Back Enabled

Loop-back has been applied to tributary z. This is a warning alarm.

Probable Cause

A loopback has been established on a trib using commands in the CT System/Controls screen.

Recommended Actions

To remove the alarm, deselect the loopback.

Ring Manual Lock

Ring manual lock is active. This is a warning alarm.

Probable Cause

A ring lock has been established using commands in the CT System/Controls screen.

Recommended Actions

To remove the alarm, deselect the lock(s).

RDI In

Remote degrade/defect indication in this section. This is a major alarm.

Probable Cause

Problem with the transmitted signal.

Recommended Actions

Check for other alarms.

Replace the DAC 155oM or its optical transceiver.

Additional Information

1. Indicates a remote degrade/defect in this section. K2[6..8] = "110" for 3 frames.
2. This alarm is returned to the transmitting-end (local) mux upon detection at the remote-end mux of an incoming signal degrade/defect.

AIS In

Multiplexer section Alarm Indication Signal detected in. This is a major alarm.

Probable Cause

Signal source for this section is not present.

Recommended Actions

1. Check the signal source and connections at the input to the remote-end multiplexer.
2. Check to see if the remote mux is in diagnostic mode (loopbacks set).

Signal Degrade BER

BER exceeded the configured threshold based on B2 of line overhead. This is a major alarm.

Probable Cause

Cable integrity, optical transceiver.

Recommended Actions

1. Check for higher-level alarms, such as Signal Fail BER and LOS.
2. Check cable, connectors and if the probelm persists replace the optical transceiver or mux card at the local end, followed by the remote end.

Additional Information

Alarm is raised when BER exceeds the configured threshold. Threshold is user configurable for 10-6, 10-7, or 10-8. Based on B2 of line overhead.

Signal Fail BER

BER exceeded the signal fail threshold (10^{-3}). This is a critical alarm.

Probable Cause

Cable integrity, optical transceiver.

Recommended Actions

Check other alarms for an indication of a cable failure, a remote-end mux malfunction, or local-end transceiver failure.

Additional Information

Alarm is based on B2 of the line overhead.

LOS

Loss of Signal (LOS) alarm detected in the regenerator. This is a critical alarm.

Probable Cause

A cable is disconnected or the pier equipment laser is off.

Recommended Actions

1. Check presence of other alarms to help determine if the problem is cable or equipment based.
2. Check remote-end mux/regenerator operation.

Additional Information

Loss of signal is raised when the signal level drops below the threshold at which a BER of 1 in 10-3 is predicted. Clears when two consecutive framing patterns are received and no new LOS condition is detected.

LOF

Loss of Frame (LOF) alarm detected in the regenerator. This is a critical alarm.

Probable Cause

Pier equipment malfunction.

Recommended Actions

1. Check presence of other alarms to help determine if the problem is cable or equipment based.
2. Check remote-end mux/regenerator operation.

Additional Information

Occurs when an OOF state persists, typically for 3 mS. Clears when an in-frame condition exists continuously - typically 3 milliseconds.

OOF

Out of Frame (OOF) alarm detected in the regenerator. This is a critical alarm.

Probable Cause

Pier equipment malfunction.

Recommended Actions

1. Check presence of other alarms.
2. Check operation of the remote-end mux/regenerator.

Additional Information

Occurs when consecutive frames (typically 4-5) are received with errored patterns (A1/A2 bytes). Max time to detect is 625 uS - clears within 250 uS when two consecutive frames are received with valid framing.

Container x AIS

AIS detected in container x. This is a minor alarm.

Probable Cause

Signal source for this container is not present.

Recommended Actions

Check the remote-end signal source.

Additional Information

Alarm is raised for ‘All 1’s in pointer bytes H1 and H2 for three consecutive frames.

Container x LOP

Loss of Pointer (LOP) detected in container x. This is a major alarm.

Probable Cause

Signal source for this container is not present.

Recommended Actions

1. Check for other alarms that may indicate a loss of signal or a weak/degraded signal, such as LOS, OOF or Signal Degrade/Fail BER.

2. Check to see if alarms are present on the remote-end mux, which may indicate a both-way cable-related fault. If one way (far-end Tx, local-end Rx), check/replace the optical transceiver or complete mux card at each end.

Additional Information

LOP is raised when invalid STS-1 pointers are received for 8 consecutive frames of 8 consecutive enabled NDFs were detected. It indicates loss of synchonization and/or excessive jitter.

Container x LOM

Loss of Multi-frame (LOM) detected in container x. This is a minor alarm.

Probable Cause

The multi-frame indicator is missing or invalid.

Recommended Actions

1. Check for other alarms that may indicate receipt of an errored signal, such as LOS for a weak signal and LOP for loss of sync through excessive jitter.
2. If all other indicators are OK, replace the DAC 155oM.

Additional Information

Alarm is raised for incorrect H4 value for 8 frames. The correct 4 frame sequence was not detected for 8 frames.

Container x RDI

Remote degrade/defict indication (RDI) in container x. This is a minor alarm.

Probable Cause

There is a problem with the transmitted signal in this container.

Recommended Actions

1. Check for other higher-level alarms, such as RDI-in.
2. Replace the DAC 155oM.

Additional Information

This alarm is returned to the transmitting-end (local) mux upon detection at the remote-end mux of an incoming LOS, LOF, or AIS defect.

Container x RPSLM

Receive Path Signal Label Mismatch (RPSLM) for container x. Received C2 not equal to Expected C2 byte value. This is a minor alarm.

Probable Cause

Configuration mismatch.

Recommended Actions

Check configuation of the signal label on the DAC 155oM and its remote mux.

Low Order Path, Container/Trib y in Alarm

Failure in the low order path, container y summary alarm. This is a minor alarm.

Probable Cause

Probable cause is specific to the type of failure:

- RDI (V5[8] set to 1 for 5 consecutive frames)
- AIS (V5[1..3] all 1's)
- PSLM (Received V5[5..7] not equal to expected V5[5..7])
- LOP (8 invalid pointers received or 8 consecutive enabled NDFs)
- RFI (v5[4] set to 1 for 5 consecutive frames)

Recommended Actions

1. Check for higher-order alarms on the DAC 155oM and on the remote mux.
2. If this is the only alarm check if a lower-order path alarm is also present on the remote mux.
3. Check its impact on the traffic being transported.
4. Withdraw, pause, and re-insert the DAC 155oM.
5. Replace the DAC 155oM.

Additional Information

This alarm action is triggered by one or more of the listed events.

FAN Alarms

This section describes the fan alarm.

Fan Failure (FAN)

FAN plug-in alarm. This is a warning alarm.

Probable Cause

FAN plug-in malfunction, most likely a failure of one of the two axial fans.

Recommended Actions

Replace the FAN.

Additional Information

The two axial fans operate in protected mode. In the event the operational fan fails, the standby fan will come on line. While both fans will run if the INU temperature exceeds a preset threshold, normally just one will run, and operation will be cycled between the two.

The FAN is field replaceable and can be hot-swapped; removal will not affect traffic.

CT Informational Events

This section lists informational events that may occur with CT or other equipment. The event messages for informational events, and the associated meaning, are listed below.

AIS Transmission Ceased

AIS transmission to customer connected equipment has ceased. The log entry includes a reference to the affected tributary.

AIS Transmitted

AIS is being transmitted to customer connected equipment. The log entry includes a reference to the affected tributary.

Alarm Output 1 Activated

Alarm output one has been activated. The note field indicates if the output circuit is high or low.

Alarm Output 1 Deactivated

Alarm output one has been deactivated. The note field indicates if the output circuit is high or low.

Alarm Output 2 Activated

Alarm output two has been activated. The note field indicates if the output circuit is high or low.

Alarm Output 2 Deactivated

Alarm output two has been deactivated. The note field indicates if the output circuit is high or low.

Alarm Output 3 Activated

Alarm output three has been activated. The note field indicates if the output circuit is high or low.

Alarm Output 3 Deactivated

Alarm output three has been deactivated. The note field indicates if the output circuit is high or low.

Alarm Output 4 Activated

Alarm output three has been activated. The note field indicates if the output circuit is high or low.

Alarm Output 4 Deactivated

Alarm output three has been deactivated. The note field indicates if the output circuit is high or low.

ATPC Active

The ATPC function has been enabled by the user.

ATPC Inactive

The ATPC function has been disabled by the user.

ATPC Max Power for 15 Minutes

This info event is added to the log for each 15 minute period that ATPC is at maximum.

ATPC Max Power Out of Range

The ATPC maximum power is above the maximum power or below the minimum power capabilities.

ATPC Min Power Out of Range

The ATPC minimum power is above the maximum power or below the minimum power capabilities.

ATU Flushed

The ART has been flushed and address learning will start again - unless disabled.

Automatic Learning Disabled

Automatic learning has been disabled.

Automatic Learning Enabled

Automatic learning has been enabled.

Configuration Auto Reverted

The configuration of this terminal has been automatically reverted to the previously inactive configuration. The log entry includes the original value of the revert timer.

Configuration Changed

One or more of the configurable items on this terminal have been changed.

Configuration User Reverted

The configuration of this terminal has been reverted to the previously inactive configuration.

Date / Time Changed

A user has changed the date and/or the time on the INU.

Date/Time Changed By SNTP

The date/time on the INU has been changed by SNTP.

Event Action Accepted

Event action accepted.

Event Action Created

Event action created.

Event Log Activitiy Resumed

The addition of an event to the event log has been resumed.

Event Log Activitiy Suspended

The addition of an event to the event log has been suspended. Entry includes the alarm event name.

Event System Restart

Event system has restarted due to power on or a soft reset occurring.

Excessive Dropped Frames

Ratio of dropped to total frames exceeded 10% over the last 60 seconds.

Generic Trap

Information event related to the generic trap messages defined by the SNMP standard (RFC 1157) and the SMIv2 (RFC 2578). The text description field identifies the generic trap details.

ICPU Firmware Loaded

A new ICPU firmware 8051 flash application has been downloaded (automatically due to version mismatched, empty code flash, or forced download).

Incorrect License Entered

The user has not entered in the correct licence code.

License Entered

The user has enabled functionality on this terminal by entering a licence code. The log will provide details of the new functionality.

Low Memory

The notes field will provide details of the type of memory and remaining size.

MAC Aging Time Changed

The time that an active MAC address will be kept in the ART has changed.

MAX MTU Size Changed

The maximum MTU size on a DAC GE has been changed in CT.

Module Reset Triggered

The error-free timer on a Super-PDH ring has triggered an unwrap.

MTU Size Changes

There have been MTU or maximum MTU size changes.

NMS Configuration Error

The NMS configuration is invalid.

CT User Logged Off

User logged off from the terminal or the session expired. Includes an indication if the user logged off or the session expired.

CT User Logged On

User logged on to the terminal.

POST Failed

Power on self test did not complete without errors. The log entry identifies the failed test.

Power On

The INU has completed a power on reset. Note that this entry could be replaced by the standard cold start trap.

Protected Partner Mismatched Software Version

The protected partner does not have the same software version. The notes field will display the local and partnered software versions.

Protection Switch

Protection switch has occurred. The log entry will include details of the reason for the switch. Applies to RAC and DAC protection.

Protection Switch Failure

A required protection switch was unable to occur. The log entry will include details of the reason for the failure.

Rapid TC Failure Detect Enabled

Rapid Transport Channel Failure Detection has been enabled on a RAC/Radio.

Rapid TC Failure Detect Disabled

Rapid Transport Channel Failure Detection has been disabled on a RAC/Radio.

Ring Configuration Mismatch

The ring configuration is mismatched to its neighbour node (eg. primary - primary).

Ring Manual Mode Disabled

The manual ring wrap or unwrap mode has been deconfigured by the user.

Ring Manual Mode Enabled

The manual ring wrap or unwrap mode has been configured by the user. The log entry serves as a warning that no automatic ring switching will take place while this mode is active.

RWPR Enabled

The RWPR algorithm has been enabled in this port/TC of the switch.

RWPR Disabled

The RWPR algorithm has been disabled in this port/TC of the switch.

RWPR Network Changed

The RWPR network has been changed.

Rx Performance Monitoring Reset

The Rx performance monitoring values for RSSI maximum and minimum have been reset.

Set Power Out of Range

The Tx power set was above the maximum power or below the minimum power capabilities.

Software Changed

The software version being used by the terminal has been changed. The log entry includes the new and the previous software version.

Software File Received

A file has been received by the terminal. The log entry includes the file name and size.

Software Reset

Software has been reset by CT or SNMP.

Terminal Accessed By Stratex Key

The terminal has been accessed by using a password generated by the manufacturer.

Traffic Alignment Error

Data received via a transport channel is misaligned. The log entry includes the channel number.

Unsuccessful Access Attempt

An unsuccessful user access attempt. Attempts to enter a valid user name or password have failed.

Unsupported Configuration

A value in the configuration was found to be invalid or the terminal is not calibrated. The log entry will include details of the problem.

User Authentication Disabled

User authentication disabled.

User Authentication Enabled

User authentication enabled.

User Authentication Failed

User authentication failed.

User Authentication Successful

User authentication successful.

User Password Admin Reset

User password admin reset.

Watch Dog Expired

The INU has detected that some processes are not responding.

Appendix C. INU/INUe and IDU Connector and Cable Data

This appendix provides information on:

- DAC and IDU Tributary Connectors and Cables
- NMS Connectors and Cables
- Auxiliary and Alarm Connectors and Cables

9500 MXC tributary, auxiliary and NMS cables are not to be routed with any AC mains power lines. They are also to be kept away from any power lines which cross them.

For safety reasons 9500 MXC tributary, auxiliary and NMS cables should not be connected to outside plant.

Use approved surge suppression equipment when connecting to un-protected external inputs and outputs.

DAC and IDU Tributary Connectors and Cables

Connector and cable data is provided for:

- DAC 16x Cable and Connector Data
- DAC 4x and IDU
- DAC ES

DAC 16x Cable and Connector Data

Refer to:

- DAC 16x Mini RJ-21 to BNC Cable Assembly on page -2
- DAC 16x Mini RJ-21 to RJ-45 Straight and Crossover Cable Assemblies on page -4
- DAC 16x Mini RJ-21 to Wire Wrap Cable Assembly on page -7
- DAC 16x Mini RJ-21 Connector Pin Assignments on page -9

Ensure correct orientation of the Mini RJ-21 connector before pushing it home. This can be checked by the scalloped key to one side of the connector. Additionally, a trib cable supplied by Alcatel-Lucent has the cable exiting to the right side when viewed from the front

DAC 16x Mini RJ-21 to BNC Cable Assembly

This assembly is available with a cable length of 2 m:

- Mini RJ-21 to 16xBNC Connectors, 2m, Part No: 3CC52026AAAA

Figure C-1 shows the assembly; each supports up to 8 tribs (16xBNC connectors). Two cable assemblies are required per DAC 16x if more than 8xE1/DS1tribs are to be connected.

Figure C-1. DAC 16x Mini RJ-21 to BNC Unbalanced Trib Cable Assembly for 8xE1/DS1 Tribs

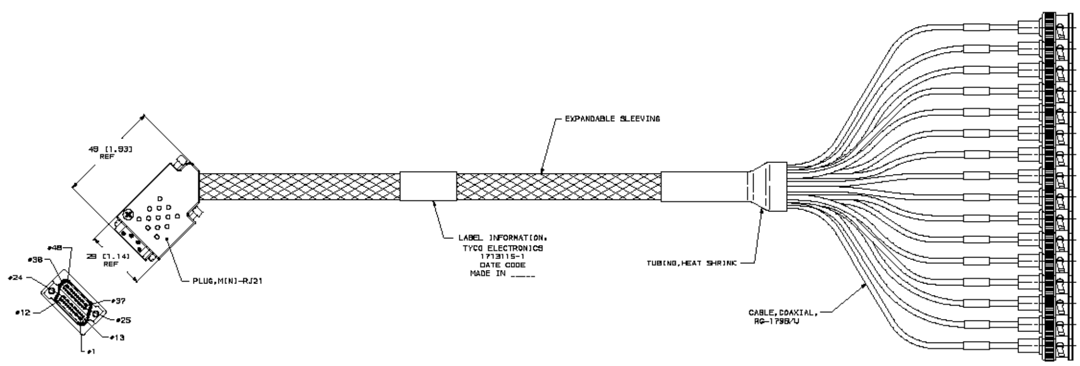
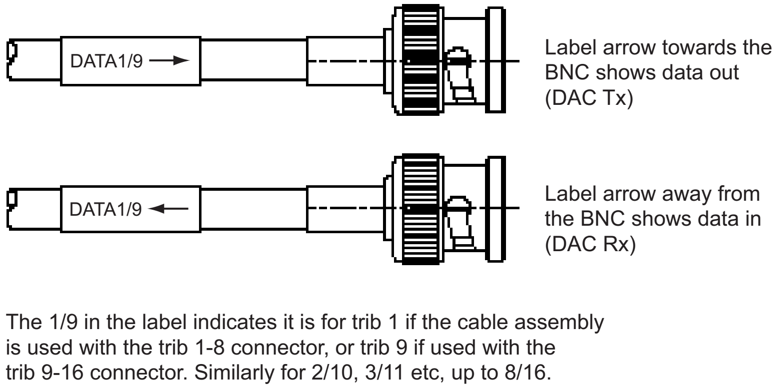


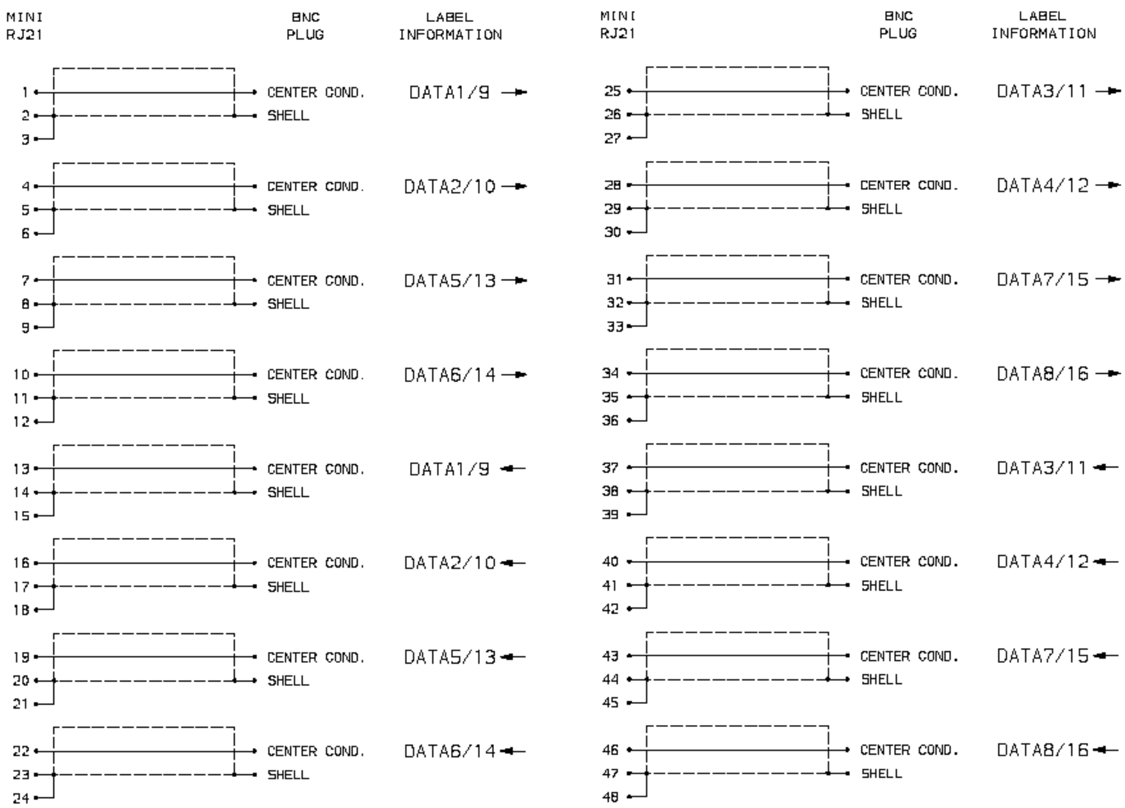
Figure C-2 shows the cable label data.

Figure C-2. Unbalanced Cable Label Data



[Figure C-3](#) shows the cable pin assignment and label data.

Figure C-3. DAC 16x Mini RJ-21 to BNC Cable Pin Assignments And Labelling



DAC 16x Mini RJ-21 to RJ-45 Straight and Crossover Cable Assemblies

These assemblies extend to balanced 120 ohm connections.

Straight cable assemblies are used when connecting to RJ-45 patch panels that have a built-in crossover function:

- Mini RJ-21 to 8xRJ-45 Connectors, Straight, 2m, Part No: 3CC52032AAAA
- Mini RJ-21 to 8xRJ-45 Connectors, Straight, 5m, Part No: 3CC52034AAAA

Crossover cable assemblies are used to interconnect one DAC or IDU RJ-45 port to another.

- Mini RJ-21 to 8xRJ-45 Connectors, Crossover, 1m, Part No: 3CC52037AAAA
- Mini RJ-21 to 8xRJ-45 Connectors, Crossover, 5m, Part No: 3CC52041AAAA

Figure C-4 shows the assembly. Each assembly supports up to eight tribs. Two cable assemblies are required per DAC 16x if more than 8xE1/DS1tribs are to be connected.

Figure C-4. DAC 16x Mini RJ-21 to RJ-45 Balanced Trib Cable Assembly for 8xE1/DS1 Tribs

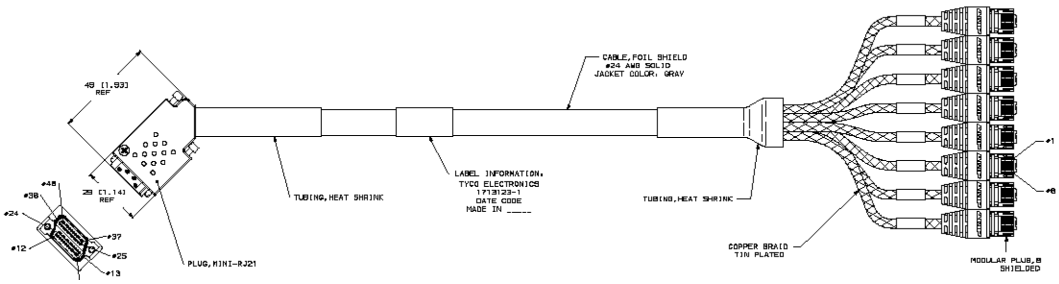


Figure C-5 shows the pin numbering for the RJ-45 cable connector.

Figure C-5. RJ-45 Cable Connector (Modular Plug) Pin Numbering

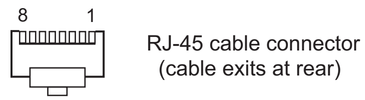
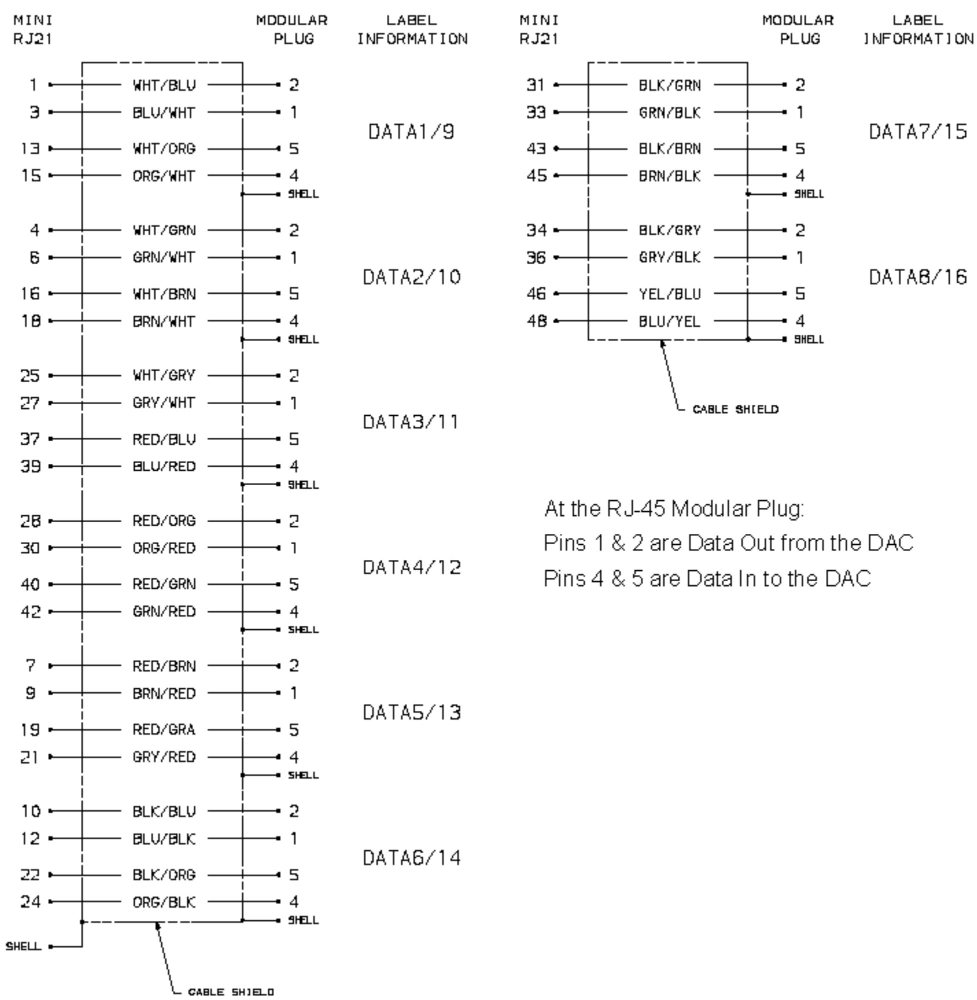


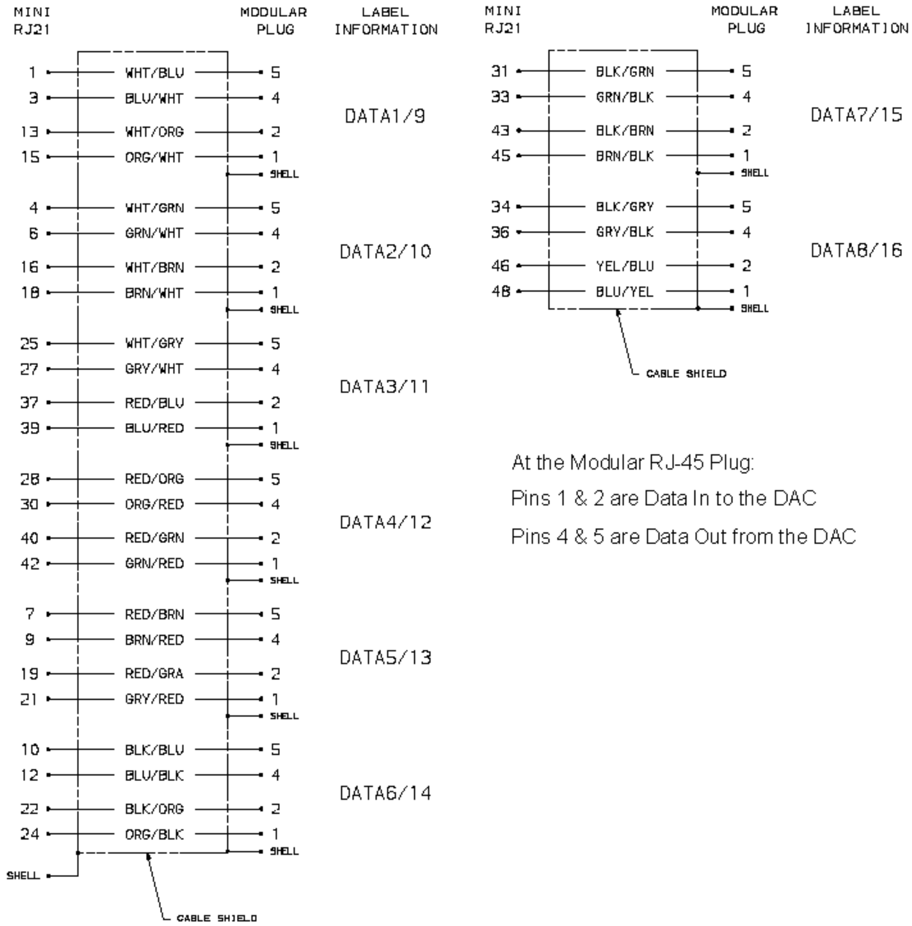
Figure C-6 shows the cable data for the straight cable assembly.

Figure C-6. DAC 16x Mini RJ-21 to RJ-45 Balanced Straight Cable Data



[Figure C-7](#) shows the cable data for the crossover cable assembly.

Figure C-7. DAC 16x Mini RJ-21 to RJ-45 Balanced Crossover Cable Data



DAC 16x Mini RJ-21 to Wire Wrap Cable Assembly

The assemblies support balanced 120 ohm connections.

Wire-end cables are intended for use with insulation displacement, punch-down termination blocks:

- Mini RJ-21 to 8xWire-Wrap, 2m, Part No: 3CC52028AAAA
- Mini RJ-21 to 8xWire-Wrap, 10m, Part No: 3CC52055AAAA
- Mini RJ-21 to 8xWire-Wrap, 32m, Part No: 3CC52076AAAA

Figure C-8 shows the assembly. Each assembly supports up to 8 tribs. Two cable assemblies are required per DAC 16x if more than 8xE1/DS1tribs are to be connected.

Figure C-8. DAC 16x Mini RJ-21 to Wire Wrap Cable Assembly

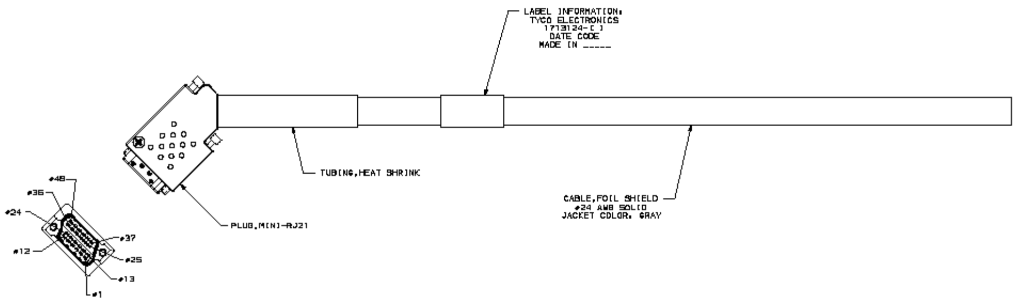
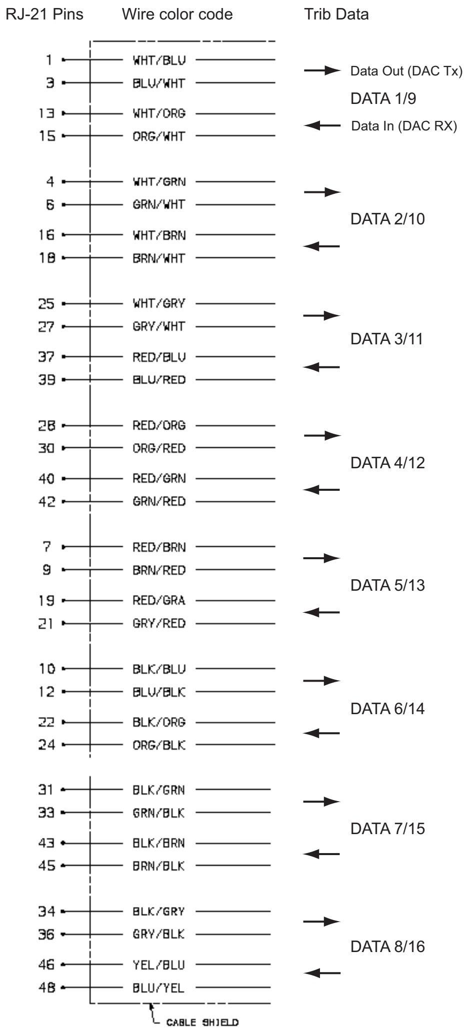


Figure C-9 shows the color coding for the cable pairs.

The 1/9 in Figure C-9 indicates it is for trib 1 if the cable assembly is used with the trib 1-8 connector, or trib 9 if used with the trib 9-16 connector. Similarly for 2/10, 3/11 and so on, up to 8/16.

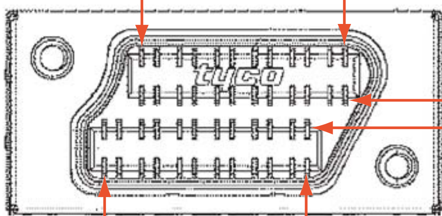
Figure C-9. DAC 16x Mini RJ-21 to Wire Wrap Cable Data



DAC 16x Mini RJ-21 Connector Pin Assignments

Table C-1shows trib 1 to 8 pin assignments for the DAC 16x front panel Mini RJ-21 connector. For trib 9 to 16 pin assignments, refer to Figure C-10.

Figure C-10. Mini RJ-21 Front Panel Connector Pin Data (face view)



TX or Transmit refers to an output from the DAC and specifies towards the user.

RX or Receive refers to an input to the DAC and specifies from the user.

Table C-1. DAC 16x Mini RJ-21 Pin Assignments for E1/DS1 Tribs 1-8

Pin	Function
1	Tributary 1 transmit tip (center)
2	Common Ground
3	Tributary 1 transmit ring (shield)
4	Tributary 2 transmit tip (center)
5	Common Ground
6	Tributary 2 transmit ring (shield)
7	Tributary 5 transmit tip (center)
8	Common Ground
9	Tributary 5 transmit ring (shield)
10	Tributary 6 transmit tip (center)
11	Common Ground
12	Tributary 6 transmit ring (shield)
13	Tributary 1 receive tip (center)
14	Common Ground
15	Tributary 1 receive ring (shield)
16	Tributary 2 receive tip (center)
17	Common Ground
18	Tributary 2 receive ring (shield)
19	Tributary 5 receive tip (center)

Pin	Function
20	Common Ground
21	Tributary 5 receive ring (shield)
22	Tributary 6 receive tip (center)
23	Common Ground
24	Tributary 6 receive ring (shield)
25	Tributary 3 transmit tip (center)
26	Common Ground
27	Tributary 3 transmit ring (shield)
28	Tributary 4 transmit tip (center)
29	Common Ground
30	Tributary 4 transmit ring (shield)
31	Tributary 7 transmit tip (center)
32	Common Ground
33	Tributary 7 transmit ring (shield)
34	Tributary 8 transmit tip (center)
35	Common Ground
36	Tributary 8 transmit ring (shield)
37	Tributary 3 receive tip (center)
38	Common Ground
39	Tributary 3 receive ring (shield)
40	Tributary 4 receive tip (center)
41	Common Ground
42	Tributary 4 receive ring (shield)
43	Tributary 7 receive tip (center)
44	Common Ground
45	Tributary 7 receive ring (shield)
46	Tributary 8 receive tip (center)
47	Common Ground
48	Tributary 8 receive ring (shield)

Table C-2. DAC 16x Mini RJ-21 Pin Assignments for E1/DS1 Tribs 9-16

Pin	Function
1	Tributary 9 transmit tip (center)
2	Common Ground
3	Tributary 9 transmit ring (shield)
4	Tributary 10 transmit tip (center)
5	Common Ground
6	Tributary 10 transmit ring (shield)
7	Tributary 13 transmit tip (center)
8	Common Ground
9	Tributary 13 transmit ring (shield)
10	Tributary 14 transmit tip (center)
11	Common Ground
12	Tributary 14 transmit ring (shield)
13	Tributary 9 receive tip (center)
14	Common Ground
15	Tributary 9 receive ring (shield)
16	Tributary 10 receive tip (center)
17	Common Ground
18	Tributary 10 receive ring (shield)
19	Tributary 13 receive tip (center)
20	Common Ground
21	Tributary 13 receive ring (shield)
22	Tributary 14 receive tip (center)
23	Common Ground
24	Tributary 14 receive ring (shield)
25	Tributary 11 transmit tip (center)
26	Common Ground
27	Tributary 11 transmit ring (shield)
28	Tributary 12 transmit tip (center)
29	Common Ground
30	Tributary 12 transmit ring (shield)
31	Tributary 15 transmit tip (center)
32	Common Ground

Pin	Function
33	Tributary 15 transmit ring (shield)
34	Tributary 16 transmit tip (center)
35	Common Ground
36	Tributary 16 transmit ring (shield)
37	Tributary 11 receive tip (center)
38	Common Ground
39	Tributary 11 receive ring (shield)
40	Tributary 12 receive tip (center)
41	Common Ground
42	Tributary 12 receive ring (shield)
43	Tributary 15 receive tip (center)
44	Common Ground
45	Tributary 15 receive ring (shield)
46	Tributary 16 receive tip (center)
47	Common Ground
48	Tributary 16 receive ring (shield)

DAC 4x and IDU

Refer to:

- DAC 4x and IDU RJ-45 to BNC Cable Assembly on page -13
- DAC 4x and IDU RJ-45 to RJ-45 Straight Cable on page -14
- DAC 4x and IDU RJ-45 to RJ-45 Crossover Cable on page -15
- DAC 4x and IDU RJ-45 to Wire Wrap Cable Assembly on page -16
- DAC 4x and IDU RJ-45 Connector Pin Assignments on page -17

DAC 4x and IDU RJ-45 to BNC Cable Assembly

The assembly is provided as a kit of three cables. Each kit provides:

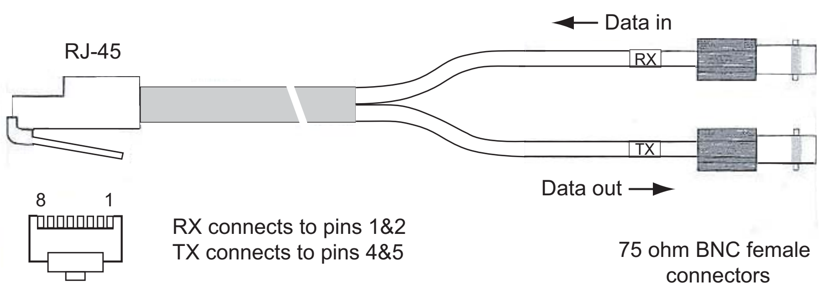
- One RJ-45 to 2 x BNC female, 0.5m long. Refer to Figure C-11.
- Two BNC to BNC male extension cables, 2m long.

The kit is labelled as a 2.5m cable kit:

- RJ-45 to 2xBNC, 2.5m, Part No: 3CC52022AAAA

Each supports one trib. Four are required if all four ports of the DAC 4x are to be connected. Twenty are required if all ports of the IDU 20x are to be connected.

Figure C-11. DAC 4x and IDU RJ-45 to BNC Cable



DAC 4x and IDU RJ-45 to RJ-45 Straight Cable

Connectors at both ends of the cable are wired pin-for-pin as shown in Figure C-12. It provides a balanced 120 ohm connection.

- RJ-45 to RJ-45, 2m, Part No: 3CC52016AAAA
- RJ-45 to RJ-45, 5m, Part No: 3CC52019AAAA

Each assembly supports one trib. Four cable assemblies are required if all four ports of the DAC 4x are to be connected. Twenty are required if all ports of the IDU 20x are to be connected.

Straight cable assemblies are used when connecting to RJ-45 patch panels, which have a built-in crossover function.

Figure C-12. DAC 4x RJ-45 to RJ-45 Straight Cable Connections

Pin	Pin	Function
1	1	Receive Ring
2	2	Receive Tip
3	3	Optional Ground
4	4	Transmit Ring
5	5	Transmit Tip
6	6	Optional Ground
7	7	Ground
8	8	Ground

DAC 4x and IDU RJ-45 to RJ-45 Crossover Cable

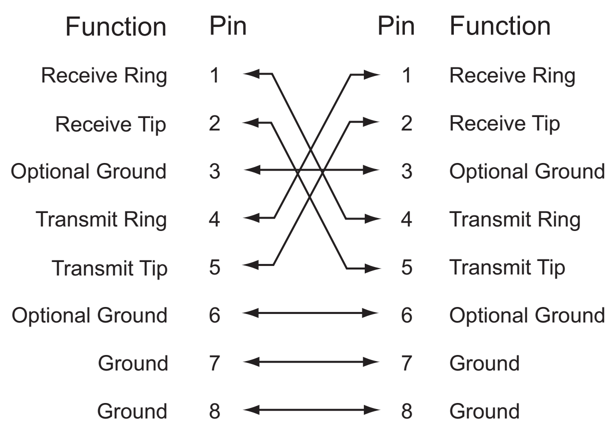
Connectors are wired such that Receive Ring and Tip at one end connect to Transmit Ring and Tip respectively, at the other. Refer to Figure C-13. Pins 3, 6, 7, 8 remain the same. It provides a balanced 120 ohm connection.

- RJ-45 to RJ-45, Crossover, 2m, Part No: 3CC52020AAAA
- RJ-45 to RJ-45, Crossover, 5m, Part No: 3CC52021AAAA

Each assembly supports one trib. Four cable assemblies are required if all four ports of the DAC 4x are to be connected. Twenty are required if all ports of the IDU 20x are to be connected.

Crossover cable assemblies are used to interconnect one DAC or IDU RJ-45 port to another.

Figure C-13. DAC 4x RJ-45 to RJ-45 Crossover Cable Assembly



DAC 4x and IDU RJ-45 to Wire Wrap Cable Assembly

The assemblies are available with cable lengths of 2 m or 5 m. It provides a balanced 120 ohm connection.

- RJ-45 to Wire-Wrap, 2m, Part No: 3CC52014AAAA
- RJ-45 to Wire-Wrap, 5m, Part No: 3CC52015AAAA

The wire is intended for use with insulation displacement, punch-down termination blocks.

Each assembly supports one trib. Four cable assemblies are required if all four ports of the DAC 4x are to be connected. Twenty are required if all ports of the IDU 20x are to be connected.

Refer to Table C-3 for cable data.

Table C-3. DAC 4x and IDU Wire Wrap Cable Data

Pin	Function	Wire Color
1	Receive Ring	White / Orange
2	Receive Tip	Orange / White
3	Optional Ground	White / Green
4	Transmit Ring	Blue / White
5	Transmit Tip	White / Blue
6	Optional ground	Green / White
7	Ground	White / Brown
9	Ground	Brown / White

DAC 4x and IDU RJ-45 Connector Pin Assignments

Table C-4 shows the pin assignments for each front panel RJ-45 trib connector. Refer to Figure C-14 for connector pin numbering.

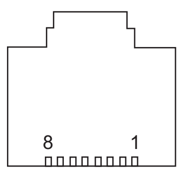
TX or Transmit refers to an output from the IDU and specifies towards the user.

RX or Receive refers to an input to the IDU and specifies from the user.

Table C-4. DAC 4x and IDU RJ-45 Trib Connector Pin Assignments

Pin	Function
1	Receive Ring
2	Receive Tip
3	* Optional Ground
4	Transmit Ring
5	Transmit Tip
6	* Optional Ground
7	Ground
8	Ground

Figure C-14. RJ-45 Front Panel Connector (face view)



DAC ES

Data is provided for:

- RJ-45 to RJ-45 Cable

DAC ES RJ-45 to RJ-45 Cable Assembly

Industry standard Ethernet RJ-45 to RJ-45 cables are used for the DAC ES trib ports.

The DAC ES allows the cable connection type to be auto-detected, or specified for a straight (Mdi) or crossover (MdiX) cable. The normal setting is Auto, where the DAC ES senses and sets the port connection cable type to Mdi or Mdix. The fixed options can be used in instances where auto negotiation fails to provide the expected result or where a fixed setting is preferred.

Straight cables are available as accessories:

- Ethernet cable, RJ-45 to RJ-45, 2m: Part No: 3CC52005AAAA
- Ethernet cable, RJ-45 to RJ-45, 5m: Part No: 3CC52006AAAA
- Ethernet cable, RJ-45 to RJ-45, 15m: Part No: 3CC52007AAAA

The crossover RJ-45 to RJ-45 cables available for the DAC 4x and IDU are not suitable for use as crossover Ethernet cables.

NMS Connectors and Cables

Data is included for:

- NMS 10/100Base-T Connector on page -19
- Maintenance V.24 Connector on page -20

NMS 10/100Base-T Connector

The NMS connector provides Ethernet access for 9500 MXC CT. Pin assignments represent industry-standard LAN cable assembly for a 10/100Base-T, RJ-45 connector.

Straight Ethernet cables are available as optional accessories:

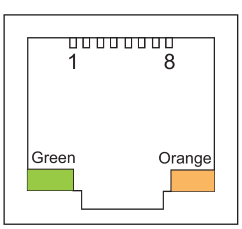
- Ethernet cable, RJ-45 to RJ-45, 2m: Part No: 3CC52005AAAA
- Ethernet cable, RJ-45 to RJ-45, 5m: Part No: 3CC52006AAAA
- Ethernet cable, RJ-45 to RJ-45, 15m: Part No: 3CC52007AAAA

The Ethernet port auto-resolves for straight and crossover cables (Mdi or MdiX). Either cable type can be used.

Table C-5. RJ-45 Ethernet NMS Connector Pin Assignments

Pin	Function
1	Ethernet transmit data +
2	Ethernet transmit data -
3	Ethernet receive data +
4	Not used
5	Not used
6	Ethernet receive data -
7	Not used
8	Not used

Figure C-15. RJ-45 Ethernet NMS Connector(s)



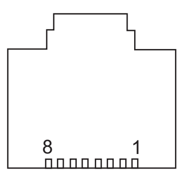
Maintenance V.24 Connector

The V.24 connector provides serial data access for 9500 MXC CT. One 2 meter industry-standard RJ-45 to DB-9 V.24 Maintenance Cable is included with every INU/IDU, Part No: 3CC52000AAAA. A 5 meter cable is available as an option, Part No: 3CC52001AAAA.

Table C-6. RJ-45 V.24 Connector Pin Assignments

Pin	Signal Name	Direction	Function
1	DSR/RI	In	Data Set Ready/Ring Indicator
2	CD	In	Carrier Detect
3	DTR	Out	Data Terminal Ready
4	GND		System Ground
5	RXD	In	Receive Data
6	TXD	Out	Transmit Data
7	CTS	In	Clear to Send
8	RTS	Out	Request to Send

Figure C-16. RJ-45 V.24 CT Connector (face view)



Auxiliary and Alarm Connectors and Cables

Data is included for AUX Plug-in (Node) IDU (Terminal) auxiliary interfaces and cable-sets.

Alarm and Auxiliary cables should not terminate to equipment outside the shelter or building. Use approved surge suppression equipment when connecting to un-protected external inputs and outputs.

Refer to:

- AUX Plug-in Connector and Cable Data
- IDU Auxiliary Connector and Cable Data

AUX Plug-in Connector and Cable Data

Refer to:

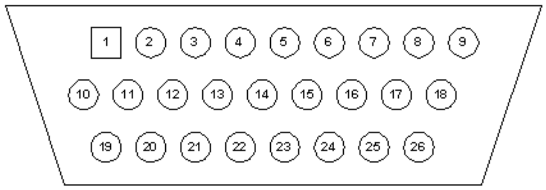
- AUX Data Cable: Async, HD26 to Wirewrap, 2 m on page -22
- AUX Data Cable: Sync, HD26 to Wirewrap, 2 m on page -23
- AUX Data Cable: Async, HD26 to 3 X DB9, 1 m on page -24
- AUX Data Cable: Sync, HD26 to 3 X DB9, 1 m on page -25
- AUX Data Cable: Async, AUX HD26 to AUX HD26, 1 m on page -26
- AUX Data Cable: Sync, AUX HD26 to AUX HD26, 1 m on page -27
- AUX Alarm I/O Cable: HD15 to Wirewrap, 5 m on page -28

Connector front views are cable-connector views.

AUX Data Cable: Async, HD26 to Wirewrap, 2 m

Part No: 3CC52109AAAA

Table C-7. AUX HD26, 2M, Async, Wirewrap Cable Data



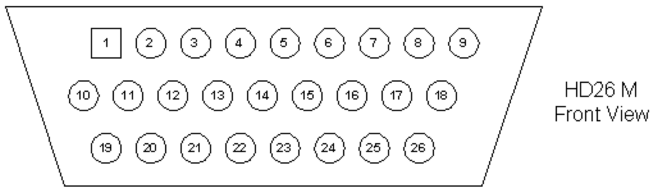
HD26 M
Front View

037-579114-001, Pin Description and Colour Code.			
Pin No	**Function**		**Wire Colour Code**
	TIA/EIA-562	DCE Direction	
1		Output	Green/Black
2		Output	Black/Green
3	Aux RXD1	Output	Black/Orange
4		Output	Brown/Black
5	Aux TXD1	Input	Orange Black
6		Input	Black/Brown
7		I/O	Brown/White
8		I/O	White/Brown
9	GND		Black/Blue
10		Output	White/Grey
11		Output	Grey/White
12	AuxRXD2	Output	Red/Grey
13		Output	Black/Grey
14	AuxTXD2	Input	Grey/Red
15		Input	Grey/Black
16		I/O	Green/White
17		I/O	White/Green
18	GND (Shared)		Drain
19		Output	Brown/Red
20		Output	Red/Brown
21	AuxRXD3	Output	Blue/Yellow
22		Output	Yellow/Blue
23	AuxTXD3	Input	Red/Blue
24		Input	Blue/Red
25		I/O	Blue/White
26		I/O	White/Blue
Not Used	Blue/Black, Green/Red, Red/Green, Red/Orange,		
Not Used	Orange/Red, White/Orange, Orange/White		

AUX Data Cable: Sync, HD26 to Wirewrap, 2 m

Part No: 3CC52110AAAA

Table C-8. AUX HD26, 2M, Sync, Wirewrap



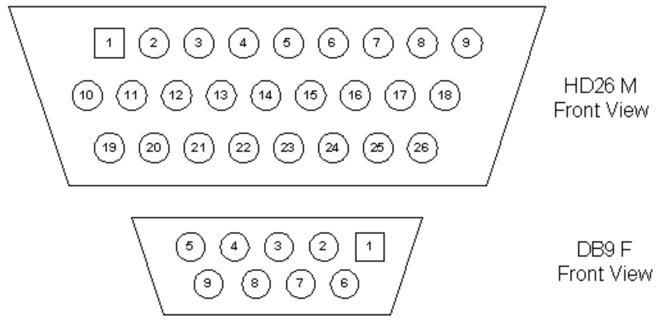
037-579115-001, Pin Description and Colour Code.			
Pin No	**Function**		**Wire Colour Code**
	TIA/EIA-422	DCE Direction	
1	1AuxRXC+	Output	Green/Black
2	1AuxRXC-	Output	Black/Green
3	1RXD-	Output	Black/Orange
4	1RXD+	Output	Orange/Black
5	1TXD+	Input	Brown/Black
6	1TXD-	Input	Black/Brown
7	1AuxTXC+	I/O	Brown/White
8	1AuxTXC-	I/O	White/Brown
9	GND		Black/Blue
10	2AuxRXC+	Output	White/Grey
11	2AuxRXC-	Output	Grey/White
12	2RXD-	Output	Red/Grey
13	2RXD+	Output	Grey/Red
14	2TXD+	Input	Black/Grey
15	2TXD-	Input	Grey/Black
16	2AuxTXC+	I/O	Green/White
17	2AuxTXC-	I/O	White/Green
18	GND (Shared)		Drain
19	3AuxRXC+	Output	Brown/Red
20	3AuxRXC-	Output	Red/Brown
21	3RXD-	Output	Blue/Yellow
22	3RXD+	Output	Yellow/Blue
23	3TXD+	Input	Red/Blue
24	3TXD-	Input	Blue/Red
25	3AuxTXC+	I/O	Blue/White
26	3AuxTXC-	I/O	White/Blue

Not Used	Blue/Black, Red/Green, Green/Red, Red/Orange,
Not Used	Orange/Red, White/Orange, Orange/White

AUX Data Cable: Async, HD26 to 3 X DB9, 1 m

Part No: 3CC52111AAAA

Table C-9. AUX HD26 TO 3 X DB9, 1M, Async



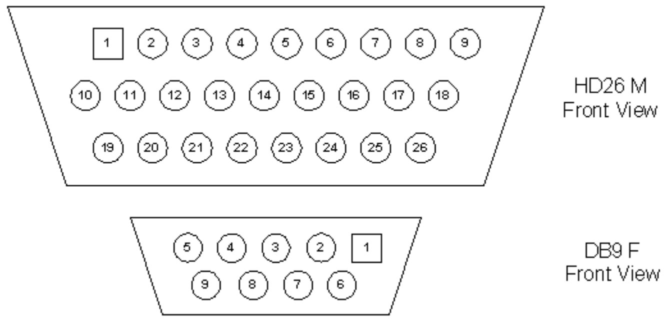
037-579116-001, Pin Descriptions

AUX	Function		AUX 1	AUX 2	AUX 3
Pin No	TIA/EIA-562	DCE Direction	Pin No	Pin No	Pin No
3	Aux RXD1	Output	2		
5	Aux TXD1	Input	3		
9	GND		5		
12	AuxRXD2	Output			2
14	AuxTXD2	Input			3
18	GND (Shared)			5	5
21	AuxRXD3	Output		2	
23	AuxTXD3	Input		3	

AUX Data Cable: Sync, HD26 to 3 X DB9, 1 m

Part No: 3CC52112AAAA

Table C-10. AUX HD26 to 3 X DB9, 1m, Sync



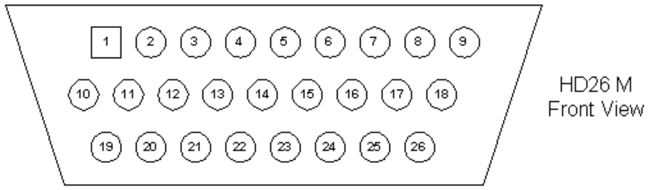
037-579117-001, Pin Descriptions

AUX	Function		AUX 1	AUX 2	AUX 3
Pin No	TIA/EIA-422	DCE Direction	Pin No	Pin No	Pin No
1	1AuxRXC+	Output	1		
2	1AuxRXC-	Output	6		
3	1RXD-	Output	2		
4	1RXD+	Output	7		
5	1TXD+	Input	3		
6	1TXD-	Input	8		
7	1AuxTXC+	I/O	4		
8	1AuxTXC-	I/O	9		
9	GND		5		
10	2AuxRXC+	Output		1	
11	2AuxRXC-	Output		6	
12	2RXD-	Output		2	
13	2RXD+	Output		7	
14	2TXD+	Input		3	
15	2TXD-	Input		8	
16	2AuxTXC+	I/O		4	
17	2AuxTXC-	I/O		9	
18	GND (Shared)			5	5
19	3AuxRXC+	Output			1
20	3AuxRXC-	Output			6
21	3RXD-	Output			2
22	3RXD+	Output			7
23	3TXD+	Input			3
24	3TXD-	Input			8
25	3AuxTXC+	I/O			4
26	3AuxTXC-	I/O			9

AUX Data Cable: Async, AUX HD26 to AUX HD26, 1 m

Part No: 3CC52113AAAA

Table C-11. AUX TO AUX, HD26, 1M, ASYNC

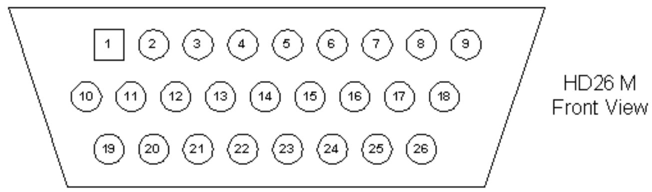


037-579120-001, Pin Descriptions			
AUX	Function		AUX
3	Aux RXD1	Aux TXD1	5
5	Aux TXD1	Aux RXD1	3
9	Ground	Ground	9
12	AuxRXD2	AuxTXD2	14
14	AuxTXD2	AuxRXD2	12
18	Ground	Ground	18
21	AuxRXD3	AuxTXD3	23
23	AuxTXD3	AuxRXD3	21

AUX Data Cable: Sync, AUX HD26 to AUX HD26, 1 m

Part No: 3CC52114AAAA

Table C-12. AUX TO AUX, HD26, 1m, Sync



037-579121-001, Pin Descriptions

AUX	Function		AUX
1	1AuxRXC+	1AuxTXC+	7
2	1AuxRXC-	1AuxTXC-	8
3	1RXD-	1TXD-	6
4	1RXD+	1TXD+	5
5	1TXD+	1RXD+	4
6	1TXD-	1RXD-	3
7	1AuxTXC+	1AuxRXC+	1
8	1AuxTXC-	1AuxRXC-	2
9	GND	GND	9
10	2AuxRXC+	2AuxTXC+	16
11	2AuxRXC-	2AuxTXC-	17
12	2RXD-	2TXD-	15
13	2RXD+	2TXD+	14
14	2TXD+	2RXD+	13
15	2TXD-	2RXD-	12
16	2AuxTXC+	2AuxRXC+	10
17	2AuxTXC-	2AuxRXC-	11
18	GND	GND	18
19	3AuxRXC+	3AuxTXC+	25
20	3AuxRXC-	3AuxTXC-	26
21	3RXD-	3TXD-	24
22	3RXD+	3TXD+	23
23	3TXD+	3RXD+	22
24	3TXD-	3RXD-	21
25	3AuxTXC+	3AuxRXC+	19
26	3AuxTXC-	3AuxRXC-	20

AUX Alarm I/O Cable: HD15 to Wirewrap, 5 m

Part No: 3CC52002AAAA

Figure C-17. ALARM I/O, HD15, 5M, WIREWRAP

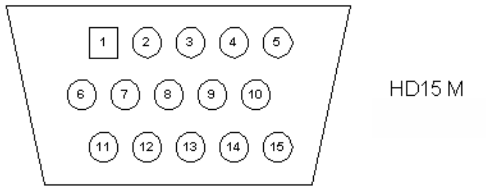


Table C-13. Pin Descriptions for 3CC52002AAAA

Pin No.	Function		Wire Color Code
1	TTL Input 1	I	Brown/White
2	Relay 1 NC	I/O	White/Brown
3	Relay 1 NO	I/O	White/Grey
4	Relay 2 Pole/TTL Input 5	I/O	Grey/White
5	Relay 3 NC	I/O	Red/Blue
6	Relay 3 NO	I/O	Blue/Red
7	Relay 4 Pole/TTL Input 3	I/O	Orange/Red
8	Ground		Drain
9	TTL Input 2	I	Red/Orange
10	Relay 1 Pole/TTL Input 6	I/O	Red/Green
11	Relay 2 NC	I/O	Green/Red
12	Relay 2 NO	I/O	Orange/White
13	Relay 3 Pole/TTL Input 4	I/O	White/Orange
14	Relay 4 NC	I/O	White/Green
15	Relay 4 NO	I/O	Green/White
Wire Colors Not Used:	White/Blue, Blue/White		

IDU Auxiliary Connector and Cable Data

Refer to:

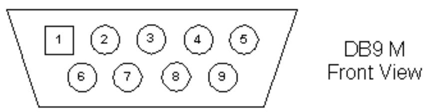
- IDU AUX Cable Data: Async, DB9 to Wirewrap, 2 m on page -29
- IDU AUX Cable Data: Sync, DB9 to Wirewrap, 5 m on page -30
- IDU AUX Cable Data: Async, IDU AUX DB9 to IDU AUX DB9, 1 m on page -30
- IDU AUX Cable: Sync, IDU AUX DB9 to IDU AUX DB9, 1 m on page -31
- IDU AUX Alarm I/O Cable: HD15 to Wirewrap, 5 m on page -31

Connector front views are cable-connector views

IDU AUX Cable Data: Async, DB9 to Wirewrap, 2 m

Part No: 3CC52105AAAA

Table C-14. IDU AUX, DB9, 2M, Async, Wirewrap

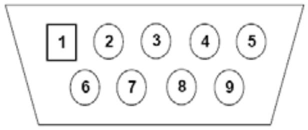


037-579177-001, Pin Description and Colour Code.			
AUX	Function		Wire Colour Code
Pin No	TIA/EIA-562	DCE Direction	
1	N/A		
2	RXD	Output	White/Blue
3	TXD	Input	Blue/White
4	N/A		
5	GND	Ground	Drain
6	N/A		
7	N/A		
8	N/A		
9	N/A		
Not Used	White/Brown, Brown/White, White/Orange,		
Not Used	Orange/White, White/Green, Green/White		

IDU AUX Cable Data: Sync, DB9 to Wirewrap, 5 m

Part No: 3CC52106AAAA

Table C-15. IDU AUX, DB9, 5M, SYNC, WIREWRAP



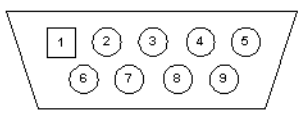
DB9 M
Front View

037-579178-001, Pin Description and Colour Code.			
AUX	Function		Wire Colour Code
Pin No	TIA/EIA-422	DCE Direction	
1	RXCLK+	Out	White/Green
2	RXD -	Out	White/Orange
3	TXD+	In	White/Blue
4	TXCLK+	I/O	White/Brown
5	GROUND		Drain
6	RXCLK -	Out	Green/White
7	RXD +	Out	Orange/White
8	TXD -	In	Blue/White
9	TXCLK -	I/O	Brown/White

IDU AUX Cable Data: Async, IDU AUX DB9 to IDU AUX DB9, 1 m

Part No: 3CC52103AAAA

Table C-16. IDU AUX to IDU AUX, DB9, 1m, Async



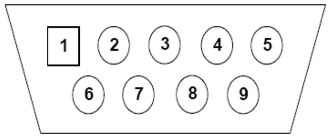
DB9 M
Front View

037-579118-001, Pin Descriptions			
AUX	Function		AUX
Pin No			Pin No
1			
2	RXD	TXD	3
3	TXD	RXD	2
4			
5	GND	GND	5

IDU AUX Cable: Sync, IDU AUX DB9 to IDU AUX DB9, 1 m

Part No: 3CC52104AAAA

Table C-17. IDU AUX TO IDU AUX, DB9, 1M, SYNC



DB9 M
Front View

037-579119-001, Pin Descriptions			
AUX	**Function**		**AUX**
Pin No			Pin No
1	RXCLK+	TXCLK+	4
2	RXD-	TXD-	8
3	TXD+	RXD+	7
4	TXCLK+	RXCLK+	1
5	GROUND	GROUND	5
6	RXCLK-	TXCLK-	9
7	RXD+	TXD+	3
8	TXD-	RXD-	2
9	TXCLK-	RXCLK-	6

IDU AUX Alarm I/O Cable: HD15 to Wirewrap, 5 m

This cable is identical to the Node (AUX Plug-in) Alarm I/O cable. Refer to AUX Alarm I/O Cable: HD15 to Wirewrap, 5 m on page -28.

Appendix D. 9500 MXC NMS Networking Essentials

This appendix provides an overview of the characteristics of a 9500 MXC management network and guidance on IP addressing for small to medium size networks.

Refer to:

- General Considerations on page -1
- Rules, Hints and Tips on page -1
- Recommended Address Ranges on page -5
- Example Networks on page -6

General Considerations

In instances where the network topology is not straight-forward, or the number of links is to exceed 50 (approximately), the planning for the network management must be referred to Alcatel-Lucent for comment.

Plan the management network at the outset in conjunction with the planning for the physical rollout of the network to avoid revisiting sites to reset IP addresses and routing to get a working management system.

Issues that might not seem significant for a small network, can become major issues in a large or expanding network.

Rules, Hints and Tips

Rules, hints and tips for 9500 MXC IP addressing and routing.

General

- A router function with dynamic and static routing options is provided within each 9500 MXC terminal (INUs and IDUs).
- Each 9500 MXC terminal is hosted behind its Ethernet NMS port IP address: the terminal address is the Ethernet port address.
- Other ports, such as the LINK NMS ports, where an INU can have up to three and an INUe up to six, can be configured to have:
  - An unnumbered port address when the Single IP addressing option is selected in CT (all ports assume the Ethernet port address), or
  - A unique IP addresses when the Interface IP addressing option is selected in CT. With this option all ports can be uniquely numbered.

IP Addressing

- Single IP addressing would normally be used. It is easier to set up a network using just one IP address for each terminal, compared to having to specify each port per terminal. The single IP address is the terminal/Ethernet port address.
- The Interface addressing (advanced) option allows each port on the 9500 MXC router to be uniquely numbered. It may be used in instances where:
  - There is a requirement to partition a network between OSPF and RIP routing.
  - There is a wish by an operator to adopt an IP address structure, which dictates use of unique IP addresses for each network interface, and to treat the radio link as a separately identifiable network. However, bear in mind that for static routed networks, interface addressing would require all interfaces to also be entered in the static route tables for all network devices.
- If interface addressing is used, and the operator has no need to view each NMS radio path as a separately identifiable network within their routing plan, then the interface addressing for link NMS ports should be set such that they are shown to assume the address of the router, the Ethernet port, by entering an IP address of 0.0.0.0 and a subnet mask of 255.255.255.255. A practical example of this occurs when an operator needs to use a different auto-routing setting on an NMS radio path.

9500 MXC NMS over a radio (RAC) or fiber (DAC 155oM) uses a proprietary link protocol.

- The V.24 maintenance port can also be uniquely numbered under interface addressing. This is for use when the maintenance port connects to a router, or similar device. Otherwise it should always be set to 0.0.0.0 with a subnet mask of 255.255.255.255.

Communication Parameters

9500 MXC NMS over a radio (RAC) or fiber (DAC 155oM) link is managed under a proprietary layer 2 link protocol. As a consequence normal router-router network addressing rules do not apply, except where an operator configures an IP addressing plan using the interface (advanced) addressing options, where every point-to-point link is a network.

Typically, when two routers are connected together on the same network (link) the network portion of the IP address must be the same on both routers. This does not apply to 9500 MXC terminals where single IP addressing is used, but does apply where link ports are uniquely numbered (have a unique IP address) using the interface addressing options.

- Instead, at each network site, 9500 MXC terminals must be identified with a unique network address - the network portion of the IP address must be unique.

- Where two or more terminals are co-located (same site) and are Ethernet NMS-interconnected (on the same LAN) they must be configured to have a common network address (the network portion of the IP address is the same), and a unique host address (the host portion of the IP address is unique).
  - For 9500 MXC terminals connected by their Ethernet ports, normal LAN rules apply.
- This separate network identity for each site means there are many networks in a 9500 MXC management network. Essentially, each network supports just one host unless other devices, such as other radios, are interconnected via their Ethernet NMS ports. This is a fundamental difference to a normal network situation where multiple hosts are almost always LAN-connected under one network address.

Routing Options and Function

- For static routing, the routing entries specify:
  - Destination: The IP network address of the destination network, where for a 9500 MXC network the destination network is a 9500 MXC terminal or a group of terminals at one site (two or more terminals at one site connected on a common Ethernet LAN). Only the network portion of the IP address is required.
  - Subnet Mask: The subnet mask or netmask delineates the network portion of the IP address.
  - Interface: The interface must specify the port used to exit the terminal to get to its destination network. Where it is over a radio link there are prompts on a terminal for all installed links (on an INU), such as LINK 1 NMS or LINK 2 NMS, where the number represents the slot number of the RAC. (For a protected link, the number corresponds to the slot number of the primary RAC).
  - Next Hop: A next hop entry is only required where the next IP hop is via the Ethernet port to another network. Next hop defines the exit point or 'gateway' from one network to the destination network.

A Next Hop entry is not required for a radio (RAC) or fiber (DAC 155oM) link interface as there is always only one device connected; the remote end device. This is not the case with the Ethernet port as there can be many devices connected via a LAN, hence the need to define the device on the LAN which provides the gateway to the destination network.

The requirement to specify a Next Hop IP address on an Ethernet connection particularly applies where stand-alone terminals, such as 9500 MXC IDUs, are networked using static routing.

  - Default Gateway: A special case of a static route in which the address is 0.0.0.0 and the subnet mask is 0.0.0.0. It matches any destination address that is not matched by any other static route.

- Default gateway routes are typically used in conjunction with static routes to reduce data entry requirements. Towards the NOC a single default gateway route (0.0.0.0) is entered on each terminal instead of static routes. Away from the NOC static entries are required in the normal way - each terminal must have an entry for all other terminals that are on its away side only.

- Static routing can be used with single or interface IP addressing.
  - When static routing is used with interface addressing, the destination address for a LINK NMS entry must be the network address for the terminal at the far end of the link - not the address of the interface.
- For dynamic routing the options are OSPF, RIP1 (RIPv1), and RIP2 (RIPv2):
  - OSPF is the more recent and more comprehensive protocol. It is not metric-hop limited, unlike RIP, which has a hop-count limit of 15 hops.

    Each 9500 MXC INU/INUe counts as one IP hop (one metric hop) for RIP hop count purposes, and applies regardless of whether single IP addressing or interface IP addressing is selected. This means that the number of 9500 MXC INU links that can be traversed with RIP1 or RIP2 selected is 15, which is the RIP count limit.

    Each 9500 MXC IDU link counts as two IP hops. RIP networks made up of back-to-back connected radio terminals are restricted to 7 hops because each terminal has a unique IP address, and the hard-wired Ethernet connection between them counts as one additional hop.
  - RIP2 is recommended over RIP1. RIP1 does not support sub-netted addressing. RIP2 is backward compatible with RIP1.
- Dynamic routing is generally used in preference to static routing (it is much easier to set and maintain). Exceptions include small networks of one to four links that are to be installed in an existing network, which uses static routing.
- Static routing can be used in conjunction with dynamic routing and has particular application in large networks where route summarization is used to make more efficient use of address space and to reduce CPU loading.
- Routing between OSPF and RIP networks is supported. For example, a network comprising 9500 MXC terminals configured for OSPF can be connected to a network configured for RIP2 or RIP1.
  - Best practice requires use of the interface (advanced) addressing screen on the junction 9500 MXC terminal, whereby OSPF is set only on the Link NMS interface(s) and RIP only on the Ethernet interface (10/100Base-T NMS ports).
  - The single IP addressing screen can be used, but do so only where both RIP and OSPF are required on the Ethernet interface, such as at sites where two or more 9500 MXC terminals on OSPF are Ethernet connected to one or more RIP terminals.

    Single IP addressing means that OSPF and RIP co-exist on the 9500 MXC Ethernet interface and on the Link NMS interface(s). This is acceptable providing the terminal at the far end of each 9500 MXC link (and within the remainder of the 9500 MXC network) is set for OSPF only.
- Routing between OSPF (or RIP) and static routed networks is supported. In this instance single IP addressing can be used on the 9500 MXC terminal at the junction of the networks; dynamic routing is enabled and static routes set to all static-routed terminals, meaning OSPF (or RIP) co-exists with static routes on the 9500 MXC Ethernet interface.

- Within a 9500 MXC network set for dynamic routing, enable OSPF or RIP, never both. If both are enabled on multiple terminals, routes installed by one protocol are propagated by the other to result in a proliferation of conflicting routes.
- Dynamic routing is a requirement for 9500 MXC Super-PDH ring-protected networks.
- Dynamic routing options are disabled on the V.24 interface for single IP addressing. They are enabled only within interface addressing.

CT PC Connection

Compared to V.24, the Ethernet connection option provides much faster data throughput, and supports CT access to other nodes on the 9500 MXC network. But unlike V.24, an Ethernet connection is node / IP address specific:

As the V.24 connection option is not address specific; it does not require knowledge of a node IP address. Connection speed is significantly slower than with Ethernet. V.24 only provides CT access to the directly connected node, but ping, tracert and related commands can be used to check network routing.

- To connect to a 9500 MXC network using the Ethernet port, the PC must have a LAN card and a LAN compatible address installed.
- As each Node/Terminal in and 9500 MXC network has a unique network address (unless interconnected on a LAN at the same site), *you must change your PC network settings each time you go to a new site.*
- Entering an IP Address and subnet mask on your PC requires configuration of the LAN card TCP/IP settings. This is so that your PC is recognized as a device on the 9500 MXC NMS LAN.
- The procedure to change PC TCP/IP settings is described in CT Chapter 2. It includes reference to the use of a default gateway to allow access to other nodes on the network without having to enter static routes on your PC.

Recommended Address Ranges

- The management network is network-address prolific. It is not host prolific. A Class C address range should be a first choice, but with subnetting Class A and Class B addresses can also provide a large number of network addresses. Essentially, any non-Internet range of addresses can be used. An Internet address range can be used *providing* there is no gateway to the Internet. Example address ranges include:
  - Class A: 10.0.0.0 to 10.255.255.255
  - Class B: 172.16.0.0 to 172.31.255.255
  - Class C: 192.168.0.0 to 192.168.255.255

- The non-Internet class B address space 172.16.x.x is not appropriate for radio networks except at the connection point to NOC LAN segments.
- The address range of 192.168.255.0 to 192.168.255.255 ***must not be used*** as it is used for internal (embedded) addressing within 9500 MXC.

Example Networks

The following examples provide guidance on IP addressing and routing options for 9500 MXC Nodes.

Examples are given for the following configurations:

- Single Link on page -6
- Small Four Node Network on page -7
- Network with Static and Default Gateway Routing on page -8
- Complex Networks on page -11
- Ring Network on page -16

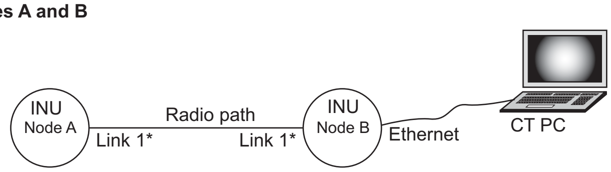
Single Link

Figure D-1 on page -6 shows one INU to INU link:

- Class C network addressing has been selected.
- Static and dynamic routing options are shown.
- A CT PC is shown connected to Node B. Node B has been selected as the default gateway in the PC TCP/IP settings to support access to Node A. The default gateway avoids the need to enter a static route for Node A on the PC (using DOS commands).

Figure D-1. 9500 MXC Node Routing Example 1

9500 MXC Nodes A and B



	Node A	Node B
IP Address:	192.168.1.1	192.168.2.1
Mask:	255.255.255.0	255.255.255.0

NODES
Select Single IP Addressing and Static *or* Dynamic Routing

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
Node A:	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
Node B:	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0

Dynamic Routing: Select OSPF or RIP

* The number associated with the Link references indicates the RAC slot number

9500 MXC CT PC
Enter compatible IP settings for the Ethernet LAN connection

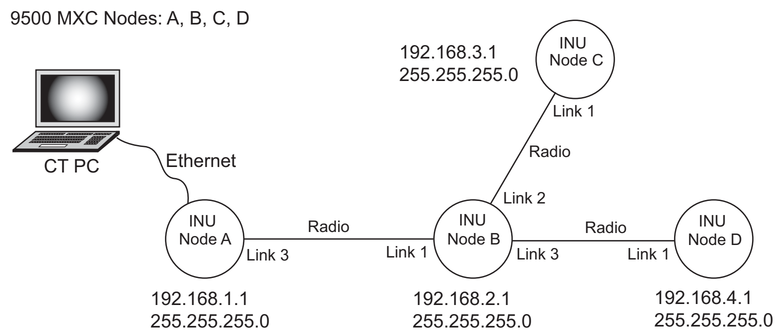
IP address:	192.168.2.2
Subnet mask:	255.255.255.0
Default gateway:	192.168.2.1

Small Four Node Network

Figure D-2 shows a small 9500 MXC-only network. Both static and dynamic routing options are shown.

- Class C network addressing is used.
- This example shows that dynamic routing is a much easier option.
- Figure D-3 on page -8 shows the CT static routing screen for Node B.
- The CT PC is shown connected to Node A, with Node entered as the default gateway.

Figure D-2. 9500 MXC Node Routing Example 2



Select Single IP Addressing and Static *or* Dynamic Routing (Dynamic recommended)

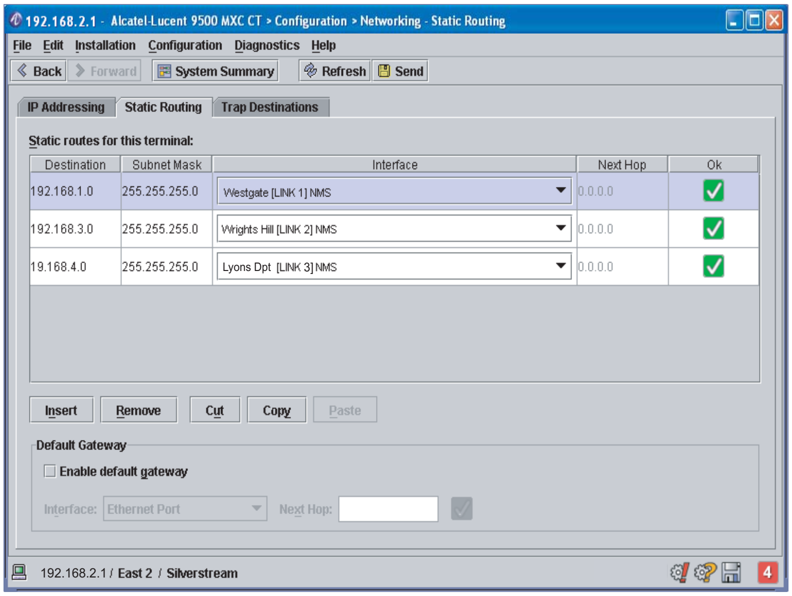
Static Routing:	Destination	Subnet Mask	Interface	Next Hop
Node A:	192.168.2.0	255.255.255.0	Link 3 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 3 NMS	0.0.0.0
	192.168.4.0	255.255.255.0	Link 3 NMS	0.0.0.0
Node B:	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 2 NMS	0.0.0.0
	192.168.4.0	255.255.255.0	Link 3 NMS	0.0.0.0
Node C:	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.4.0	255.255.255.0	Link 1 NMS	0.0.0.0
Node D:	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0

Dynamic Routing: Select OSPF or RIP

9500 MXC CT PC
Enter compatible IP settings for the Ethernet LAN connection

IP address: 192.168.1.2
Subnet mask: 255.255.255.0
Default gateway: 192.168.1.1

Figure D-3. Static Routing Screen for Node B in Figure D-2



Network with Static and Default Gateway Routing

These examples also show NOC NMS settings.

The default gateway option can be used in conjunction with static routing to reduce data entry requirements and support flexible adding/changing of PC connections at the NOC LAN[1]:

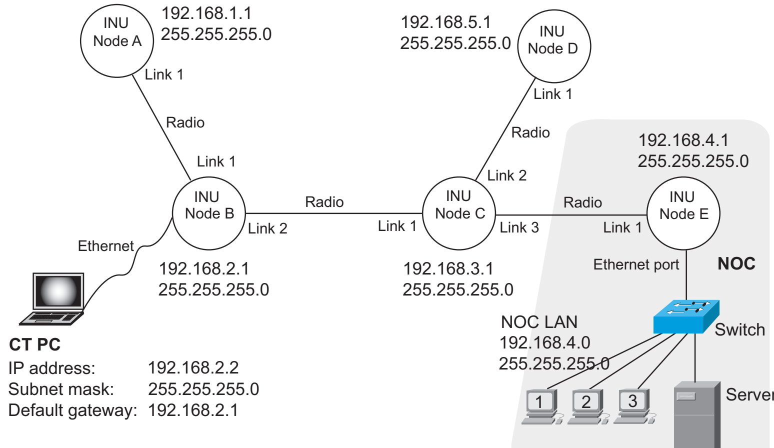
- *Towards* the NOC a single default gateway is entered on each Node/Terminal instead of static routes.
- *Away* from the NOC static entries are required in the normal way - each Node/Terminal must have an entry for all other Nodes/Terminals that are on its *away side only*.
- No static routes are required from Nodes/Terminals to address NOC host devices (PCs, Server), meaning NMS PCs (CT) can be added/removed from the NOC LAN without affecting network visibility.
- At the NOC, each of the LAN hosts (PCs, Server) are also configured with a default gateway in their TCP/IP properties. Entry of static routes to Nodes/Terminals is not required.
- A CT PC connected at any Node will be able to see (log into) all other Nodes, providing the PC TCP/IP settings are set match the network address of the Node it is connected to.
- **Dynamic routing, OSPF or RIP, may be used instead of static routing**.

Figure D-4 on page -9 shows such a network with the NOC (Network Operating Center) LAN supported directly from Node E.

Figure D-5 on page -10 shows the same network but with a 3rd party router supporting the NOC LAN.

1 *Assumes a single NOC site. Where multiple NOCs are deployed, default gateways can be established on individual branches of the network, but at branching sites specific route is required to the NOCs.*

Figure D-4. Static Routing with Default Gateways: NOC LAN off Node E



Node A

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	None	-----	-----	-----

Default Gateway:	Enabled	Interface	Next Hop
	Yes	Link 1 NMS	0.0.0.0

Node B

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0

Default Gateway:	Enabled	Interface	Next Hop
	Yes	Link 2 NMS	0.0.0.0

Node C

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.5.0	255.255.255.0	Link 2 NMS	0.0.0.0

Default Gateway:	Enabled	Interface	Next Hop
	Yes	Link 3 NMS	0.0.0.0

Node D

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	None	-----	-----	-----

Default Gateway:	Enabled	Interface	Next Hop
	Yes	Link 1 NMS	0.0.0.0

Node E

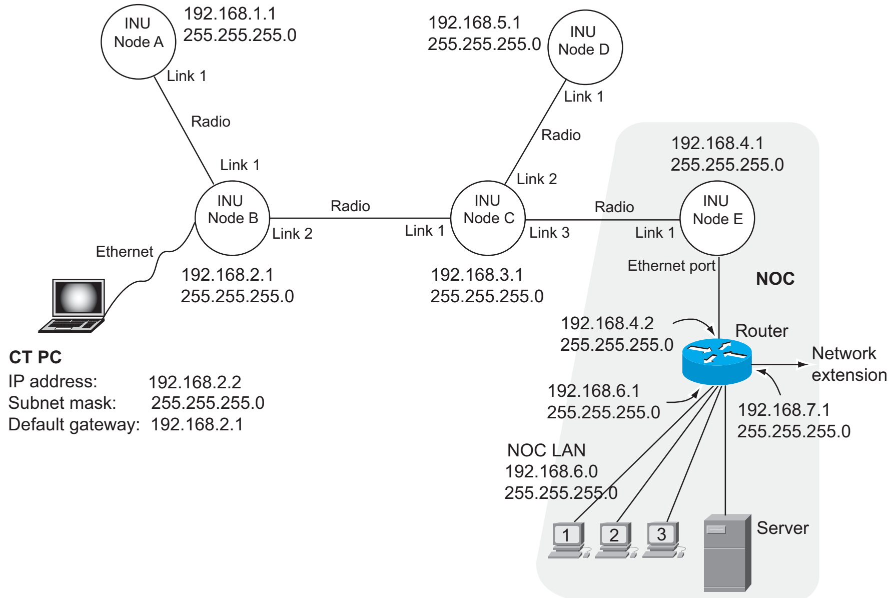
Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.5.0	255.255.255.0	Link 1 NMS	0.0.0.0

Default Gateway:	Enabled	Interface	Next Hop
	No	-----	-----

NOC TCP/IP Properties

	IP Address	Subnet Mask	Default Gateway
Server:	192.168.4.2	255.255.255.0	192.168.4.1
PC1:	192.168.4.3	255.255.255.0	192.168.4.1
PC2:	192.168.4.4	255.255.255.0	192.168.4.1
PC3:	192.168.4.5	255.255.255.0	192.168.4.1

Figure D-5. Static Routing with Default Gateways: NOC LAN off Router



Node E

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.5.0	255.255.255.0	Link 1 NMS	0.0.0.0

Default Gateway: Enabled	Interface	Next Hop
Yes	Ethernet	192.168.4.2

NOC Router

Static Routing:	Destination	Subnet Mask	Interface	Next Hop
	192.168.1.0	255.255.255.0	192.168.4.2	192.168.4.1
	192.168.2.0	255.255.255.0	192.168.4.2	192.168.4.1
	192.168.3.0	255.255.255.0	192.168.4.2	192.168.4.1
	192.168.5.0	255.255.255.0	192.168.4.2	192.168.4.1

NOC TCP/IP Properties

	IP Address	Subnet Mask	Default Gateway
Server:	192.168.6.2	255.255.255.0	192.168.6.1
PC1:	192.168.6.3	255.255.255.0	192.168.6.1
PC2:	192.168.6.4	255.255.255.0	192.168.6.1
PC3:	192.168.6.5	255.255.255.0	192.168.6.1

Complex Networks

Figure D-6 on page -12 shows a more complex network of 9500 MXC and other radio terminals. In this example it has been assumed that the other terminals are static routed and that the 9500 MXC nodes are to be similarly configured. Figure D-7 shows the CT static routing screen for Node A. Note that Node A and Terminal X share the same network address of 192.169.1.0 (on the same LAN), therefore only one network address is required for these two devices in the static routing tables in the other nodes/ terminals. The same situation applies to Node C and Terminal U.

Figure D-8 on page -14 shows the same network, but with the 9500 MXC portion of the network configured for dynamic routing. This is achieved by partitioning the 9500 MXC nodes at the junctions with the other terminals in the network (Nodes A and C), such that each port in use on these two nodes is numbered (given an IP address) using the interface addressing option, and each port has its own routing option (static or dynamic).

On the radio side of the 9500 MXC network (LINK NMS), dynamic routing (RIP2 or OSPF) is selected in the CT Interface Addressing screen. On the Ethernet side, static routing is entered for the Ethernet port in the Static Routing screen.

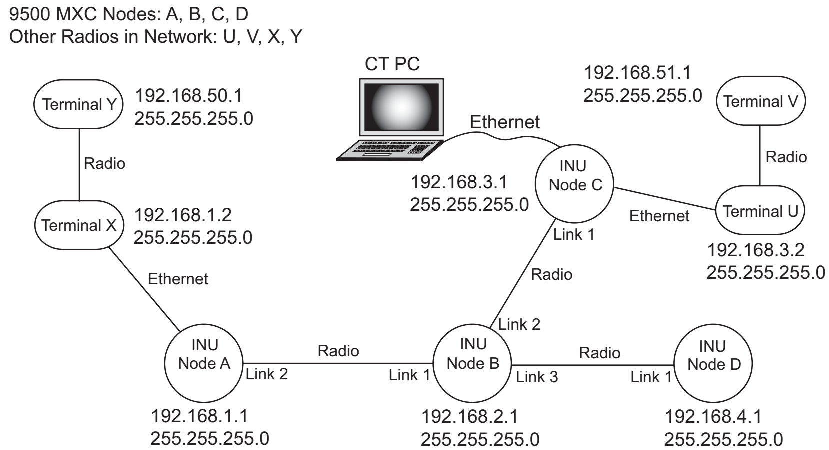
Of specific interest is the addressing for the LINK NMS ports at Nodes A and C. Given that the radio path for NMS is handled as a PPP link, no real IP addressing is required on these ports. However, to maintain good routing practice it is recommended that LINK NMS ports are addressed such that they are shown to assume the address of the router, the Ethernet port, by entering an IP address of 0.0.0.0 and a subnet mask of 255.255.255.255. Unique IP addresses could have been used but they would serve no purpose except where the operator wishes to treat the radio path as a separately identifiable network within the routing tables.

Unique IP addressing may have application in some larger networks where an operator wishes to number the radio path as a routed network to conform with a numbering plan used throughout their network. However, for static routed networks, doing so would require these interfaces to also be entered in the static route tables for all network devices.

For consistency, the V.24 port has also been set to assume the same IP address. Changing the IP address of the V.24 port in the Interface Addressing screen does not affect the default access for V.24 connection of CT.

Figure D-9 on page -15 shows the Interface IP Addressing screen for Node A in Figure D-8 on page -14. Figure D-10 on page -15 shows the Static Routing screen for the same node.

Figure D-6. 9500 MXC Node Static Routing Example 3



Static Routing:	Destination	Subnet Mask	Interface	Next Hop
Node A:	192.168.1.0	255.255.255.0	Ethernet Port	0.0.0.0
	192.168.50.0	255.255.255.0	Ethernet Port	192.168.1.2
	192.168.2.0	255.255.255.0	Link 2 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 2 NMS	0.0.0.0
	192.168.51.0	255.255.255.0	Link 2 NMS	0.0.0.0
	192.168.4.0	255.255.255.0	Link 2 NMS	0.0.0.0
Node B:	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.50.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 2 NMS	0.0.0.0
	192.168.51.0	255.255.255.0	Link 2 NMS	0.0.0.0
	192.168.4.0	255.255.255.0	Link 3 NMS	0.0.0.0
Node C:	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.50.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Ethernet Port	0.0.0.0
	192.168.51.0	255.255.255.0	Ethernet Port	192.168.3.2
	192.168.4.0	255.255.255.0	Link 1 NMS	0.0.0.0
Node D:	192.168.2.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.1.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.50.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.3.0	255.255.255.0	Link 1 NMS	0.0.0.0
	192.168.51.0	255.255.255.0	Link 1 NMS	0.0.0.0

9500 MXC CT PC
Enter compatible IP settings for the Ethernet LAN connection

IP address: 192.168.3.3
Subnet mask: 255.255.255.0
Default gateway: 192.168.3.1

Figure D-7. Static Routing Screen for Node A in Figure D-6

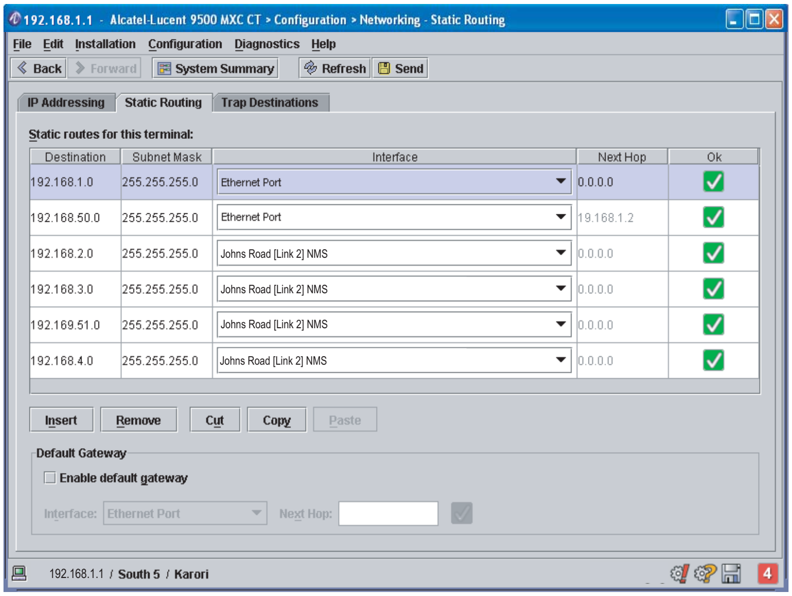
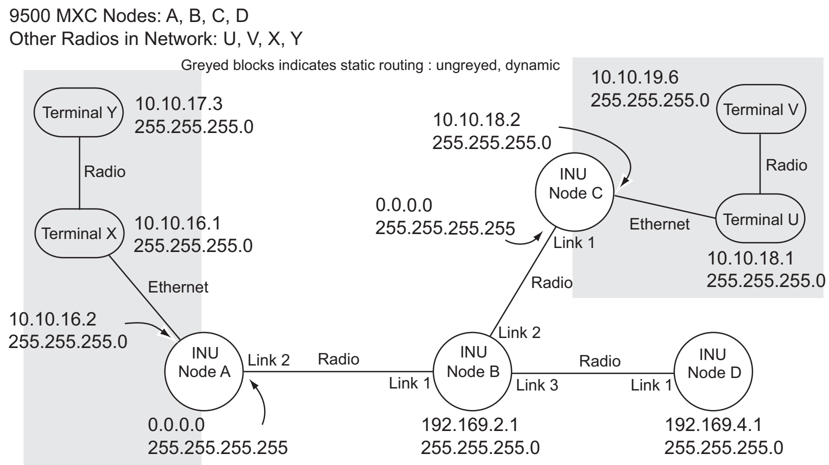


Figure D-8. Split Static and Dynamic Routing Example



Routing and IP Addressing:

Node A: Select Interface IP Addressing and assign IP addresses to each port, in this case the Ethernet and Link 2 NMS ports.

- The Ethernet connected Node A port and and Terminal X must be on the same network (LAN) and therefore require a common *network* address, in this case 10.10.16.0.
- The LINK 2 NMS port is given an IP address of 0.0.0.0 and a mask of 255.255.255.255.
- Select RIP2 for the Link 2 NMS port.

In the static routing screen, assign routes (below) on the Node A Ethernet Port towards terminals X and Y.

Destination	Subnet Mask	Interface	Next Hop
10.10.16.0	255.255.255.0	Ethernet Port	0.0.0.0
10.10.17.0	255.255.255.0	Ethernet Port	10.10.16.1

Node B: Select Single IP Addressing and RIP2

Node C: Select Interface IP Addressing and assign IP addresses to each port, in this case the Ethernet and Link 1 NMS ports.

- The Ethernet connected Node C port and and Terminal U must be on the same network (LAN) and therefore require a common *network* address, in this case 10.10.18.0.
- The LINK 1 NMS port is given an IP address of 0.0.0.0 and a mask of 255.255.255.255.
- Select RIP2 for the Link 1 NMS port.

In the static routing screen, assign routes (below) on the Node A Ethernet Port towards terminals U and V.

Destination	Subnet Mask	Interface	Next Hop
10.10.18.0	255.255.255.0	Ethernet Port	0.0.0.0
10.10.19.0	255.255.255.0	Ethernet Port	10.10.18.1

Node D: Select Single IP Addressing and RIP2

Figure D-9. Interface Addressing Screen for Node A in Figure D-8

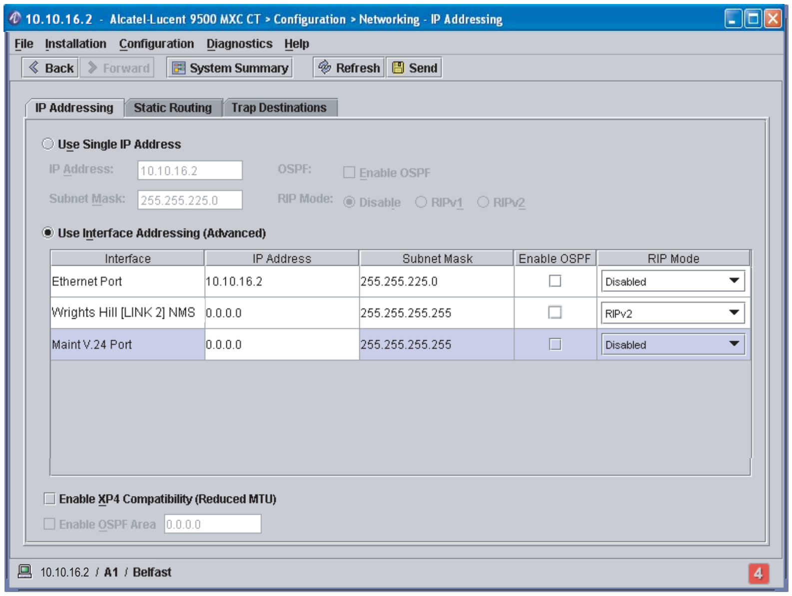
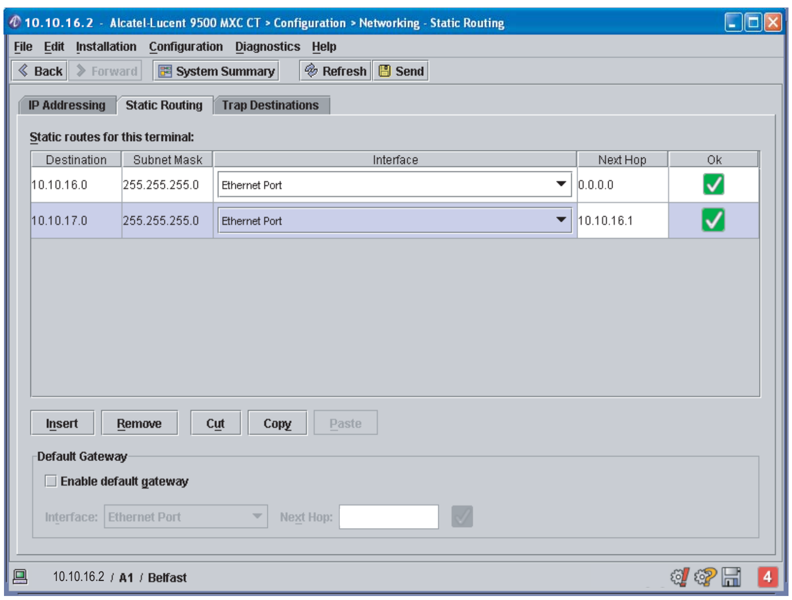


Figure D-10. Static Routing Screen for Node A in Figure D-8

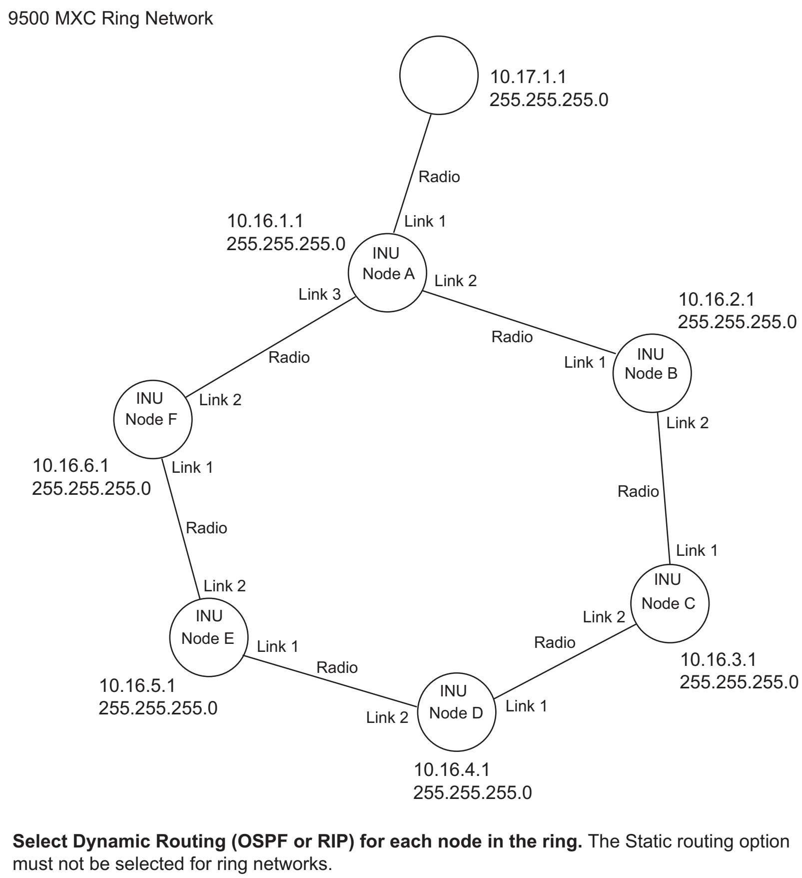


Ring Network

Figure D-11 shows 9500 MXC Nodes in a ring network. All nodes in a 9500 MXC ring must be configured for one of the dynamic routing options, OSPF or RIP.

Single IP Addressing would normally be used. An exception would be where the north-bound interface (Node A) must interface with a network which is static routed. In this instance Node A would be partitioned, as in the Figure D-8 example. Specifically, Interface Addressing would be selected with LINK 1 NMS set for static routing, and LINK 2 NMS and LINK 3 NMS set for dynamic routing.

Figure D-11. Ring Network Example



Appendix E. Node Capacity Rules

The TDM bus capacity and the access to it determines the traffic handling maximums for a 9500 MXC node. These capacity maximums apply equally to the INU and INUe.

- The primary determinant of node capacity is its bus capacity.
- The usage of bus capacity differs for linear and ring nodes.

Refer to:

- Bus Capacity Rules on page -1
- Linear Node Applications on page -1
- Ring Node Applications on page -4

Bus Capacity Rules

Table E-1 lists the rules that govern node bus capacity.

Table E-1. Backplane Capacity Rules

Backplane Configuration	TDM Bus Capacity Rule
E1	Maximum 100xE1, or 200 timeslots, where each timeslot represents a Tx or Rx slot on the bus.
DS1	Maximum 128xDS1, or 256 timeslots, where each timeslot represents a Tx or Rx slot on the bus.
STM1/OC3	Maximum 2xSTM1/OC3, or 4 timeslot groups, where each represents a Tx or Rx group on the bus.

Application of these rules is considered for linear and ring networks:

Linear Node Applications

For a linear network node the number of E1, DS1 or STM1 circuits required on the on the bus equals the number of circuits *passed through and dropped*.

Linear Node Rule
Bus capacity used = Total of circuits passed through the node, *and* dropped at the node.

For an aggregation (back-haul) node this equates to the capacity of the over-air 'pipe' used back towards the network core. Refer to Figure E-1 and the example shown in Figure E-2 of a 64xE1 back-haul link, which is well within the 100xE1 maximum count for an E1 bus configuration.

Figure E-1. Aggregation Node

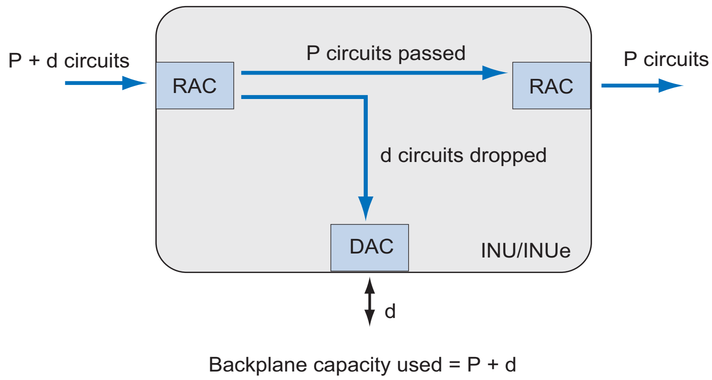
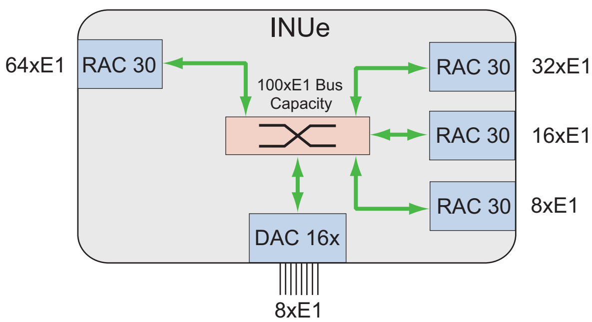


Figure E-2. Aggregation Node Example



For a simple aggregation node using a single RAC 30V3 towards the network core (75xE1, 100xDS1 or STM1/OC3 maximums), bus capacity issues will not arise.

However, capacity issues must be considered where *co-channel* operation is required, given the available RAC 40 capacity options of:

- Co-channel 64/75xE1
- Co-channel 84/100xDS1
- Co-channel STM1/OC3

As *one* INU/INUe has a maximum backplane bus capacity of 100xE1, 128xDS1, or 2xSTM1/OC3, the available co-channel options means that only co-channel STM1/OC3 operation is viable, and then only for a network terminal or repeater node:

- One INU supports co-channel STM1/OC3 over a single link or repeated link. Refer to the example shown in Figure E-3.
- For other capacity options two co-located INU/INUes must be used, as shown in Figure E-4 where two co-channel 64xE1 RAC 40s are installed *across* the INUs to support a 128xE1 backhaul.

Figure E-3. Co-Channel STM1 Terminal Node

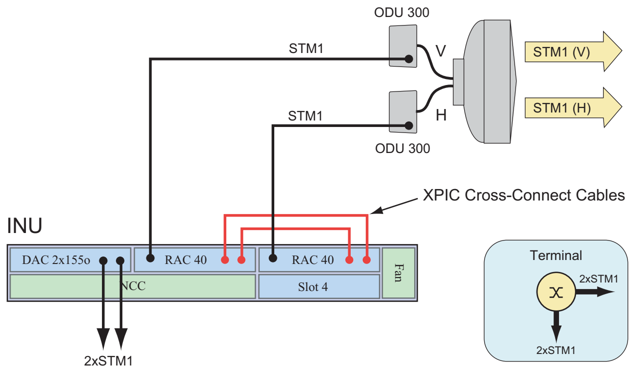
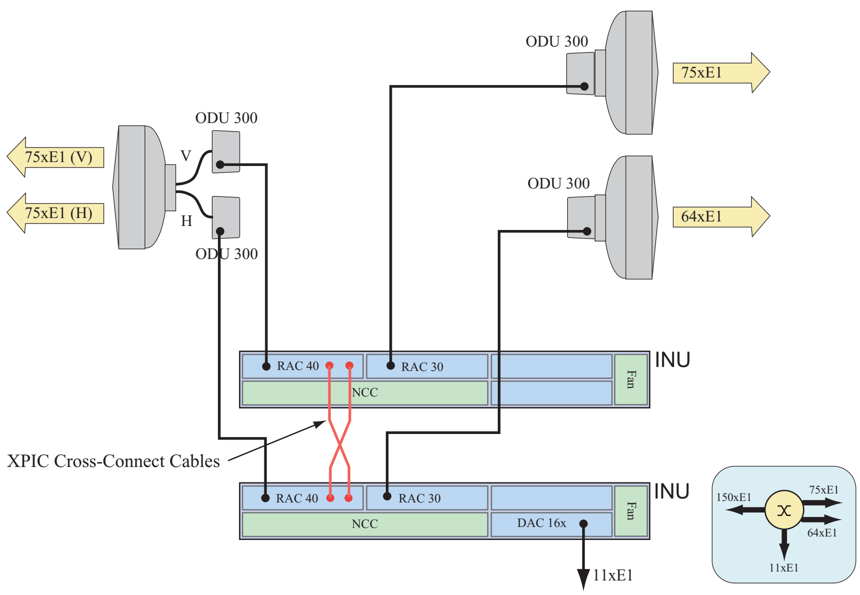


Figure E-4. Co-channel 64xE1 (128xE1) Backhaul Node



For co-channel 64/75xE1 or 84/100xDS1 operation, use paired INUs, with one RAC 40 installed in each. For more information, refer to co-channel operation in Volume II, Chapter 4.

Ring Node Applications

Two ring applications are considered:

- Rings without point-to-point traffic overlay; all circuits on the ring are ring-protected. See Rings Without Pt-to-Pt Overlay on page -4.
- Rings with point-to-point traffic overlay. See Rings With Pt-to-Pt Traffic Overlay on page -5.

Examples shown are for NxE1, or NxDS1 rings. While 9500 MXC may be used to implement an STM1/OC3 protected ring, the ring protection mechanism is performed within a paired SDH mux; *not within 9500 MXC*.

- For *SDH* rings, STM1/OC3 traffic is transported by 9500 MXC as point-to-point circuits; linear node rules apply.

Rings Without Pt-to-Pt Overlay

At the ring network nodes:

- Each *drop-insert* circuit uses three bus *timeslots*. This may also be stated as: each drop-insert circuit uses the equivalent of one-and-one-half bus *circuits*.
- *Pass-through* circuits use the standard two-timeslots, one for Tx and one for Rx (one circuit on the bus).

Ring node capacity rules may therefore be stated as:

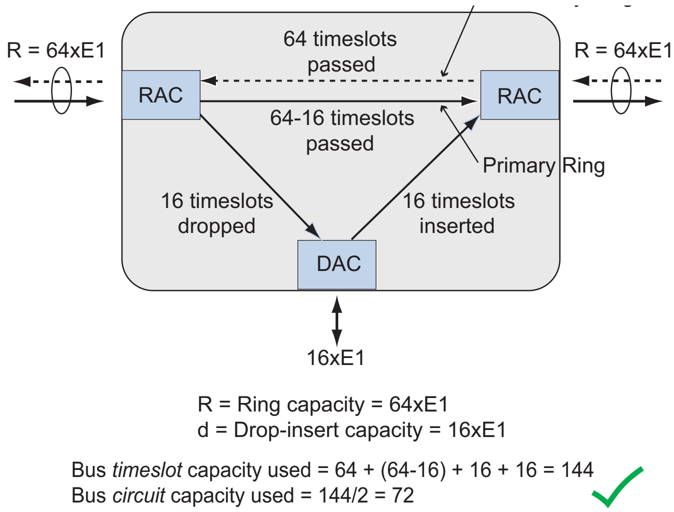
Ring Type	Rule Based on Number of E1 or DS1 Circuits	Rule Based on Number of E1 or DS1 Timeslots
NxE1	$R + d/2 \leq 100$	$2R + d \leq 200$
NxDS1	$R + d/2 \leq 128$	$2R + d \leq 256$

Where:

- R = The ring capacity (total number of *circuits* on the ring)
- d = The drop-insert circuit capacity (number of *circuits* dropped and inserted at the node)

This is illustrated in Figure E-5 for a 64xE1 ring node with a 16xE1 drop-insert.

Figure E-5. Ring Node Bus-Capacity Example



From this it may be determined that:

- Where all traffic on the ring is ring-protected, the number of E1/DS1 circuits used on a 9500 MXC backplane equates to the number of circuits on the ring plus half the number of circuits drop-inserted on the backplane. The total must not exceed 100 or 128 respectively.

  Such circuits may be dropped to a DAC as local tribs, and/or to a RAC to go to remote tribs.
- For a north-south gateway ring, through which all circuits on the ring are sourced, 64xE1 or 84xDS1 is the usable maximum. For example, a 75xE1 north-south capacity is not possible as 113xE1 would be needed at the gateway. Working backwards, the maximum that can be north-south sourced is nominally 64xE1 (leaves 4xE1 spare).
- Where there are two or more gateways on the ring, a full 75xE1 or 100xDS1 ring capability can be used, *providing* the backplane capacity formula is not infringed for any node on the network.

Co-channel ring operation is to be supported in a later release, and requires co-located INU/INUes at each site.

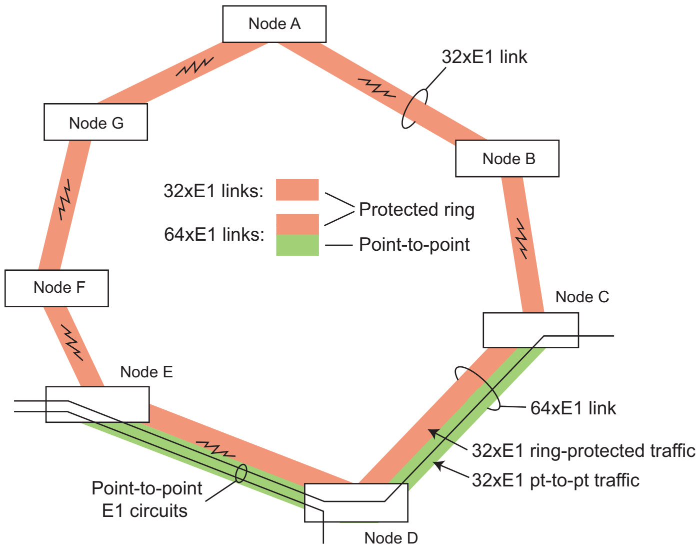
Rings With Pt-to-Pt Traffic Overlay

This application has point-to-point traffic transported side-by-side with ring-protected traffic:

- Ring traffic is protected by normal ring operation.
- Point-to-point traffic is not protected by the ring.
- Point-to-point traffic can be transported over one, many, or all ring hops.

Refer to the example in Figure E-6, which shows a 32xE1 ring with 32xE1 point-to-point overlay on two hops:

Figure E-6. Ring with Point-to-Point Overlay



For nodes, which carry ring *and* overlay traffic, bus capacity rules may be stated as:

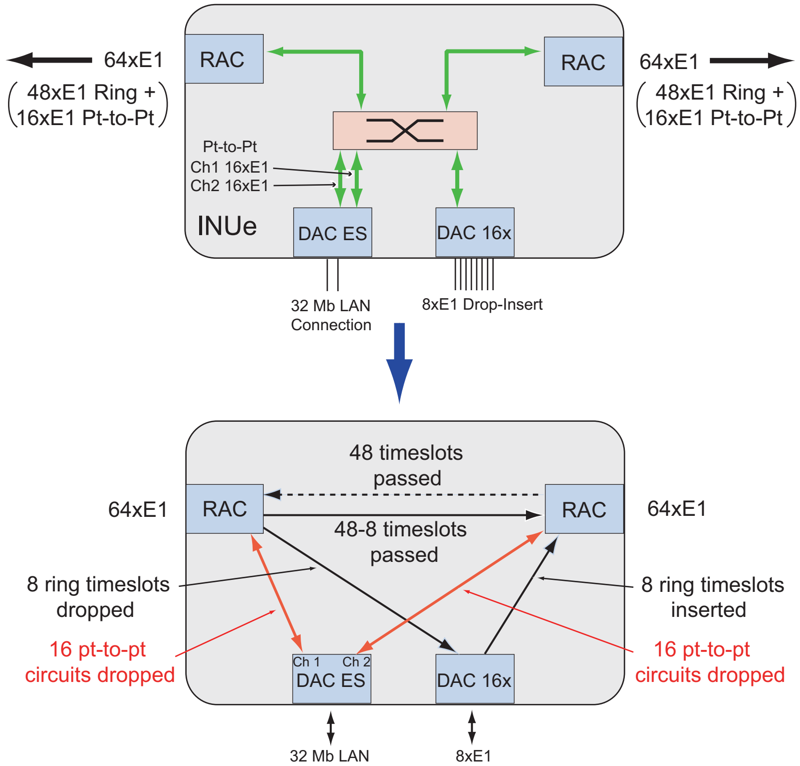
Ring Type	Rule Based on Number of E1 or DS1 Circuits	Rule Based on Number of E1 or DS1 Timeslots
NxE1	$P + R + d/2 \leq 100$	$2P + 2R + d \leq 200$
NxDS1	$P + R + d/2 \leq 128$	$2P + 2R + d \leq 256$

Where:

- P = Total number of point-to-point *circuits* passed through the node, *and* dropped at the node. (This is the same as for linear nodes).
- R = The ring capacity (total number of *ring circuits*).
- d = The drop-insert circuit capacity (number of *circuits* dropped and inserted *from/to the ring*).

This is illustrated in Figure E-7 for a 48xE1 ring with a 16xE1 point-to-point overlay in both directions (total 64xE1 over-air capacity in both directions).

Figure E-7. Example Ring Node with Pt-to-Pt Overlay



P = Pt-to-Pt capacity (total dropped) = 32xE1
R = Ring capacity = 48xE1
d = Ring drop-insert capacity = 8xE1

Bus capacity used = P + R + d/2
= 32xE1 + 48xE1 + 4xE1 = 84xE1 ✓

In this example bus capacity demands are within the 100xE1 maximum. However, if *all* ring-protected circuits are to be sourced/sunk *at one ring node*, then the capacity formula shows that for such a node:

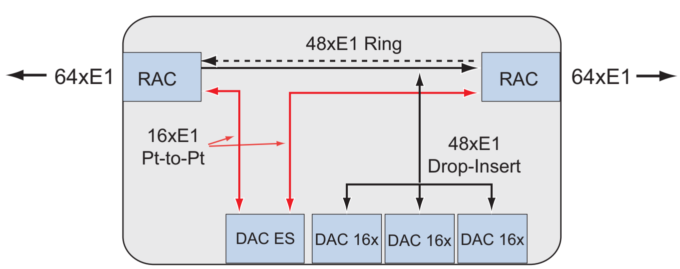
P = Pt-to-Pt capacity (total dropped) = 32xE1

R = Ring capacity = 48xE1

d = Ring drop-insert capacity = 24xE1

Bus capacity used = 32 + 48 + 24 = 104, which is not valid. Refer to Figure E-8.

Figure E-8. Example Ring Node with Overlay at Maximum Bus Capacity



Bus capacity required = 104xE1 ✗

When checking capacity validity, always first check the capacity required at the node which is drop-inserting the highest capacity.

Appendix F. System Block Diagrams and Descriptions

This chapter provides high-level block diagrams and system descriptions for 9500 MXC Node in non-protected, hot-standby, diversity and ring configurations.

For the plug-ins, information on function, interfaces, and configurable options is provided in Volume II, Chapter 3.

Refer to:

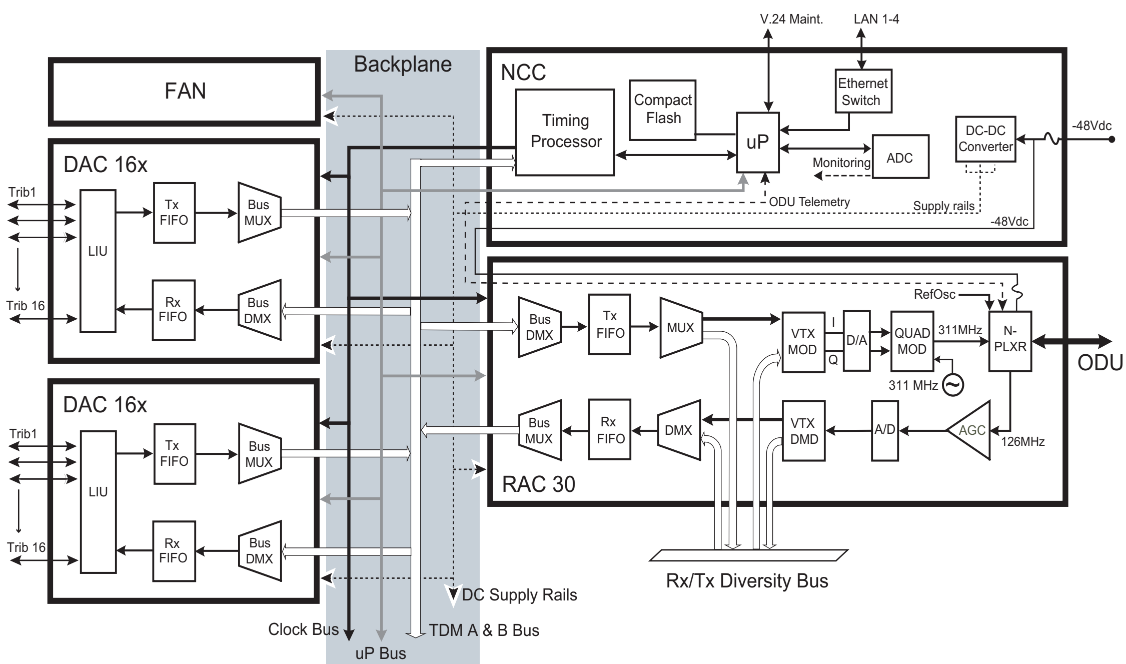
- Non-protected (1+0) INU/INUe on page -1
- ODU 300 on page -7
- Protected and Diversity Operation on page -8

Non-protected (1+0) INU/INUe

The block diagram of an INU in Figure F-1 shows the mandatory NCC and FAN plug-ins, plus three option plug-ins; two DAC 16x and a RAC 30. In this configuration three of the four universal INU slots are used.

For an INUe, one NCC and two FAN plug-ins are mandatory. Universal slots total six, restricted slots three, and an additional slot is reserved for an NPC option.

Figure F-1. INU 1+0 System Block Diagram



Function and operation is described for:

- NCC on page -2
- Backplane on page -3
- TDM Bus on page -3
- RAC 30 on page -3
- RAC 40 on page -4
- Rx and Tx Diversity Bus on page -6
- DAC on page -6

NCC

The NCC is central to the operation of the INU/INUe. It provides management and control functions, local NMS access, and DC power input. Refer to Table F-1 for details.

Table F-1. NCC Operation

NCC Function	Description
Microprocessor	Supports primary control and management of the node.
Timing Processor	Supports the operation of the backplane TDM bus (buses A&B; specifically the timing (data rate) and control (frame synchronization). When an NPC plug-in is installed in an INU/INUe, timing processor functions are backed-up (protected) by the NPC.
ODU - INU Telemetry Channels	Supports up to six INU/ODU telemetry channels, one for each possible RAC/ODU installation. The telemetry channels connect directly between the RAC plug-in and a microprocessor-supported serial controller. They are not carried on the TDM bus.
Compact Flash	The CompactFlash card plugs into the right side of the NCC, or at the rear of the IDU (9500 MXC Terminal). It holds the system configuration (CT config.), system software (embedded software) and, for the 9500 MXC Node, the licensed level. Each CompactFlash is assigned a unique serial number, which is the license serial number.
Ethernet Switch	Supports four RJ-45 10/100Base-T Ethernet ports for NMS access, and router functionality for static and dynamic routing options.
Maintenance Port	One RJ-45 port provides a serial asynchronous data port (V.24) for dial-up CT access.
Analog to Digital Converter (ADC)	Supports monitoring of power supply voltages and other analog signals. • One channel of the ADC is dedicated to a temperature sensor associated with FAN control. • It includes an internal level reference accurate to within ± 1% over the INU/INUe operating temperature range.
DC Converter	Provides the various internal voltage rails.

Backplane

The backplane carries signal and power interconnection between INU/INUe plug-ins. It is a multi-layered PCB with connectors positioned for each plug-in.

TDM Bus

The TDM bus enables traffic interconnect between plug-ins. It comprises two high-speed parallel buses, each divided into time slots, the timing (bus timing) of which can be user-selected for E1, DS1, E3, DS3, or STM1/OC3 rates. In this way, an INU/INUe can be configured as an E1, DS1. E3, DS3 or STM1/OC3 platform.

Slot traffic includes payload and overhead. Each plug-in has access to the entire bus, but slot access depends on its function and configuration.

Bus timing and frame synchronization are provided by the NCC, which can be protected by the installation of the NPC option.

RAC 30

RAC 30 supports the ODU 300 for bandwidth options to 28/30 MHz using modulation options from QPSK to 128QAM.

Operation of the transmit and receive paths are described in turn for the RAC 30 diagram shown in Figure F-1 on page -1.

RAC 30 Transmit

The Bus Demux extracts the payload and overhead traffic from the TDM bus and passes it to FiFo (First-in, First out) buffer and Mux stages, which accepts, synchronizes and frames:

- Up to 64xE1, 84xDS1, 4xE3, 3xDS3, or STM1/OC3 channel capacities.
- One NMS channel, plus the INU-to-INU communication overhead.
- Up to six auxiliary data channels.

The framed data stream is passed to the Vantex modulator, where:

- Reed-Solomon FEC check data and associated block interleaving is inserted.
- It is rate modulated for the selected (in CT) capacity and bandwidth/modulation options.
- 90 degree phase-shifted I and Q data streams are generated.

The I and Q streams are converted to analog signals in the D/A converter, and passed to the quadrature modulator, which impresses the data onto a 311 MHz IF carrier. This IF is passed to the N-Plexer, where it is combined with telemetry and reference oscillator signals, plus 48Vdc power, to go to the ODU.

RAC 30 Receive

Receive traffic is carried on a 126 MHz IF from the ODU. It is extracted at the N-Plexer, along with telemetry data, which goes directly to the NCC.

The 126 MHz IF is passed to an analog to digital converter via a gain controlled amplifier, which compensates for losses in the ODU cable. The digital stream from the converter is fed to the Vantex demodulator, where:

- It is demodulated to derive the framed baseband data.
- FEC decoding is applied.
- Adaptive equalization is applied.
- Errorless receive switching is initiated for protected and diversity link configurations.
- Receive signal quality-monitoring data is extracted for threshold alarms and G.826 statistics.

The output is passed to the de-multiplexer where framing data is removed to recover traffic and overhead data streams. A FiFo buffers and de-jitterizes the data prior to the Bus Mux, which inserts it onto the TDM bus.

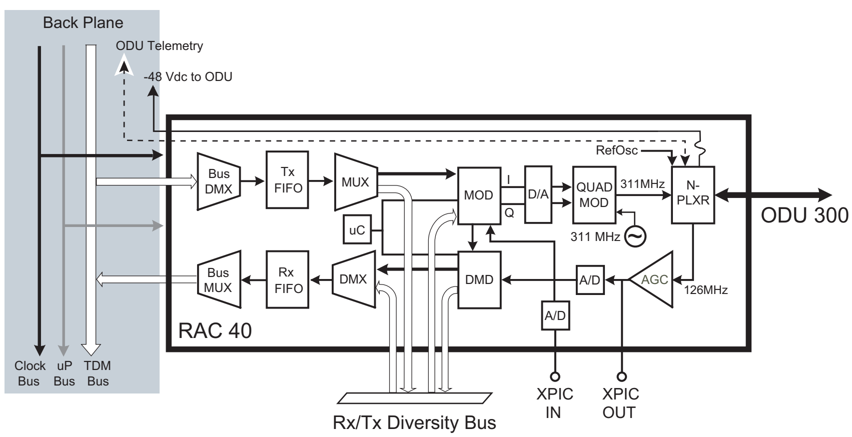
RAC 40

RAC 40 operates with ODU 300; refer to Figure F-2 on page -4.

RAC 40 is similar in operation to RAC 30, except for:

- The incorporation of a micro-controller to manage the modulator and demodulator functions.
- XPIC In/Out connections.
- Reed-Solomon *and* Viterbi FEC.

Figure F-2. RAC 40 Block Diagram



RAC 40 Transmit

The Bus Demux extracts the payload and overhead traffic from the TDM bus and passes it to FiFo (First-in, First out) buffer and Mux stages which accepts, synchronizes and frames:

- Up to 64xE1, 84xDS1, or STM1/OC3 channel capacities.
- One NMS channel plus INU-to-INU communication overhead.
- Up to six auxiliary data channels.

The framed data stream is passed to the modulator, where:

- FEC encoding is applied: Reed-Solomon with block interleaving, and Viterbi.

- It is rate modulated for the selected (in CT) capacity and bandwidth/modulation options.
- 90 degree phase-shifted I and Q data streams are generated.

The I and Q streams are converted to analog signals in the D/A converter, and passed to the quadrature modulator, which impresses the data onto a 311 MHz IF carrier. This IF is passed to the N-Plexer, where it is combined with telemetry and reference oscillator signals, plus 48Vdc power, to go to the ODU.

RAC 40 Receive

Receive traffic is carried on a 126 MHz IF from the ODU. At the N-Plexer it is extracted along with telemetry data, which goes directly to the NCC.

The 126 MHz signal is passed to a gain controlled amplifier, which compensates for losses in the ODU cable. Two data streams are taken from the amplifier:

- One is directed to the demodulator via an A/D converter.
- The other is directed to the XPIC OUT connector on the front panel. This is the sample of the received signal, which are used by the *paired* RAC 40 for its use in removing signal corruption caused by lack of polarization discrimination.

The cross-polarized signal sample *from* the paired RAC 40 (XPIC IN) is converted to a digital signal by the A/D converter and passed to the modulator, where signal equalization is applied. The equalized sample is sent to the demodulator where it is processed with the wanted signal to remove cross-polar signal corruption.

Other demodulator processes include:

- FEC decoding.
- Adaptive equalization.
- Errorless receive switch initiation (for protected RAC 40 configurations).
- Extraction of receive signal quality-monitoring data for threshold alarms and G.826 statistics.

The output is passed to the de-multiplexer where framing data is removed to recover traffic and overhead data streams. A FiFo buffers and de-jitterizes the data prior to the Bus Mux, which inserts it onto the TDM bus.

ODU Cable, Interfaces and Traffic

A single 50 ohm coaxial cable connects a RAC to its ODU. The preferred cable type is Belden 9913, which supports INU-to-ODU cable lengths up to 300m (985 ft.). The ODU cable is provided within a cable kit, which includes cable ties, cable ground kits, and Type N crimp connectors.

At the building end, it connects to a lightning surge suppressor, and then via a jumper cable to the RAC.

At the ODU end it connects to a lightning surge suppressor, which is fastened directly to the ODU connector.

The ODU cable carries DC power (-48 Vdc) for the ODU and five signals:

- TX telemetry
- Reference signal to synchronize the ODU IQ Mod/Demod oscillator

- 311 MHz IQ modulated signal from the RAC (transmit IF)
- Receive telemetry
- 126 MHz IQ modulated signal from the ODU (receive IF)

Signal extracting and merging is carried out in N-Plexers within the RAC and ODU.

Rx and Tx Diversity Bus

This bus is not accessed for non-protected or ring configurations. Refer to Protected and Diversity Operation on page -8 for details.

DAC

DACs interface customer data to the TDM bus.

Different DACs support different traffic types and rates.

DAC 16x

Basic DAC functionality is explained for the DAC 16x shown in Figure F-1 on page -1:

Line isolation and surge protection is provided at the tributary in/out connections prior to the Line Interface Unit (LIU).

Interface matching for E1 (75 ohms unbalanced or 120 ohms balanced), or DS1 (AMI or B8ZS encoding), is enabled within the LIU (configured from CT). The LIU also supports trib and bus facing loopbacks (for local and remote trib loopbacks respectively).

In the transmit direction (to the TDM Bus) trib data streams are converted within the Bus Mux from serial to parallel data, and rate-adapted from the E1 (or DS1) trib clock domain to the TDM bus clock. The resultant bus-framed data is inserted onto the TDM bus in blocks NxE1 (or DS1) data, where N is the number of tribs in use.

In the receive direction, data from the TDM Bus is de-multiplexed to extract the tribs and trib clocking, is de-jitterized, converted back to a serial E1 (or DS1) data format, and passed to the LIU.

The Bus Mux also supports AIS insertion, and a PRBS generator and receiver function for trib BER measurement[1].

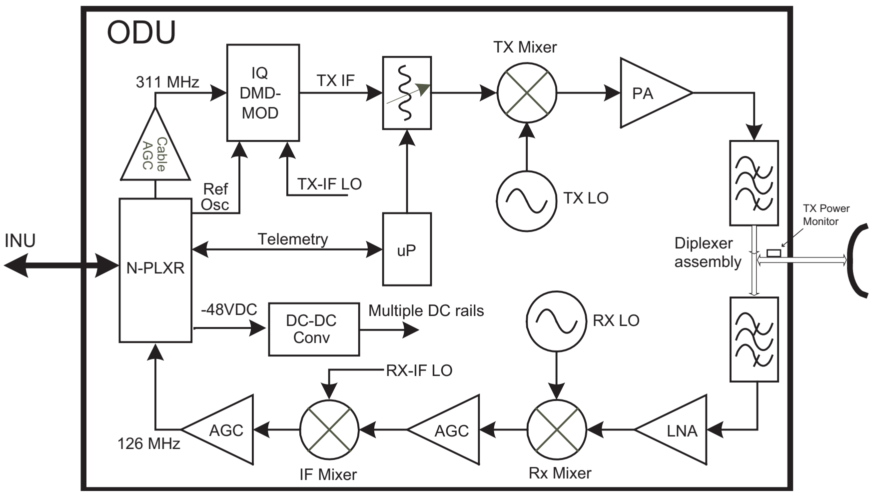
[1] *The PRBS function is a scheduled capability.*

ODU 300

ODU 300 platforms for 6 to 15 GHz, and 18 to 38 GHz, differ in respect of the synthesizers used to derive the signal sources for the Tx and Rx mixer stages. For the 6 to 15 GHz ODU, separate synthesizers are used. For 18 to 38 GHz, a common synthesizer is used.

Figure F-3 shows a 6 to 15 GHz ODU 300ep block diagram.

Figure F-3. ODU 300, 6 to 15 GHz



The quadrature modulated 311 MHz IF signal from the RAC is extracted at the N-Plexer and passed via a cable AGC circuit to an IQ demodulator/modulator. Here the 311 MHz IF is demodulated to derive the separate I and Q signals using the 10 MHz synchronizing reference signal from the RAC.

These I and Q signals modulate a Tx IF, which has been set to a specific frequency between 1700 and 2300 MHz, such that when mixed with the Tx local oscillator signal (TXLO) in the subsequent mixer stage, provides the selected transmit frequency. Both the IF and Tx local oscillators are synthesizer types.

Between the IQ modulator and the mixer, a variable attenuator provides software adjustment of Tx power.

After the mixer, the transmit signal is amplified in the PA (Power Amplifier) and passed via the diplexer to the antenna feed port.

A microprocessor in the ODU supports configuration of the synthesizers, transmit power, and alarm and performance monitoring. The ODU microprocessor is managed under the NCC microprocessor, with which it communicates via the telemetry channel.

A DC-DC converter provides the required low-voltage DC rails from the -48 Vdc supply.

In the receive direction, the signal from the diplexer is passed via the LNA (Low Noise Amplifier) to the Rx mixer, where it is mixed with the receive local oscillator (RXLO) input to provide an IF of between 1700 and 2300 MHz. It is then amplified in a gain-controlled stage to compensate for fluctuations in receive level, and in the IF mixer, is converted to a 126 MHz IF for transport via the ODU cable to the RAC.

The offset of the transmit frequencies at each end of the link is determined by the required Tx/Rx split. The split options provided are based on ETSI and FCC plans for each frequency band. The *actual* frequency range per band and the allowable Tx/Rx splits are range-limited within 9500 MXC to prevent incorrect user selection.

A power monitor circuit is included in the common port of the diplexer assembly to provide measurement of transmit power. It is used to confirm transmit output power for performance monitoring purposes, and to provide a closed-loop for power level management over the specified ODU temperature and frequency range.

Protected and Diversity Operation

The INU/INUe supports protection via hot-standby, space diversity, frequency diversity, or ring.

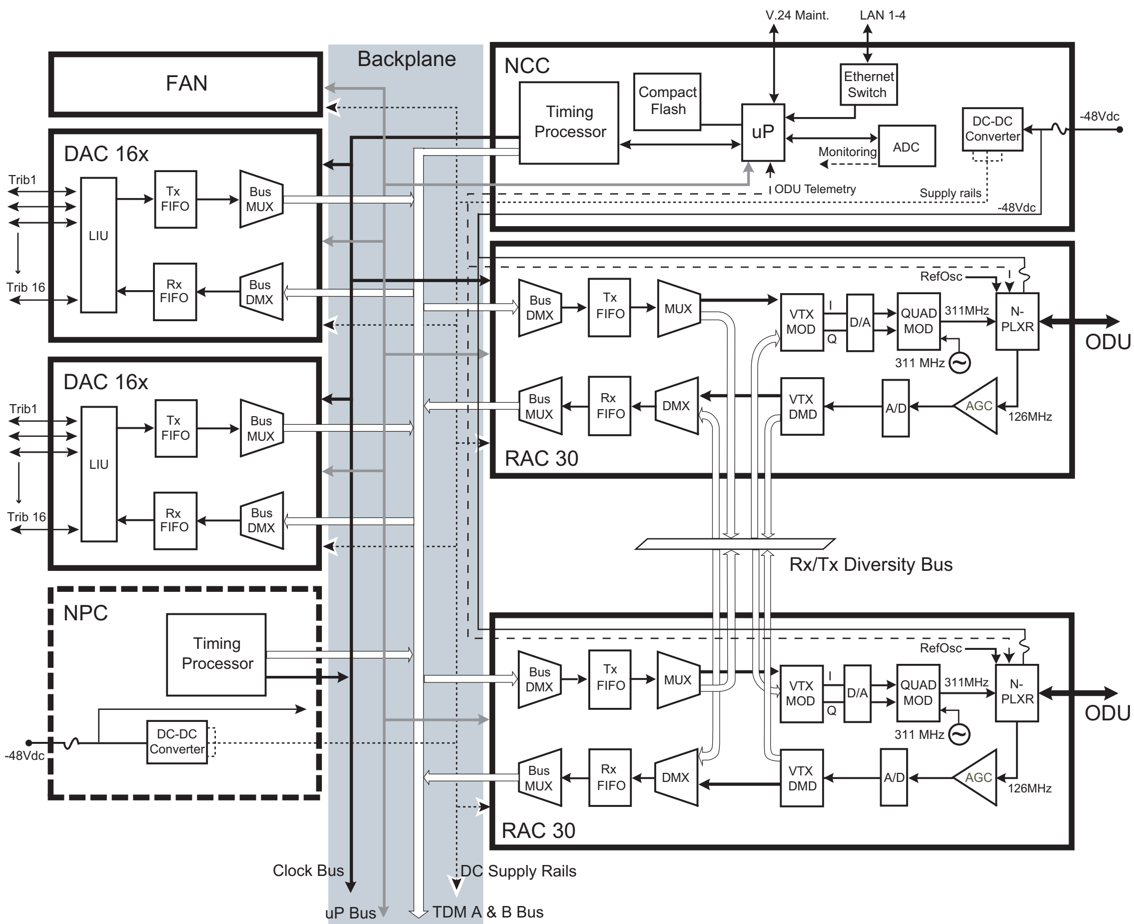
All options are supported by RAC 30, RAC 3X or RAC 40.

Figure F-4 on page -9 shows a basic protected or diversity INU using two RAC 30 plug-ins. It also incorporates two DAC 16x plug-ins and an NPC. The NPC provides backup (protection) for the timing processor and DC-DC power supply functions within the NCC.

For a protected or frequency diversity configuration the two ODUs would normally connect to a common antenna using a coupler, which can be specified for unequal or equal splits. For space diversity or ring protection, each ODU is attached to its own antenna.

Protected NCC operation is identical to non-protected.

Figure F-4. INU Protected or Diversity System Block Diagram with NPC Option



Protected and diversity configurations use a Tx/Rx diversity bus to support Tx and Rx switching.

Receive switching between two receiving RACs is hitless. Transmit switching has a maximum restoration time of 500 ms. For information on protection switching criteria, refer to Volume II, Chapter 3.

The default INU/INUe configuration (within CT) selects the *primary* RAC as the online Tx RAC, and the *secondary* RAC as the online Rx RAC.   The rationale is that if the primary RAC suffers a transmit failure, then the secondary RAC becomes both the online Tx RAC and online Rx RAC. The primary RAC can then be removed from the INU without further affecting transmit traffic.

Refer to the following sections for an explanation of the protection options and the Rx/Tx diversity bus:

- Hot Standby on page -10
- Space Diversity on page -11
- Frequency Diversity on page -11
- Ring Protection on page -12

Hot Standby

Figure F-5 shows data routing for a hot standby configuration using RAC 30s.

The originating data source is shown as a DAC, but the process applies to all DAC, RAC or AUX sources on the TDM bus.

Transmit direction:

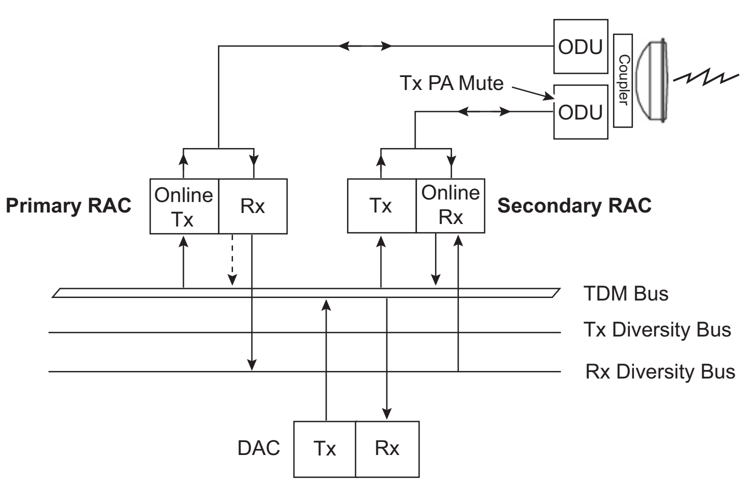
- DAC Tx drives to the TDM bus.
- The primary RAC (online Tx) uplifts DAC Tx data from the TDM bus and delivers it to its ODU.
- The secondary RAC (offline Tx) also uplifts the same DAC Tx data but at its ODU the PA is muted (no ODU transmit).

Receive direction:

- Both primary and secondary RACs receive data, but only the secondary RAC (online Rx), drives to the TDM bus (secondary RAC is default Rx online).
- Data from the primary RAC Rx is routed to the Rx diversity bus, where it is uplifted by the secondary RAC.
- The secondary RAC decides on a frame-by-frame basis, which receive stream (primary or secondary RAC data) to pass to the TDM bus. The decision favours the data source for the previous frame if both frames are un-errored. This selection process is hitless.
- The DAC uplifts received data from the TDM bus.
- The online Rx RAC only switches (secondary RAC to primary RAC) in the event the secondary RAC is missing/incorrect, or there is a software load failure. When either occurs, received data is sent directly to the TDM bus by the primary RAC. This switching from online primary Rx RAC to the secondary RAC is not hitless; there is a maximum 500 ms detection, acquisition and recovery period (service restoration time).

The *Tx* diversity bus is not used for hot-standby.

Figure F-5. Hot Standby Protection



Space Diversity

Space diversity protection operation is identical to hot standby except for the use of two vertically separated antennas. The upper antenna should be installed with the online Tx (primary RAC/ODU).

Frequency Diversity

Frequency diversity has both transmitters and receivers operational.

The Tx diversity bus is used to ensure identical frame synchronization on the two parallel transmit streams, to enable hitless frame-by-frame selection at the receive end.

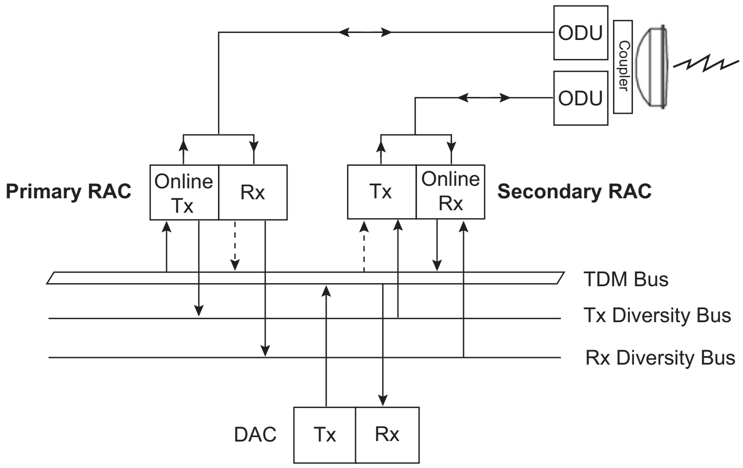
Transmit direction:

- DAC Tx drives to the TDM bus.
- The primary RAC (online Tx) uplifts DAC Tx data from the TDM bus and delivers it to its ODU. It also sends its same (framed) data stream to the secondary RAC via the Tx diversity bus.
- The secondary RAC/ODU transmits the data (on a different frequency).

Receive direction:

- Both primary and secondary RACs receive the transmitted data, but only the secondary RAC (online Rx), drives to the TDM bus (secondary RAC is default Rx online).
- Data from the primary RAC Rx is routed to the Rx diversity bus, where it is uplifted by the secondary RAC.
- The secondary RAC decides on a frame-by-frame basis, which receive stream (primary or secondary) to pass to the TDM bus. The decision favours the data source for the previous frame if both frames are un-errored.
- The online Rx RAC only switches (secondary to primary RAC) in the event the secondary RAC is missing/incorrect, or there is a software load failure. When either occurs, the received data is sent directly to the TDM bus by the primary RAC.
- Similarly, the online Tx RAC only switches (primary to secondary) in the event the primary RAC is missing/incorrect, or there is a software load failure. When either occurs, the transmit data is uplifted directly from the TDM bus by the secondary RAC.

Figure F-6. Frequency Diversity



Ring Protection

East facing (*primary)* RAC/ODUs drive the clockwise, primary ring. The reverse, secondary ring, is driven by the West facing (*secondary*) RAC/ODUs[2].

Only nodes adjacent to the failure point are involved in the wrapping action; all other nodes on the ring continue to transmit and receive data in the same pre-fault clockwise direction. The wrapping action is performed on the TDM bus.

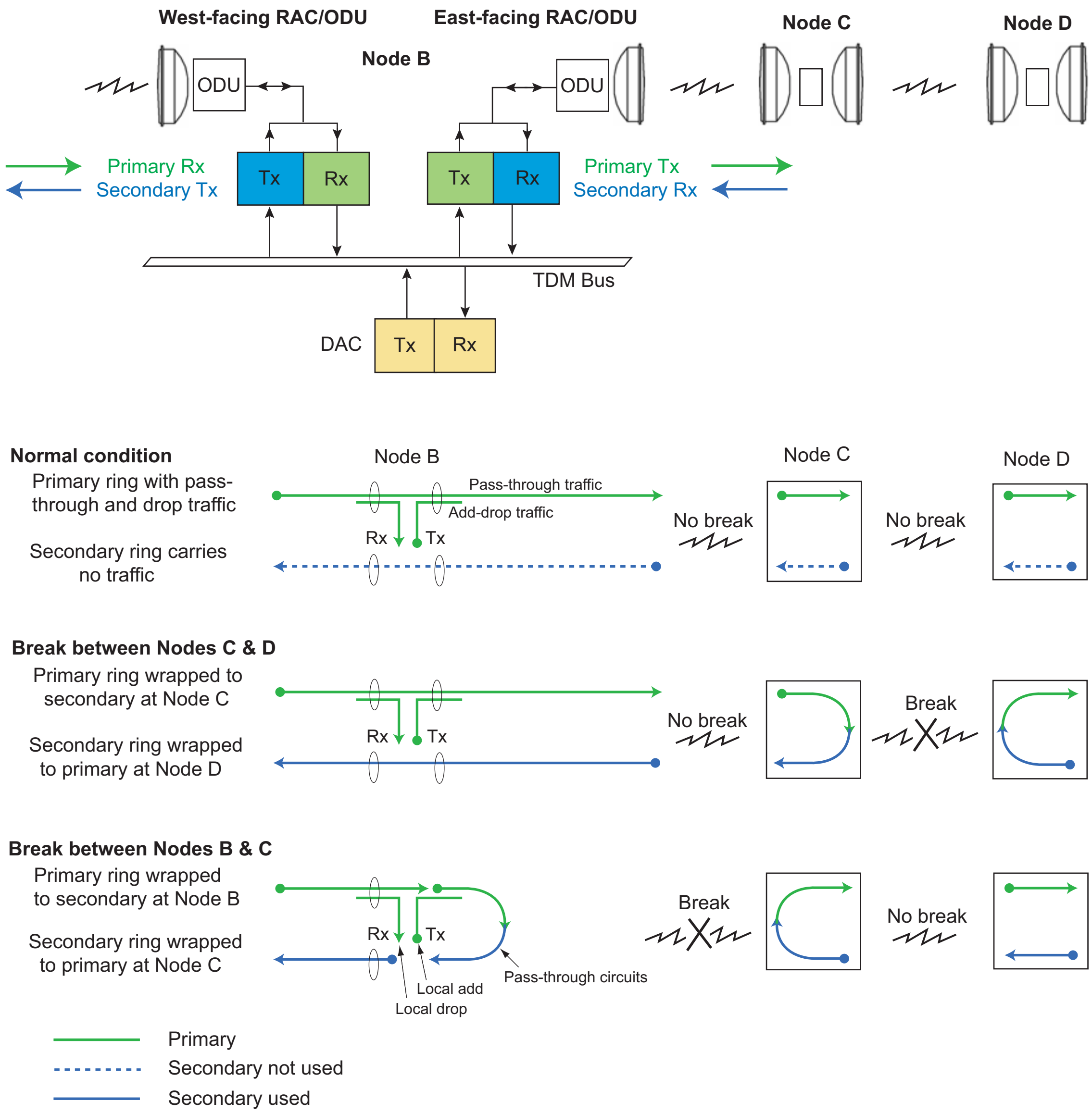
Figure F-7 on page -13 illustrates a back-to-back configuration of a typical east-west node. At Node B, the normal and fault scenarios shown are:

- For normal, no-fault situations, the east-facing RAC is online *transmitting* valid traffic, and the west-facing RAC is online *receiving*, for a clockwise data flow. There is no valid traffic sent in the opposite direction, from the west-facing Tx and east-facing Rx (secondary ring).
- For a break between nodes C and D, there is no change to the operation of node B, but the secondary ring passing through it is now carrying wrapped data from node C.
- For a break between nodes B and C, node B wraps data from the primary to secondary ring, and does so without involving its primary Tx RAC[3]. Node B drop-insert circuits remain intact.

[2] *The east, west, clockwise and anti-clockwise descriptors are conventions used to describe and configure 9500 MXC ring operation. The physical implementation of a ring may be quite different.*

[3] *Wrapping can occur at the east-facing or west-facing RAC connections to the TDM bus. In this way, should a ring-break be due to a fault within a RAC/ODU, the failed RAC will not participate in the traffic re-direction.*

Figure F-7. Pass-through, Drop and Wrapping Action



Glossary

About This Glossary

This Glossary defines terms and acronyms used in this manual and in microwave radio publications.

Numbers

1+1 protected system

Two transceivers are used at each end of a link to protect against transmission failure. If a data transmission fails on the operating transceiver, it is transferred to the backup transceiver. With a 1+1 protected microwave radio link, the protection mechanism normally allows receiver switching independently of the transmitter, and vice-versa.

1U

Standard Electronic Industries Association size for a single rack unit (44.5 mm / 1.75 in.)

A

AACS

Access and Administration Control System.

ACU

Antenna Coupling Unit.

ADC

Analog-to-digital Converter. A device that converts an analog signal to a digital signal that represents equivalent information.

Address

The unique number ID assigned to one host or interface in a network.

ADM

Add/Drop Multiplexer. Digital multiplexing equipment that adds/removes individual signals to/from a collection of multiplexed signals in a network.

AGC

Automatic Gain Control. A process that automatically adjusts gain as a function of a specified parameter, such as received signal level. AGC is used to help maintain a constant output level when the input signal level is changing.

AIS

Alarm Indication Signal - The code generated by a regenerator upon loss of input signal or loss of frame. A signal transmitted in lieu of the normal signal to maintain transmission continuity and to indicate to the receiving terminal that there is a transmission fault that is located either at, or upstream from, the transmitting terminal.

AIS-L

Line Alarm Indication Signal.

ALC

Automatic Level Control. See AGC.

AMI

Alternate Mark Inversion Signal. A pseudoternary signal, representing binary digits. Successive marks are of alternately positive and negative polarity and the absolute values of their amplitudes are normally equal. Spaces are of zero amplitude.

Analog signal

A signal that has a continuous nature instead of pulsed or discrete.

ANSI

American National Standards Institute.

APS

Automatic Protection Switch or Automatic Protection Switching.

ARP

Address Resolution Protocol.

ASCII

American National Standard Code for Information Interchange.

ASIC

Application Specific Integrated Circuit.

ATM

Asynchronous Transfer Mode. A dedicated connection switching technology that organizes digital data into 53-byte cell units and transmits them over a physical medium using digital signal technology. Relative to other related cells, each cell is processed asynchronously and queued before being multiplexed over the transmission path.

ATPC

Automatic Transmit Power Control. A feature of digital microwave radio equipment that adjusts the transmitter output power based on path fading detected at the receiver. This feature reduces interference with neighboring systems and permits greater link density.

AUX

Auxiliary services module.

Auxiliary Data Channel

A data channel between microwave radio terminals that is outside the customer payload channel(s). The auxiliary data channel is normally transported in the radio overhead.

AWG

American Wire Gauge. A wire diameter specification. The smaller the AWG number, the larger the wire diameter.

Azimuth

The angle in the horizontal ground plane with respect to true North (such as, horizontal direction); used in reference to antenna alignment.

B

B1

Bit Interleaved Parity-8 (BIP-8). An RSOH byte for error checking the complete STM-1 signal at the end of a regenerator section.

B2

Bit Interleaved Parity-24 (BIP-24). MSOH bytes for error checking an STM-1 signal (minus the RSOH) at the end of the multiplexer section.

B3ZS

Binary 3 zeros substitution. A “1” is substituted for every 3 zeros.

B8ZS

Binary 8 zeros substitution/Bipolar 8 zero substitution.

BAPT

Bundesamtfur Post Und Telekommunikation (German Telecom Regulatory Agency).

BBER

Background Block Error Ratio.

BBP

Baseband Processing.

BCH

Bose-Chaudhuri-Hochquenghem code. A multilevel, cyclic, error-correcting, variable-length digital code used to correct errors up to approximately 25% of the total number of digits.

Beamwidth

The beamwidth of an antenna is defined as the angle between the two half-power (-3 dB) points on either side of the main lobe of radiation (half power beamwidth).

BER

Bit Error Ratio or Bit Error Rate - The number of erroneous bits divided by the total number of bits transmitted, received, or processed over some stipulated period.

BML

Business Management Level in the TMN model

BNC

Type of coaxial connector.

BPDU

Bridge Protocol Data Unit.

bps

Bits per second.

BSI

British Standards Institute.

Bursty Traffic

Communications data does not flow in a steady stream.

C

Carrier Ethernet

A ubiquitous, standardized carrier-class service defined by five attributes that distinguish Carrier Ethernet from LAN-based Ethernet: standardized services, scalability, reliability, quality of service, and service management.

CAS

Channel Associated Signalling.

CBS

Committed Burst Size.

CB-149

The Bell Core standard that was used before the ITU standard was adopted.

CCITT

International Telegraph and Telephone Consultive Committee.

CCS

Common Channel Signaling.

CDMA

Code Division Multiple Access.

CE

Conformité Européene. The CE marking indicates that the product has been designed and manufactured in conformity with the essential requirements of all relevant EU (European Union) directives, and submitted to the relevant conformity assessment procedure.

CEMF

Cisco Element Management Framework.

CEPT

The European Conference of Postal and Telecommunications Administrations.

CEPT-1

ITU-T digital signal level 1 (2.048 Mbps) = E1

CEPT-2

ITU-T digital signal level 2 (8.448 Mbps) = E2

CEPT-3

ITU-T digital signal level 3 (34.368 Mbps) = E3

CEPT-4

ITU-T digital signal level 4 (139.264 Mbps)

CEPT-n

Conference of European Posts and Telecommunications level n.

CET

Carrier Ethernet Transport.

CIR

Committed Information Rate.

CLEC

Competitive Local Exchange Carrier Market. A service provider that builds and operates communication networks in metropolitan areas, thus providing customers with an alternative to local telephone companies. USA terminology.

CLI

Command Line Interface.

CMOS

Complementary Metal Oxide Semiconductor.

CODEC

Abbreviation of coder/decoder. A device that encodes and/or decodes a signal. For example, telcos use codecs to convert digital signals to analog signals - and vice-versa.

Commissioning

A radio link is commissioned when customer traffic circuits have been connected and the link is completely ready to provide a data service.

Community String

When configuring an SNMP agent, the community string (which is a name or combination of characters) is input as part of the configuration information. When a management system wants to communicate with the device, it authenticates using the community string. There are normally two community strings accommodated by a device, one for reading values and one for writing (setting) values. These are normally set to “Public” or “Private”, but can be set to other values as a form of security.

Component

The *component replacement level* describes the smallest field-replaceable parts of a system. For example, for a split-mount radio terminal, the IDU and ODU normally represent the lowest level of field replaceable items.

CORBA

Common Object Request Broker Architecture.

CoS

Class of Service.

CPE

Customer Premise Equipment.

CRC

Cycle Redundancy Check.

CTB

Cable Termination Block.

CTU

Customer Termination Unit.

C-VLAN

Customer VLAN.

D

D / A

Digital to Analog.

DAC

1) For 9500 MXC: Digital Access Card; 2) Digital to Analog Converter.

DADE

Differential Absolute Delay Equalization. An equalization process used to render a protected system hitless.

DART

Digital Access Radio Technology. A digital microwave radio system.

dB

The abbreviation for decibel; the standard unit of measure for relative signal power.

DB9

A standardized connector with 9 pins.

dBm

db referenced to one milliwatt = 0 dBm. The standard unit of measure for absolute power values.

dc

Direct current; 9500 MXC radios operate on dc power.

dc-dc Converter

An electrical device used to convert direct current from one level to another.

DCE

Data Communications Equipment.

DDS

Direct Digital Synthesizer.

DEMUX

De-multiplexer.

DFE

Decision Feedback Equalizer.

DHCP

Dynamic Host Configuration Protocol.

Diagnostic Controls or Functions

Radio system features used for troubleshooting or testing the radio or radio link. Some examples: RF loopback, PA mute, and tributary loopback.

Diplexer

A RF filter device used to separate the Tx and Rx signals at the transceiver antenna feed port.

Digital signal (DS)

A signal format where the intelligence is transported as binary code.

Digital signal 1 (DS1)

An ANSI digital signaling rate of 1.544 Mb/s, corresponding to the North American and Japanese T1 designator.

DLC

Digital Loop Control.

DQPSK

Differential Quadrature Phase Shift Keying.

DS1

Digital signal 1: an ANSI digital signaling rate of 1.544 Mb/s, corresponding to the North American and Japanese T1 designator.

DS3

Digital signal 3: an ANSI digital signal level 3 (44.736 Mbps), the North American T3 designator.

DSL

Digital Subscriber Line.

DSTM

Derived System Timing Mode, i.e., derived from incoming Ethernet frames.

DSx

ANSI digital signal level x.

DTE

Data Terminal Equipment. Devices acting as data source, data sink, or both. They typically connect to a network via a DCE.

Dual Link

Two radio links operating in parallel, on different frequencies, and transporting different data.

DTM

Derived Timing Mode. Recovered service clocks are derived from the incoming Ethernet frame.

DTMF

Dual Tone Multi-frequency.

DTPC

Dynamic Transmit Power Control. A feature enabling the regulation of a target receive signal level by remotely and proportionally controlling the corresponding transmitter output power level.

DUART

Dual Universal Asynchronous Receiver-Transmitter.

DVM

Digital Volt Meter.

E

E1

ITU digital signal level 1 (2.048 Mbps) = CEPT 1.

E3

ITU digital signal level 3 (34.368 Mbps) = CEPT 3.

E/I

Energy to Interference ratio.

E/N

Energy to Noise ratio.

ECC

Error Correction Code.

9500 MXC Node

Refers to the 9500 MXC INU or INUe with ODU300. Plug-in cards provide multiple link and tributary options. Capacity extends from 4xE1/DS1 to 2xSTM1/OC3. Modulation options extend from QPSK to 256QAM. Protection options support hot standby, space diversity, frequency diversity, or ring.

9500 MXC Terminal

Refers to the 9500 MXC IDU with ODU 300. Different version are available to transport NxE1/DS1 tribs, STM1/OC3, or Fast Ethernet. Terminals are protectable, using two co-located Terminals with an inter-connecting protection cable.

EEPROM

Electrically Erasable Programmable Read Only Memory

EIA

Electronic Industries Association

EIR

Excess Information Rate

EISA

Extended Industry Standard Architecture - A 32-bit bus standard that supports the features of microchannel architecture. A special card is required for 32-bit operations that maintain compatibility with the older ISA (Industry Standard Architecture).

Electromagnetic Spectrum

Though the electromagnetic spectrum was, by custom and practice, formerly divided into 26 alphabetically designated bands, the ITU formally recognizes 12 bands, from 30 Hz to 3000 GHz.

E-LAN

An Ethernet service type that is based on a multipoint-to-multipoint EVC.

EM

Element Manager.

EMC

Electro-Magnetic Compatibility.

EMI

Electromagnetic interference.

EML

Element Management Level in the TMN model.

EMS

Element Management System.

End-to-end delay

The time it takes a signal to travel from point of transmission, to the point of reception.

EOW

Engineering Orderwire (Voice and/or Data).

ERP

Effective Radiated Power.

ES

Errored Second.

ESD

Electrostatic discharge.

ESR

Errored Second Ratio.

Ethernet

The term Ethernet refers to the family of local-area network (LAN) products covered by the IEEE 802.3 standard that defines what is commonly known as the CSMA/CD protocol. Data rates are defined for:

- 10 Mbit/s - 10Base-T Ethernet
- 100 Mbit/s - Fast Ethernet
- 1000 Mbit/s - Gigabit Ethernet
- 10000 Mbit/s - 10-Gigabit Ethernet

ETSI

European Telecommunications Standards Institute. Provides international technical standards for wireless radios. 9500 MXC radios are in compliance with all relevant ETSI standards.

EVC

Ethernet Virtual Connection. An association of two or more UNIs that limits the exchange of frames to UNIs in the Ethernet Virtual Connection.

F

Fade margin

The amount of attenuation a link can suffer before link performance is affected. Typically measured as the dB difference between the received signal strength and the receive threshold.

FCAPS

Fault, Configuration, Accounting, Performance and Security functions in the TMN model.

FCC

Federal Communications Commission. The FCC is an independent United States government agency, directly responsible to Congress. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite and cable. The FCC's jurisdiction covers the 50 states, the District of Columbia, and U.S. possessions.

FCS

Frame Check Sequence.

FD

Frequency Diversity. A path protection mode. The main and standby radios are transmitting simultaneously and are tuned to different frequencies (at least two channels apart) to avoid interference. When a fault is detected on the active radio, the traffic is switched to the standby radio.

FEC

Forward Error Correction. A system of error control for data transmission. It compensates for errors induced in the transmitted stream, by sending along with the primary data payload, additional information to correct for errors that occur in transmission.

FER

Frame Error Ratio.

FFE

Feed Forward Equalizer.

FIFO

First In First Out.

FIR

Finite Impulse Response filter. Designates one of two primary types of digital filters used in Digital Signal Processing (DSP) applications.

FLR

Frame Loss Ratio. This is the measure of lost frames between the ingress UNI and the egress UNI. Frame Loss Ratio is expressed as a percentage.

FM

Fault Management.

FPGA

Field Programmable Gate Array.

Frame

Short for “Ethernet Frame.”

Frame Delay

The time required to transmit a Service Frame from ingress UNI to egress UNI.

FSK

Frequency-shift Keying. The modulating signal shifts the output *frequency* between predetermined values.

G

G.821

An ITU-T recommendation on error performance parameters and objectives for primary-rate (64 kbit/s) data circuits. It can be used for higher bit-rates, typically up to to 2 Mbit/s. G.821 is a bit-based system.

G.826

An ITU-T recommendation on error performance parameters and objectives for high-speed data circuits; circuits operating at 2 Mbit/s and above. G-826 is a block-based system.

Ga AsFET

Gallium Arsenide Field Effect Transistor.

Gain

The increase in signal power caused by a device or network (for example, the signal gain provided by an antenna).

GARP

Generic Attribute Registration Protocol

GB

Gigabyte.

GbE

Gigabit Ethernet.

GHz

Gigahertz.

Golden Cells

These are sites where it is imperative that communications traffic continues at peak performance. They are typically sites where any communications down-time can mean significant loss of revenue, or a significant breach against a service level agreement (SLA).

GSM

Global Systems for Mobile.

GUI

Graphical User Interface.

H

H.323

A standard approved by the ITU that defines how audiovisual conferencing data is transmitted across networks. In theory, H.323 should enable users to participate in the same conference even though they are using different videoconferencing applications.

HDB3

High Density Bipolar Order 3. The default method of encoding transmissions for E1 and E3 radios. Substitutes a 1 for every 3 zeros.

HDLC

High-level Data Link Control. A bit-oriented synchronous data link layer protocol developed by ISO. HDLC specifies a data encapsulation method on synchronous serial links using frame characters and checksums.

HHT

Handheld terminal.

Hitless Receive Switching

A protected system configuration whereby if a fault occurs at the receiving end of the link, the traffic is switched to the standby radio without causing errors.

Hot Standby

Hot Standby is a protected configuration whereby standby equipment is held ready to be switched immediately into service if the main equipment fails.

HPA

High Power Amplifier.

HSB

Hot-Standby Protection Mode.

HSC

Hardware/Software Compatibility. Different hardware may require different software versions.

I

I/O

Input / Output.

ICMP

Internet Control Message protocol. An integral part of the Internet Protocol that handles error and control messages.

IDC

Indoor Chassis.

IF

Intermediate Frequency. The signal frequency or frequencies intermediate between the modem electronics and the transmitted/received frequencies.

IIOP

CORBA's Internet Inter-ORB Protocol.

IDU

Indoor Unit. The IDU s the control center of a split-mount radio system. It interfaces between the customer signals and the ODU.

IEEE

Institute of Electrical and Electronics Engineers.

IETF

Internet Engineering Task Force.

IGP

Interior Gateway Protocol.

Intermodulation

Intermodulation can occur in systems where multiple signals are present at the same point. Where there is a nonlinearity in the system any signal will generate harmonics, but when two signals are present, harmonics of both are produced. The harmonics of the two signals can intermix, resulting in further spurious signals that are known as intermodulation products. The result of an intermodulation signal can have a major impact on reception if it falls in a receive channel. As the number of signals increases and/or TX power increases, the probability of an intermodulation signal causing noise in a receive channel grows.

ITU

International Telecommunications Union. A civil organization established to promote international standards for telecommunications.

INU

Intelligent Node Unit. INU is the term used to describe the indoor unit of a 9500 MXC Node. The INU is a 1U chassis (the IDC) fitted with mandatory cards plus option cards. It supports up to three ODUs for three non-protected links, or one protected/diversity link and one non-protected link.

INUe

Expanded Intelligent Node Unit. The term used to describe the 2U indoor unit of a 9500 MXC Node. The INUe supports up to six ODUs for six non-protected links, or up to three protected/diversity links.

IP

Internet Protocol. A method or protocol by which data is sent from one device to another on the Internet.

IRU

Indoor Radio Unit.

ISI

Inter-Symbol Interference.

ISO

International Standards Organization.

ITU-R

International Telecommunication Union - Radio Communication Sector (formerly CCIR and IFRB).

ITU-T

International Telecommunication Union - Telecommunication Standardization Sector (formerly CCITT).

K

K1 and K2

In an SDH system, K1 and K2 are MSOH bytes used for

* controlling the multiplexer section protection switching,

* signalling Alarm Indication Signal (AIS), Far End Remote Failure (FERF), and

* signalling Automatic Protection Switching (APS) alarms, when implemented.

L

L1

Layer 1.

L2

Layer 2.

LACP

Link Aggregation Control Protocol.

LAG

Link Aggregation Group.

LAN

Local-area Network. A data network located on a user's premises within a limited geographical area. Ethernet is the most widely used LAN transport technology.

LBO

Line Build-Out (I/O Cable Distance Compensator).

LED

Light Emitting Diode.

Link

A radio link comprises two terminals, one at each end of the link.

Liquid Bandwidth

Liquid bandwidth refers to the 9500 MXC ability to seamlessly assign capacity to Ethernet and to companion E1/DS1 or STM1/OC3 traffic. This scalability is enabled by the unique universal modem design built into 9500 MXC. It does not distinguish between the type of data to be transported, Ethernet or TDM; data is simply mapped into byte-wide frames to provide a particularly efficient and flexible wireless transport mechanism, with the result that when configured for Ethernet and/or TDM, the full configured capacity is available for user throughput.

LLC

Logical Link Control.

LMCDR

Low-medium capacity data radio.

LMT

Local Maintenance Terminal.

LNA

Low Noise Amplifier.

LO

Local Oscillator.

LOF

Loss of Frame or Loss of Frame Alignment.

LOH

Line Overhead. Contains the media's framing, routing protocol, and network-layer protocol overhead.

Loopback

A diagnostic function designed to assist testing of system components by routing traffic back to the direction it came from.

LOS

1) Loss of signal; 2) Line of Sight.

LSP

Label Switched Path.

LSR

Label Switched Router.

LTE

Line Termination Equipment.

M

MAC

Media Access Control.

MAC address

Media Access Control address. A unique number assigned to every layer 2 Ethernet device in the world.

Management Information System (MIS)

An organized assembly of resources that collects, processes, and distributes data.

Mbps

Megabits Per Second. Also Mbit/s.

Mapper

A device or logic that implements a mapping function.

MEF

Metro Ethernet Forum.

MEN

Metro Ethernet Network.

Message Board

Scratch pad text area that allows radio users to leave each other messages.

MGB

Master Ground Bar.

MHSB

Monitored Hot Standby.

MHz

Megahertz = 1 million hertz.

MIB

Management Information Base. A file that describes the information that can be accessed for each network device. The MIB is required by SNMP.

MMIC

Microwave Monolithic Integrated Circuit.

MIS

Management Information System. An organized assembly of resources that collects, processes, and distributes data.

MMC

MultiMediaCard. A compact, removable standard for storing and retrieving digital information in small, low-power devices. MultiMediaCards use flash technology for reusable recording, and ROM technology for read-only applications.

Modulator/Demodulator

A device used to convert digital signals into analog signals suitable for transmission over analog communications channels and/or recover digital signals from analog signals.

MPLS

Multi-Protocol Label Switching.

MSOH

Multiplexer Section Overhead. Part of an SDH frame.

MSU

Multiplexer Switching Unit.

MTBF

Mean Time Between Failure. The average time (usually expressed in years) over which a component operates without failure.

MTBO

Mean Time Between Outages. A function of MTBF, MTTR and the probability that the monitoring circuits detect a failure. The only circuits considered in the MTBO calculations are the ones that impact traffic.

MTR

Mean Time to Restore.

MTTR

Mean Time to Repair. The average time taken to repair or replace a failed device.

Multiplex

A multiplexer sends/receives two or more signals over the same channel.

Mute

When a transmitter is muted, it is prevented from transmitting.

MUX

Multiplexer. A device that combines two or more information-carrying channels for transmission over one channel, by using frequency division or time division techniques.

N

Native Ethernet

The process used to map Ethernet over a transport media whereby the Ethernet format and its structure are retained ‘untouched’ during transmission. This is distinct from the mechanism of encapsulation, where Ethernet frames are encapsulated within other formats such as E1/DS1, E3/DS3 or SDH/SONET frames.

NBI

North Bound Interface.

NE

Network Element.

NEL

Network Elements Level in the TMN model.

NMI

Network Management Interface.

Network Operator

The organization responsible for installing and maintaining a radio network.

NML

Network Management Level in the TMN model.

NMS

Network Management System.

NOC

Network Operations Center.

Node

A network device or device-grouping that is mid-point in a network, as distinct from a terminal device that is at the end/edge of a network.

Nonprotected

A 1+0 radio configuration in which there is only one set of radio equipment.

O

O&M

Overhead and Maintenance.

Object Class

The object class identifies the radio type to which the object belongs.

Object Group

A group of network elements created using user-defined selection criteria.

OC-n

Optical Carrier Level n. The optical signal that results from an optical conversion of a synchronous transport signal *n* (STS-N). This is the signal that will form the basis of the interface.

ODU

Outdoor Unit. ODU generally refers to the outdoor transceiver unit that is co-located with an antenna in a split-mount radio system.

OEM

Original Equipment Manufacturer

ohm

The unit of electrical resistance. A potential difference of one volt across a circuit resistance of 1 ohm produces a current of one ampere.

OMM

Optical Multimode

OSM

Optical Single Mode

Orderwire

An auxiliary communications channel provided for use by maintenance and service personnel, typically allowing both voice and/or data transmission between radio terminals.

Oscillator

An electronic circuit designed to produce an ideally stable alternating voltage or current.

OSI

Open Systems Interconnection

OSPF

Open Shortest Path First. An OSI layer 3 dynamic routing protocol.

OSS

Operations Support System.

P

PA

Power Amplifier.

PAM

Pulsed Amplitude Modulation.

Path

A radio path refers to the path traversed by the signal between two radios.

PBT

Provider Backbone Transport.

PCA

Printed Circuit Assembly.

PCB

Printed Circuit Board.

PCM

Pulse-code Modulation. Modulation in which a signal is sampled, quantized and then digitized for transmission. PCM is the basic method of encoding an analog voice signal into digital form using8-bit samples.

PCR

Paperless Chart Recorder. A software based diagnostic tool that stores operational data from a remote radio and provides view capability to the user.

PCS

Personal Communications Service. A set of capabilities that provides a combination of terminal mobility, personal mobility, and service profile management.

PDA

Personal Digital Assistant

PDH

Plesiosynchronous Digital Hierarchy. A multiplexing scheme of bit stuffing and byte interleaving. It multiplexes the lower level 64 kbit/s circuits into a successively higher order 2 Mbit/s, 34 Mbit/s, 140 Mbit/s and 565 Mbit/s aggregate rates.

PDU

Protocol Data Unit.

Ping

A message used to determine whether an IP address is accessible on a network.

PIU

Plug-In Unit

PLL

Phase-locked Loop. A circuit that controls an oscillator so that it maintains a constant phase angle relative to a reference signal.

PLT

Party Line Telephone.

PM

Performance Management.

PMA

Protection Multiplex Adaptor.

PN

Part Number.

Pointer

A part of the SDH/SONET overhead that locates a floating payload structure.

ppm

Parts per million.

PPP

Point-to-Point Protocol. A TCP/IP routing protocol that allows communications over serial communications lines without the use of other adapters, such as modems.

PRBS

Pseudo-Random Binary Sequence.

PROM

Programmable Read Only Memory.

Protection Switch

A unit that controls protection switching in hot-standby, diversity or ring protected devices.

Proxy

An entity that performs information preparation and exchange on behalf of a device it is representing.

PSTN

Public switched telephone network.

PSU

Power Supply Unit.

P-VLAN

Provider VLAN.

PW

Pseudo-Wire.

Q

QAM

Quadrature Amplitude Modulation. A method of modulating digital signals using both amplitude and phase coding.

QoS

Quality of Service.

QPSK

Quadrature Phase Shift Keying. A method of modulating digital signals using four phase states to code two digital bits per phase shift.

R

RAC

Radio Access Card.

RFI

Radio Frequency Interference.

RAS

Remote Access Server.

RCS

Reverse Channel Switching. A feature set that provides protection against potential far-end transmitter silent failure.

RDI-L

Remote Defect Indication - Line.

Restricted Area

A location qualified in accordance with IEC Standard 60950-1 as providing an access that can only be gained by Skilled Persons or users who have been instructed about the reasons for the restriction applied to the location and about any precautions to be taken; and access achieved through the use of a Tool, lock and key, or other means of security, and is controlled by the authority responsible for the location.

RF

Radio Frequency.

RFCOH

Radio Frame Complementary Overhead. Refers to data that is added to a data transmission unit.

RFU

Radio Frequency Unit.

Rigger

The member of the radio installation team responsible for installing the antenna and cabling on the transmission tower.

RIM

Radio Interface Module

RIP

Routing Information Protocol. An OSI layer 3 dynamic routing protocol.

RMA

1) Return Material Authorization; 2) Radio Modem Adaptor

RMS

Rack Mounting Space.

Router

A layer 3 network device that interconnects networks. It directs data between two or more networks using information held in the IP header to decide whether to foward a packet, and over which network interface to send a packet, for it to reach its destination.

Routing Protocol

Routing protocol is a protocol used between routers to exchange routing information. OSPF and RIP are the two most common dynamic routing protocols.

RPC

Radio Processing Card.

RPR

Resilient Packet Ring.

RS

Revertive Switching. A process that sends traffic back to the original working system after the system returns online.

RSL

Received Signal Level. The signal level at the receiver input (from the antenna). RSL is usually expressed in dBm.

RSOH

Regenerator Section Overhead. Part of an SDH frame.

RSSI

Received Signal Strength Indicator. The raw indicator of signal level at the receiver input (from the antenna). Usually expressed as a voltage, RSSI is usually converted to dBm and presented as an RSL.

RSTP

Rapid Spanning Tree Protocol.

RU

Rack Unit, 1 standard EIA rack unit (44.5 mm / 1.75 inch)

Rx

Receive.

S

SAW

Surface Acoustic Wave (filter).

SD

Space Diversity.

SDH

Synchronous Digital Hierarchy. An international standard for synchronous data transmission. SDH uses a multiplexing structure that enables direct access to individual 2 Mbit/s data streams from within the higher order aggregate line signals.

SDLC

Synchronous Data Link Control. A bit-oriented, full-duplex serial protocol that has spawned numerous similar protocols, including HDLC and LAPB.

Service Provider

An organization providing ethernet service(s).

SES

Severely Errored Seconds.

SESR

Severely Errored Second Ratio.

SI

System International units.

Simple Network Management Protocol (SNMP)

A networking management protocol used to monitor network-attached devices. SNMP allows messages (protocol data units) to be sent to various parts of a network. Upon receiving these messages, SNMP-compatible devices (agents) return data stored in their Management Information Bases.

Skilled Person

A skilled person in the microwave radio installation and maintenance industry is considered to have the necessary knowledge and practical experience of electrical and radio engineering to competently and safely carry out their work. They must have a full understanding of the various hazards that can arise from working on and around radio installations and be competent to take responsibility for their safety and the safety of any other personnel under their immediate supervision.

SLA

Service Level Agreement. A contract between a subscriber and an (ethernet) service provider specifying the agreed upon service level commitments and related business agreements.

SLIP

Serial-Line Internet Protocol.

SLS

Service Level Specification.

SMA

Services Management Adaptor.

SML

Service Management Level in the TMN model.

SMS

Short Message Service.

SNCP

Subnetwork Connection Protection. Designates path-switched SDH rings that employ redundant, fiber-optic transmission facilities. Organized in pairs, one fiber transmits in one direction while the backup fiber transmits in the other. If the primary ring fails, the backup takes over.

SNR

Signal-to-noise ratio.

SONET

Synchronous Optical Network. An ANSI standard for synchronous data transmission on optical media that is the equivalent of SDH, described above.

Space Diversity

A protection mode. The main and standby radios are set up in Hot Standby mode, but are connected to their own antennas. Both antennas, separated by a specific distance, are receiving the signal transmitted from the online radio at the other end of the link. If a fault occurs in the receiving end of the link, the traffic is switched to the standby radio without causing errors (hitless receive switching). As in Hot Standby mode, a fault detected in the online transmitter causes that transmitter to mute and the standby transmitter to unmute.

SSC

Software-Software Compatibility.

SSL

Secure Sockets Layer.

Static Routing

Static routing requires manual configuration of the routing table within Layer 3 routers. Data is forwarded within a network via a fixed path defined by the static routes - it cannot adjust to changing line conditions, unlike dynamic routing.

STDM

Statistical Time Division Multiplexing. Time slots are assigned to signals dynamically to make better use of bandwidth.

STM-0

ITU digital signal level used in Synchronous Digital Hierarchy (SDH) equivalent to a 51.84 Mbps data rate.

STM-1

ITU digital signal level used in Synchronous Digital Hierarchy (SDH) equivalent to a 155.52 Mbps data rate.

STM-N

Synchronous Transport Module-level N (Nx155.52 Mbps) where N = 1, 4, 16 or 64.

STP

Spanning Tree Protocol.

STS-N

Synchronous Transport Signal-level N (Nx51.84 Mbps) where N = 1, 3, 12, 48, or 192.

Subnet

A portion of a network sharing a particular subnet address.

Subnet Mask

A 32-bit combination used to describe which portion of an address refers to the subnet and which part refers to the host.

SU

Switch Unit.

SWR

Standing Wave Ratio.

T

T-R Spacing

The difference in MHz between transmit and receive frequencies for duplex radios.

T1

A digital carrier system for DS1 signals. T1 is a term for a digital facility used to transmit a DS1 formatted digital signal at 1.544 megabits per second. The 'T' is about the carrier facility and the 'DS' is about the signal format, which includes the muxed relationship between DS0, DS1, DS2, and DS3.

T3

T3 is a term for a digital facility used to transmit a DS3 formatted digital signal at 44.7 megabits per second.

The 'T' is about the carrier facility and the 'DS' is about the signal format, which includes the muxed relationship between DS0, DS1, DS2, and DS3.

TAE

Transversal Adaptive Equalization

TCP / IP

Transmission Control Protocol/Internet Protocol. Protocols that define connectivity across computer platforms interconnected via the Internet. The TCP protocol is responsible for an error free connection between two computers, while the IP protocol is responsible for the data packets sent over the network.

TCM

Trellis-Coded Modulation. A bandwidth-efficient scheme that combines error-correction coding with modulation. The redundancy thus introduced by the coding does not expand the bandwidth, since the parity bits are absorbed by the extended signal constellation. Two-dimensional (2D) TCM uses dependency between in-phase and quadrature symbols, while four-dimensional (4D) TCM introduces dependency between symbols of two successive intervals.

TCXO

Temperature Controlled Crystal Oscillator.

TDM

Time Division Multiplexing. Examples of TDM services include Nx64 k/bits, DS1, DS3, E1, E3, OC3, STM1, OC12, and STM3.

TELNET

A terminal emulation program for TCP/IP networks such as the Internet. The Telnet program runs on your computer and connects your PC to a server on the network. You can then enter commands through the Telnet program and they will be executed as if you were entering them directly on the server console. This enables you to control the server and communicate with other servers on the network. To start a Telnet session, you must log in to a server by entering a valid username and password. Telnet is a common way to remotely control Web servers.

TFTP

Trivial File Transfer Protocol.

TIM

Tributary Interface Module.

TMN

Telecommunications Management Network.

Tombstone

A database stored in nonvolatile memory.

Trap

A program interrupt, usually caused by some exceptional situation in the user program. In most cases, the operation system performs some action, then returns control to the program. Used for event notification with SNMP.

Tree View

A ‘trunk to branches and leaves’ view. It is often applied to a network where the core of the network is the trunk, and the various end-user connections are the leaves.

Trib

Tributary.

Transistor-Transistor Logic (TTL)

A common semiconductor technology for building discrete digital logic integrated circuits. It originated from Texas Instruments in 1965.

Tx

Transmit.

U

UDP/IP

Universal Datagram Protocol/Internet Protocol. Used primarily for short, broadcast messages, such as for SNMP messaging. UDP does not guarantee reliability or ordering in the way that TCP does. Datagrams may arrive out of order, appear duplicated, or go missing without notice. Avoiding the overhead of checking whether every packet actually arrived makes UDP faster and more efficient than TCP, at least for applications that do not need guaranteed delivery. Time-sensitive applications often use UDP because dropped packets are preferable to delayed packets.

UNI

The UNI is the physical interface or port that is the demarcation between the customer and the service provider.

UTC

Coordinated Universal Time. A time format used when a time zone independent time and date is required. Identical to Greenwich mean time (GMT) for most purposes.

V

V.24

Serial data communication interface. Also called RS-232.

VC

Virtual Container.

VCO

Voltage Controller Oscillator. An electronic circuit designed to produce an ideally stable alternating voltage.

Vdc

Volts, direct current.

VDE

Video Display Emissions.

VF

Voice Frequency signal.

Video graphics array (VGA)

A display standard for IBM PCs.

Viterbi

Viterbi is a “convolutional code” which is used in data correction circuits. It operates on serial data, one or a few bits at a time, unlike block codes such as Reed-Solomon, which operate on relatively large message blocks (typically greater than 100 bytes).

VLAN

Virtual Local Area Network.

VLAN ID

VLAN Identifier

VLSI

Very Large Scale Integration.

Voltage Controlled Oscillator (VCO)

An electronic circuit designed to produce an ideally stable alternating voltage.

VPLS

Virtual Private LAN Service.

VPN

Virtual Private Network.

VSWR

Voltage Standing Wave Ratio.

VT100

A port on the IDU for making a connection to the NMI card.

W

WAN

Wide-area Network. A network that provides telecommunication services to a geographic area larger than that served by a local area network or a metropolitan area network.

WAP

Wireless Application Protocol.

WMT

Web-based Maintenance Terminal.

WR-xx

The designation for a specific size of waveguide used to transmit the microwave RF signal.

X

XPD

Cross-Polar Discrimination.

XPIC

Cross Polarized Interference Cancellation.

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Symbols

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