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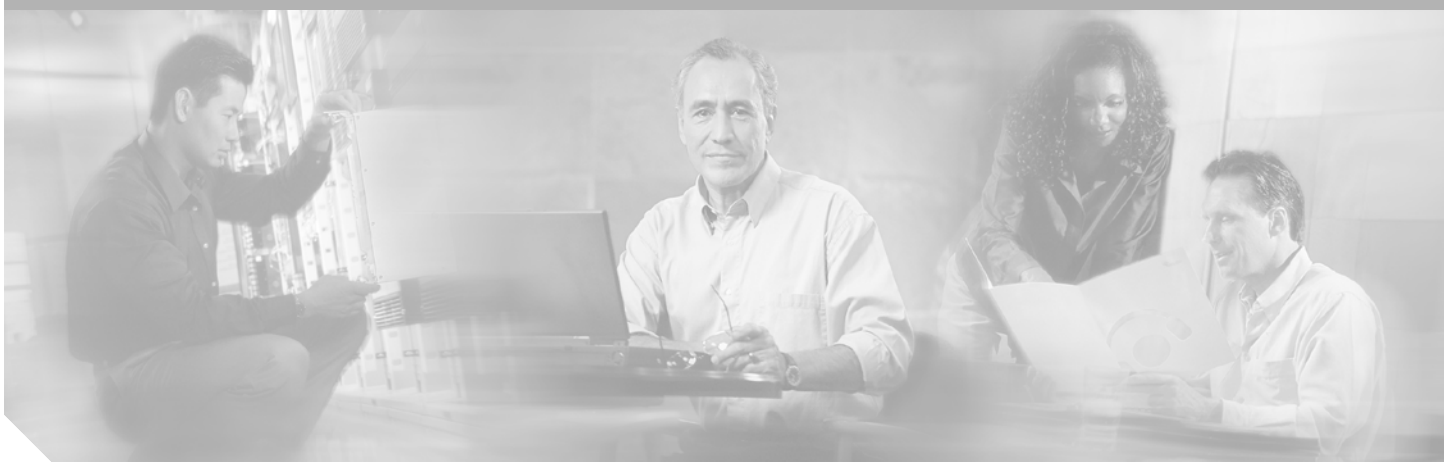

Cisco ONS 15454 Reference Manual

Product and Documentation Release 4.6
Last Updated: April, 2008

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About this Manual

This section explains the objectives, intended audience, and organization of this publication and describes the conventions that convey instructions and other information.

> **Note** The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Revision History

Date	Notes
03/30/2007	Revision History Table added for the first time
08/21/2007	Updated About this Guide
04/09/2008	Added a Note in the User Password, Login, and Access Policies section of the Security and Timing chapter.

This section provides the following information:

- Document Objectives
- Audience
- Document Organization
- Related Documentation
- Document Conventions
- Where to Find Safety and Warning Information
- Obtaining Documentation
- Documentation Feedback
- Obtaining Technical Assistance
- Obtaining Additional Publications and Information

Document Objectives

This manual provides reference information for the Cisco ONS 15454.

Audience

To use this publication, you should be familiar with Cisco or equivalent optical transmission hardware and cabling, telecommunications hardware and cabling, electronic circuitry and wiring practices, and preferably have experience as a telecommunications technician.

Document Organization

Table 1 Cisco ONS 15454 Reference Manual Chapters

Title	Summary
Chapter 1, "Shelf and Backplane Hardware"	Includes descriptions of the rack, backplane, backplane pins, ferrites, power and ground, fan-tray assembly, air filter, card slots, cables, cable connectors, and cable routing.
Chapter 2, "Common Control Cards"	Includes descriptions of the TCC+, TCC2, XC, XCVT, XC10G, AIC, and AIC-I cards.
Chapter 3, "Electrical Cards"	Includes descriptions of EC-1, DS-1, DS-3, and DS3E cards, card temperature ranges, and compatibility.
Chapter 4, "Optical Cards"	Includes descriptions of the OC-3, OC-12, OC-48, OC-192, TXP_MR_10G, and MXP_2.5G_10G cards, as well as card temperature ranges and card compatibility.
Chapter 5, "Ethernet Cards"	Includes descriptions of the E-Series, G-Series, and ML-Series Ethernet cards and Gigabit Interface Converters (GBICs).
Chapter 6, "DWDM Cards"	Includes descriptions of the optical service channel cards, optical amplifier cards, multiplexer and demultiplexer cards, and optical add/drop multiplexer (OADM) cards.
Chapter 7, "Card Protection"	Includes electrical and optical card protection methods.
Chapter 8, "Cisco Transport Controller Operation"	Includes information about CTC installation, the CTC window, computer requirements, software versions, and database reset and revert.
Chapter 9, "Security and Timing"	Includes user set up and security, and node/network timing.

Table 1 Cisco ONS 15454 Reference Manual Chapters (continued)

Title	Summary
Chapter 10, "Circuits and Tunnels"	Includes STS and VT, bidirectional and unidirectional, revertive and nonrevertive, electrical and optical, multiple and path trace circuit information, as well as DCC tunnels.
Chapter 11, "SONET Topologies"	Includes the SONET configurations used by the ONS 15454; includes bidirectional line switch rings (BLSRs), path protection, linear add/drop multiplexers (ADMs), subtending rings, and optical bus configurations, as well as information about upgrading optical speeds within any configuration.
Chapter 12, "DWDM Topologies"	Includes the DWDM configurations used by the ONS 15454; including hubbed rings, multihubbed rings, single span links, meshed rings, and linear configurations, as well as information about DWDM node types, automatic power control, automatic node setup, and DWDM network topology discovery.
Chapter 13, "IP Networking"	Includes IP addressing scenarios and information about IP networking with the ONS 15454.
Chapter 15, "Performance Monitoring"	Includes performance monitoring statistics for all cards.
Chapter 16, "Ethernet Operation"	Includes Ethernet applications for the G-Series and E-Series Ethernet cards.
Chapter 17, "FC_MR-4 Operation"	Includes descriptions of the FC_MR-4 Fiber Channel/Fiber Connectivity (FICON) card, card temperature ranges, compatibility, and applications.
Chapter 18, "SNMP"	Explains Simple Network Management Protocol (SNMP) as implemented by the Cisco ONS 15454.

Related Documentation

Use the *Cisco ONS 15454 Reference Manual, Release 4.6* with the following referenced publications:

- *Cisco ONS 15454 Procedure Guide, Release 4.6*—Provides procedures to install, turn up, provision, and maintain a Cisco ONS 15454 node and network.
- *Cisco ONS 15454 Troubleshooting Guide, Release 4.6*—Provides general troubleshooting procedures, alarm descriptions and troubleshooting procedures, and hardware replacement instructions.
- *Cisco ONS 15454 TL1 Test Access Quick Start Guide*—Provides test access TL1 commands, configurations, and parameter types.
- *Release Notes for Cisco ONS 15454 Release 4.6*—Provides caveats, closed issues, and new feature and functionality information.

Document Conventions

This publication uses the following conventions:

<table>
<tr><th>Convention</th><th>Application</th></tr>
<tr><td>boldface</td><td>Commands and keywords in body text.</td></tr>
<tr><td>italic</td><td>Command input that is supplied by the user.</td></tr>
<tr><td>[ ]</td><td>Keywords or arguments that appear within square brackets are optional.</td></tr>
<tr><td>{ x | x | x }</td><td>A choice of keywords (represented by x) appears in braces separated by vertical bars. The user must select one.</td></tr>
<tr><td>Ctrl</td><td>The control key. For example, where Ctrl + D is written, hold down the Control key while pressing the D key.</td></tr>
<tr><td><code>screen font</code></td><td>Examples of information displayed on the screen.</td></tr>
<tr><td><code>boldface screen font</code></td><td>Examples of information that the user must enter.</td></tr>
<tr><td>< ></td><td>Command parameters that must be replaced by module-specific codes.</td></tr>
</table>

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the document.

Caution Means *reader be careful*. In this situation, the user might do something that could result in equipment damage or loss of data.

Warning **IMPORTANT SAFETY INSTRUCTIONS**

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. To see translations of the warnings that appear in this publication, refer to the translated safety warnings that accompanied this device.

Note: SAVE THESE INSTRUCTIONS

Note: This documentation is to be used in conjunction with the specific product installation guide that shipped with the product. Please refer to the Installation Guide, Configuration Guide, or other enclosed additional documentation for further details.

Where to Find Safety and Warning Information

For safety and warning information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document that accompanied the product. This publication describes the international agency compliance and safety information for the Cisco ONS 15xxx systems. It also includes translations of the safety warnings that appear in the ONS 15xxx system documentation.

Obtaining Documentation

Cisco documentation and additional literature are available on Cisco.com. Cisco also provides several ways to obtain technical assistance and other technical resources. These sections explain how to obtain technical information from Cisco Systems.

Cisco.com

You can access the most current Cisco documentation at this URL:

http://www.cisco.com/univercd/home/home.htm

You can access the Cisco website at this URL:

http://www.cisco.com

You can access international Cisco websites at this URL:

http://www.cisco.com/public/countries_languages.shtml

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You can find instructions for ordering documentation at this URL:

http://www.cisco.com/univercd/cc/td/doc/es_inpck/pdi.htm

You can order Cisco documentation in these ways:

- Registered Cisco.com users (Cisco direct customers) can order Cisco product documentation from the Ordering tool:

  http://www.cisco.com/en/US/partner/ordering/index.shtml

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco Systems Corporate Headquarters (California, USA) at 408 526-7208 or, elsewhere in North America, by calling 800 553-NETS (6387).

Cisco Optical Networking Product Documentation CD-ROM

Optical networking-related documentation, including Cisco ONS 15454 product documentation, is available in a CD-ROM package that ships with your product. The Optical Networking Product Documentation CD-ROM is updated periodically and may be more current than printed documentation.

Documentation Feedback

You can send comments about technical documentation to bug-doc@cisco.com.

You can submit comments by using the response card (if present) behind the front cover of your document or by writing to the following address:

Cisco Systems
Attn: Customer Document Ordering
170 West Tasman Drive
San Jose, CA 95134-9883

We appreciate your comments.

Obtaining Technical Assistance

For all customers, partners, resellers, and distributors who hold valid Cisco service contracts, Cisco Technical Support provides 24-hour-a-day, award-winning technical assistance. The Cisco Technical Support Website on Cisco.com features extensive online support resources. In addition, Cisco Technical Assistance Center (TAC) engineers provide telephone support. If you do not hold a valid Cisco service contract, contact your reseller.

Cisco Technical Support Website

The Cisco Technical Support Website provides online documents and tools for troubleshooting and resolving technical issues with Cisco products and technologies. The website is available 24 hours a day, 365 days a year at this URL:

http://www.cisco.com/techsupport

Access to all tools on the Cisco Technical Support Website requires a Cisco.com user ID and password. If you have a valid service contract but do not have a user ID or password, you can register at this URL:

http://tools.cisco.com/RPF/register/register.do

Submitting a Service Request

Using the online TAC Service Request Tool is the fastest way to open S3 and S4 service requests. (S3 and S4 service requests are those in which your network is minimally impaired or for which you require product information.) After you describe your situation, the TAC Service Request Tool automatically provides recommended solutions. If your issue is not resolved using the recommended resources, your service request will be assigned to a Cisco TAC engineer. The TAC Service Request Tool is located at this URL:

http://www.cisco.com/techsupport/servicerequest

For S1 or S2 service requests or if you do not have Internet access, contact the Cisco TAC by telephone. (S1 or S2 service requests are those in which your production network is down or severely degraded.) Cisco TAC engineers are assigned immediately to S1 and S2 service requests to help keep your business operations running smoothly.

To open a service request by telephone, use one of the following numbers:

Asia-Pacific: +61 2 8446 7411 (Australia: 1 800 805 227)
EMEA: +32 2 704 55 55
USA: 1 800 553 2447

For a complete list of Cisco TAC contacts, go to this URL:

http://www.cisco.com/techsupport/contacts

Definitions of Service Request Severity

To ensure that all service requests are reported in a standard format, Cisco has established severity definitions.

Severity 1 (S1)—Your network is “down,” or there is a critical impact to your business operations. You and Cisco will commit all necessary resources around the clock to resolve the situation.

Severity 2 (S2)—Operation of an existing network is severely degraded, or significant aspects of your business operation are negatively affected by inadequate performance of Cisco products. You and Cisco will commit full-time resources during normal business hours to resolve the situation.

Severity 3 (S3)—Operational performance of your network is impaired, but most business operations remain functional. You and Cisco will commit resources during normal business hours to restore service to satisfactory levels.

Severity 4 (S4)—You require information or assistance with Cisco product capabilities, installation, or configuration. There is little or no effect on your business operations.

Obtaining Additional Publications and Information

Information about Cisco products, technologies, and network solutions is available from various online and printed sources.

- Cisco Marketplace provides a variety of Cisco books, reference guides, and logo merchandise. Visit Cisco Marketplace, the company store, at this URL:

  http://www.cisco.com/go/marketplace/

- The Cisco *Product Catalog* describes the networking products offered by Cisco Systems, as well as ordering and customer support services. Access the Cisco Product Catalog at this URL:

  http://cisco.com/univercd/cc/td/doc/pcat/

- *Cisco Press* publishes a wide range of general networking, training and certification titles. Both new and experienced users will benefit from these publications. For current Cisco Press titles and other information, go to Cisco Press at this URL:

  http://www.ciscopress.com

- *Packet* magazine is the Cisco Systems technical user magazine for maximizing Internet and networking investments. Each quarter, Packet delivers coverage of the latest industry trends, technology breakthroughs, and Cisco products and solutions, as well as network deployment and troubleshooting tips, configuration examples, customer case studies, certification and training information, and links to scores of in-depth online resources. You can access Packet magazine at this URL:

  http://www.cisco.com/packet

- *iQ Magazine* is the quarterly publication from Cisco Systems designed to help growing companies learn how they can use technology to increase revenue, streamline their business, and expand services. The publication identifies the challenges facing these companies and the technologies to help solve them, using real-world case studies and business strategies to help readers make sound technology investment decisions. You can access iQ Magazine at this URL:

  http://www.cisco.com/go/iqmagazine

- *Internet Protocol Journal* is a quarterly journal published by Cisco Systems for engineering professionals involved in designing, developing, and operating public and private internets and intranets. You can access the Internet Protocol Journal at this URL:

  http://www.cisco.com/ipj

- World-class networking training is available from Cisco. You can view current offerings at this URL:

  http://www.cisco.com/en/US/learning/index.html

Shelf and Backplane Hardware

This chapter provides a description of Cisco ONS 15454 shelf and backplane hardware. Card descriptions are provided in Chapter 2, "Common Control Cards," Chapter 3, "Electrical Cards," Chapter 4, "Optical Cards," Chapter 5, "Ethernet Cards," and Chapter 6, "DWDM Cards." To install equipment, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

Note The Cisco ONS 15454 assembly is intended for use with telecommunications equipment only.

Warning **Only trained and qualified personnel should be allowed to install, replace, or service this equipment.**

Warning **This equipment must be installed and maintained by service personnel as defined by AS/NZS 3260. Incorrectly connecting this equipment to a general purpose outlet could be hazardous. The telecommunications lines must be disconnected 1) before unplugging the main power connector and/or 2) while the front door is open.**

Warning **The ONS 15454 is intended for installation in restricted access areas. A restricted access area is where access can only be gained by service personnel through the use of a special tool, lock, key, or other means of security. A restricted access area is controlled by the authority responsible for the location.**

Warning **The ONS 15454 is suitable for mounting on concrete or other non-combustible surfaces only.**

Caution Unused card slots should be filled with a blank faceplate (Cisco P/N 15454-BLANK). The blank faceplate ensures proper airflow when operating the ONS 15454 without the front door attached, although Cisco recommends that the front door remain attached.

Note The ONS 15454 is designed to comply with Telcordia GR-1089-CORE Type 2 and Type 4. Install and operate the ONS 15454 only in environments that do not expose wiring or cabling to the outside plant. Acceptable applications include Central Office Environments (COEs), Electronic Equipment Enclosures (EEEs), Controlled Environment Vaults (CEVs), huts, and Customer Premise Environments (CPEs).

Note You can search for cross-referenced Cisco part numbers and CLEI (Common Language Equipment Identification) codes at the following link: http://www.cisco.com/cgi-bin/front.x/clei/code_search.cgi.

1.1 Overview

When installed in an equipment rack, the ONS 15454 assembly is typically connected to a fuse and alarm panel to provide centralized alarm connection points and distributed power for the ONS 15454. Fuse and alarm panels are third-party equipment and are not described in this documentation. If you are unsure about the requirements or specifications for a fuse and alarm panel, consult the user documentation for the related equipment. The front door of the ONS 15454 allows access to the shelf assembly, fan-tray assembly, and cable-management area. The backplanes provide access to alarm contacts, external interface contacts, power terminals, and BNC/SMB connectors.

Warning **The ONS 15454 relies on the protective devices in the building installation to protect against short circuit, overcurrent, and grounding faults. Ensure that the protective devices are properly rated to protect the system, and that they comply with national and local codes.**

Warning **Incorporate a readily-accessible, two-poled disconnect device in the fixed wiring.**

You can mount the ONS 15454 in a 19- or 23-inch rack (482.6 or 584.2 mm). The shelf assembly weighs approximately 55 pounds (24.94 kg) with no cards installed. The shelf assembly includes a front door for added security, a fan tray module for cooling, and extensive cable-management space.

ONS 15454 optical cards have SC and LC connectors on the card faceplate. Fiber optic cables are routed into the front of the destination cards. Electrical cards (DS-1, DS-3, DS3XM-6, and EC-1) require electrical interface assemblies (EIAs) to provide the cable connection points for the shelf assembly. In most cases, EIAs are ordered with the ONS 15454 and come preinstalled on the backplane. See the "1.5 Electrical Interface Assemblies" section on page 1-15 for more information about the EIAs.

The ONS 15454 is powered using –48 VDC power. Negative, return, and ground power terminals are accessible on the backplane.

Note In this chapter, the terms "ONS 15454" and "shelf assembly" are used interchangeably. In the installation context, these terms have the same meaning. Otherwise, shelf assembly refers to the physical steel enclosure that holds cards and connects power, and ONS 15454 refers to the entire system, both hardware and software.

Install the ONS 15454 in compliance with your local and national electrical codes:

- United States: National Fire Protection Association (NFPA) 70; United States National Electrical Code
- Canada: Canadian Electrical Code, Part I, CSA C22.1
- Other countries: If local and national electrical codes, are not available, refer to IEC 364, Part 1 through Part 7.

Warning **Dispose of this product according to all national laws and regulations.**

1.2 Rack Installation

Warning **To prevent the equipment from overheating, do not operate it in an area that exceeds the maximum recommended ambient temperature of 131°F (55°C) unless configured for industrial temperature (I-temp). All I-temp rated components are –40°F to +149°F (–40°C to +65°C). To prevent airflow restriction, allow at least 1 inch (25.4 mm) of clearance around the ventilation openings.**

The ONS 15454 is mounted in a 19- or 23-in. (482.6- or 584.2-mm) equipment rack. The shelf assembly projects five inches (127 mm) from the front of the rack. It mounts in both EIA-standard and Telcordia-standard racks. The shelf assembly is a total of 17 inches (431.8 mm) wide with no mounting ears attached. Ring runs are not provided by Cisco and might hinder side-by-side installation of shelves where space is limited.

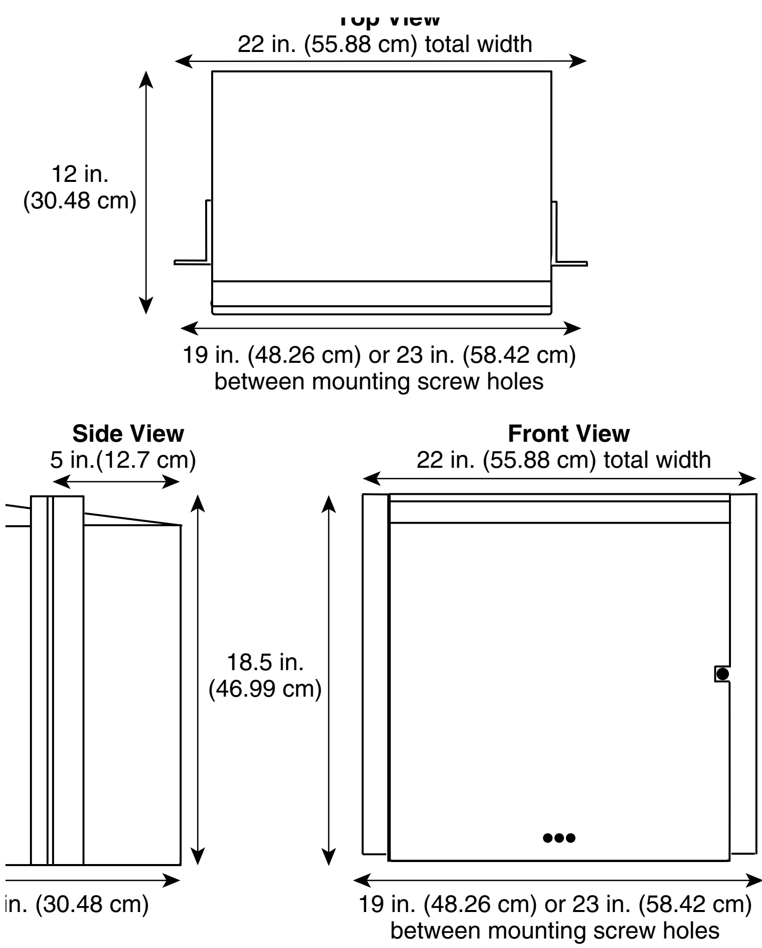
The ONS 15454 measures 18.5 inches (469.9 mm) high, 19 or 23 inches (482.6 or 584.2 mm) wide (depending on which way the mounting ears are attached), and 12 inches (304.8 mm) deep. You can install up to four ONS 15454s in a seven-foot (2133.6 mm) equipment rack. The ONS 15454 must have one inch (25.4 mm) of airspace below the installed shelf assembly to allow air flow to the fan intake. If a second ONS 15454 is installed underneath the shelf assembly, the air ramp on top of the lower shelf assembly provides the air spacing needed and should not be modified in any way. Figure 1-1 shows the dimensions of the ONS 15454.

Note A 10-Gbps-compatible shelf assembly (15454-SA-ANSI or 15454-SA-HD) and fan-tray assembly (15454-FTA3 or 15454-FTA3-T) are required if ONS 15454 XC10G cards are installed in the shelf.

Warning **The ONS 15454 should be installed in the lower rack position or mounted above another ONS 15454 shelf assembly.**

Warning **The ONS 15454 must have 1 inch (25.4 mm) of airspace below the installed shelf assembly to allow air flow to the fan intake. The air ramp (the angled piece of sheet metal on top of the shelf assembly) provides this spacing and should not be modified in any way.**

Figure 1-1 Cisco ONS 15454 Dimensions



1.2.1 Reversible Mounting Bracket

Caution Use only the fastening hardware provided with the ONS 15454 to prevent loosening, deterioration, and electromechanical corrosion of the hardware and joined material.

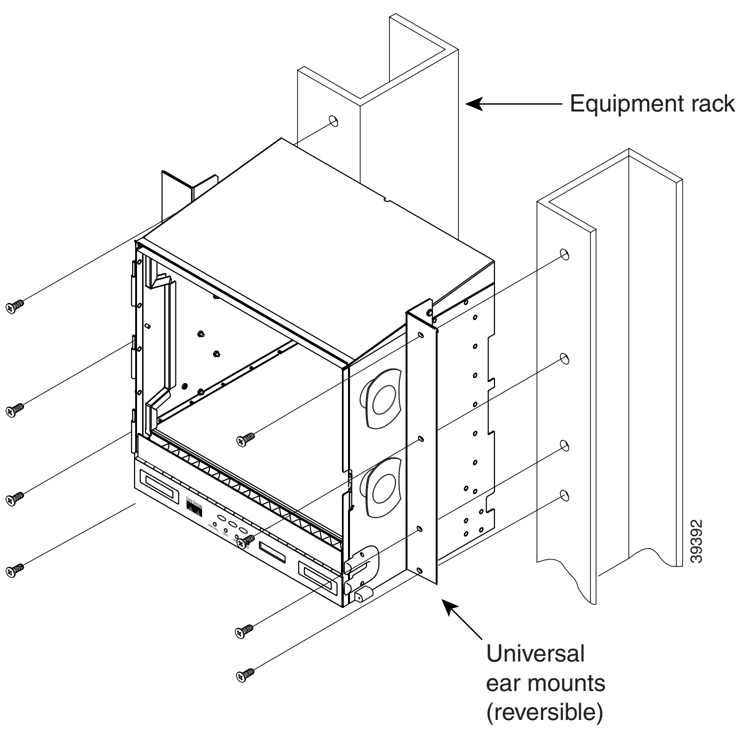
Caution When mounting the ONS 15454 in a frame with a nonconductive coating (such as paint, lacquer, or enamel) either use the thread-forming screws provided with the ONS 15454 shipping kit, or remove the coating from the threads to ensure electrical continuity.

The shelf assembly comes preset for installation in a 23-inch (584.2 mm) rack, but you can reverse the mounting bracket to fit the smaller 19-inch (482.6 mm) rack.

1.2.2 Mounting a Single Node

Mounting the ONS 15454 in a rack requires a minimum of 18.5 inches (469.9 mm) of vertical rack space and one additional inch (25.4 mm) for air flow. To ensure the mounting is secure, use two to four #12-24 mounting screws for each side of the shelf assembly. Figure 1-2 shows the rack mounting position for the ONS 15454.

Figure 1-2 Mounting an ONS 15454 in a Rack



Two people should install the shelf assembly; however, one person can install it using the temporary set screws included. The shelf assembly should be empty for easier lifting. The front door can also be removed to lighten the shelf assembly.

Note If you are installing the fan-tray air filter using the bottom (external) brackets provided, mount the brackets on the bottom of the shelf assembly before installing the ONS 15454 in a rack.

1.2.3 Mounting Multiple Nodes

Most standard (Telcordia GR-63-CORE, 19-inch [482.6 mm] or 23-inch [584.2 mm]) seven-foot (2,133 mm) racks can hold four ONS 15454s and a fuse and alarm panel. However, unequal flange racks are limited to three ONS 15454s and a fuse and alarm panel or four ONS 15454s and a fuse and alarm panel from an adjacent rack.

If you are using the external (bottom) brackets to install the fan-tray air filter, you can install three shelf assemblies in a standard seven-foot (2.133 m) rack. If you are not using the external (bottom) brackets, you can install four shelf assemblies in a rack. The advantage to using the bottom brackets is that you can replace the filter without removing the fan tray.

1.2.4 ONS 15454 Bay Assembly

The Cisco ONS 15454 Bay Assembly simplifies ordering and installing the ONS 15454 because it allows you to order shelf assemblies preinstalled in a seven-foot (2,133 mm) rack. The Bay Assembly is available in a three- or four-shelf configuration. The three-shelf configuration includes three ONS 15454 shelf assemblies, a prewired fuse and alarm panel, and two cable-management trays. The four-shelf configuration includes four ONS 15454 shelf assemblies and a prewired fuse and alarm panel. You can order optional fiber channels with either configuration. Installation procedures are included in the *Unpacking and Installing the Cisco ONS 15454 Four-Shelf and Zero-Shelf Bay Assembly* document that ships with the Bay Assembly.

1.2.5 Typical DWDM Rack Layouts

Typical dense wavelength division multiplexing (DWDM) applications might include:

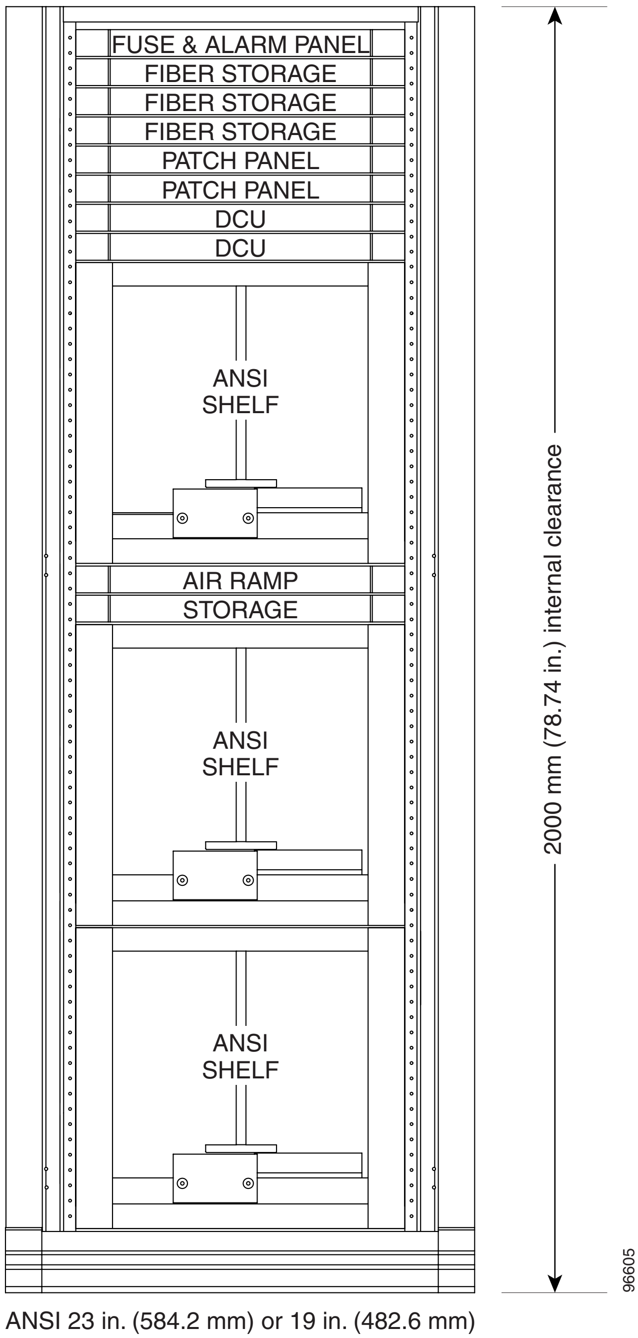
- 3 ONS 15454 shelves
- 1 Dispersion Compensating Unit (DCU)
- 7 patch panels (or fiber storage tray[s])

Or, alternatively:

- 3 ONS 15454 shelves
- 2 DCUs
- 6 patch panels (or fiber storage tray[s])

See Figure 1-3 for a typical rack layout. If you are installing a patch panel or fiber storage tray below the ONS 15454 shelf you must install the air ramp between the shelf and patch panel/fiber tray, or leave one rack mounting unit (RMU) space open.

Figure 1-3 Typical DWDM Equipment Layout

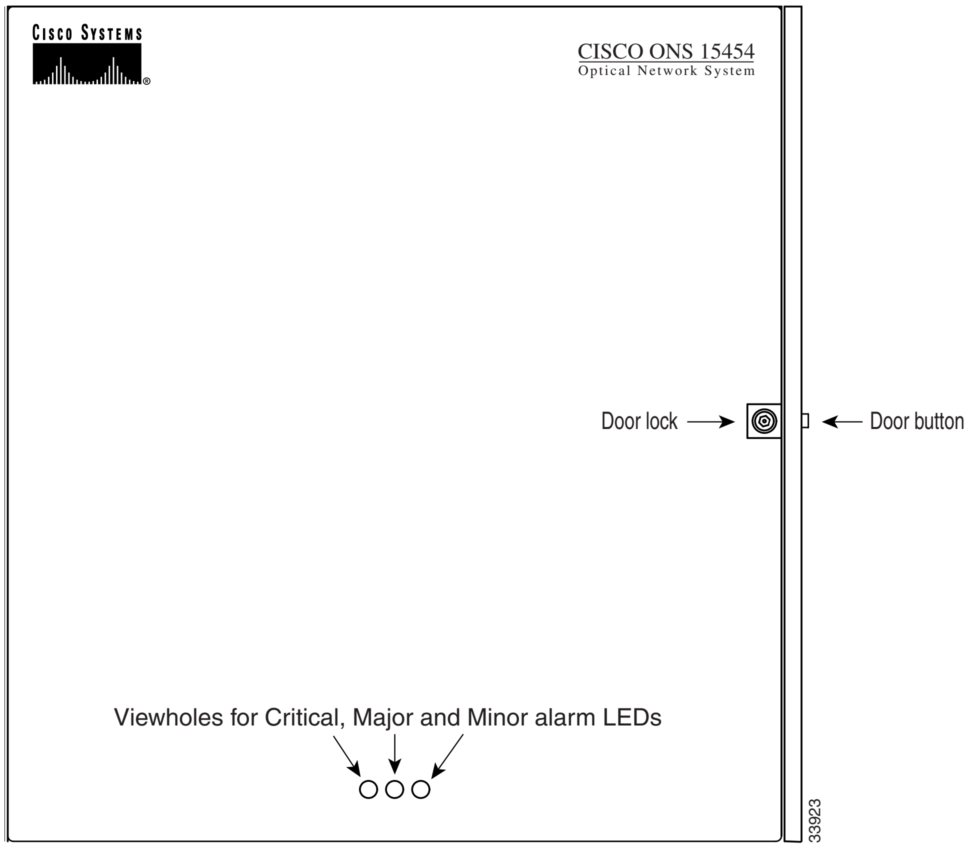


1.3 Front Door

The Critical, Major, and Minor alarm LEDs visible through the front door indicate whether a critical, major, or minor alarm is present anywhere on the ONS 15454. These LEDs must be visible so technicians can quickly determine if any alarms are present on the ONS 15454 shelf or the network. You can use the LCD to further isolate alarms.

The ONS 15454 features a locked door to the front compartment. A pinned hex key that unlocks the front door ships with the ONS 15454. A button on the right side of the shelf assembly releases the door. The front door (Figure 1-4) provides access to the shelf assembly, cable-management tray, fan-tray assembly, and LCD screen.

Figure 1-4 The ONS 15454 Front Door



You can remove the front door of the ONS 15454 to provide unrestricted access to the front of the shelf assembly. Before you remove the front door, you have to remove the ground strap of the front door (Figure 1-5).

Figure 1-5 ONS 15454 Front Door Ground Strap

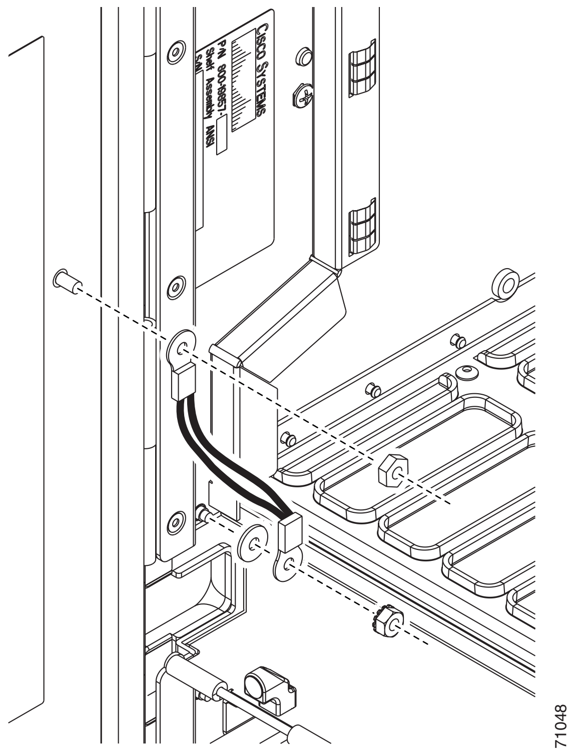
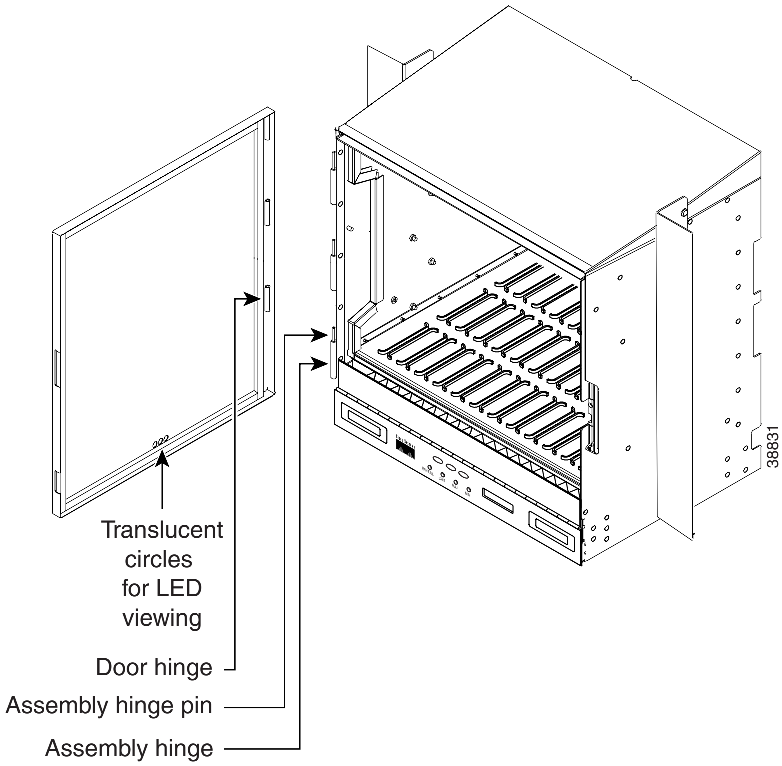


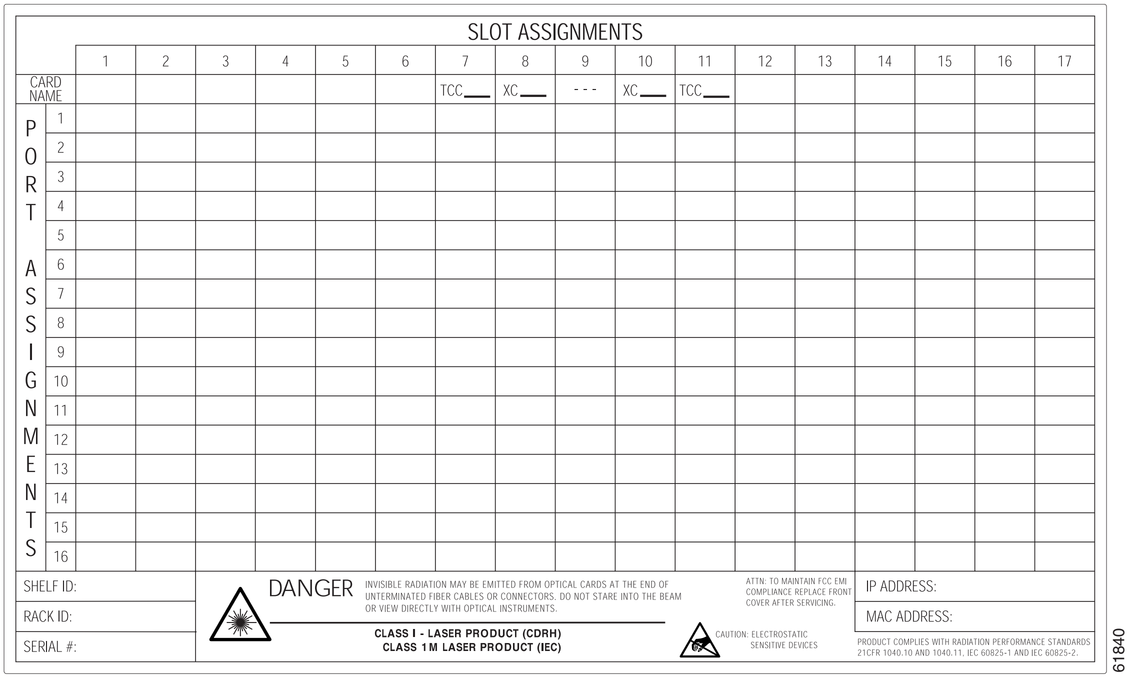
Figure 1-6 shows how to remove the front door.

Figure 1-6 Removing the ONS 15454 Front Door



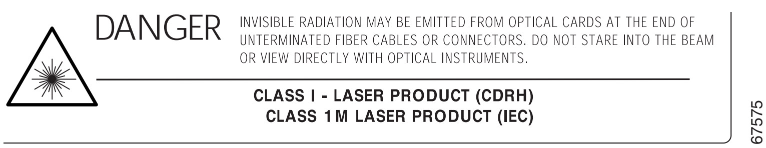
An erasable label is pasted on the inside of the front door (Figure 1-7). You can use the label to record slot assignments, port assignments, card types, node ID, rack ID, and serial number for the ONS 15454.

Figure 1-7 Front-Door Erasable Label



Note The front door label also includes the Class I and Class 1M laser warning (Figure 1-8).

Figure 1-8 Laser Warning on the Front-Door Label

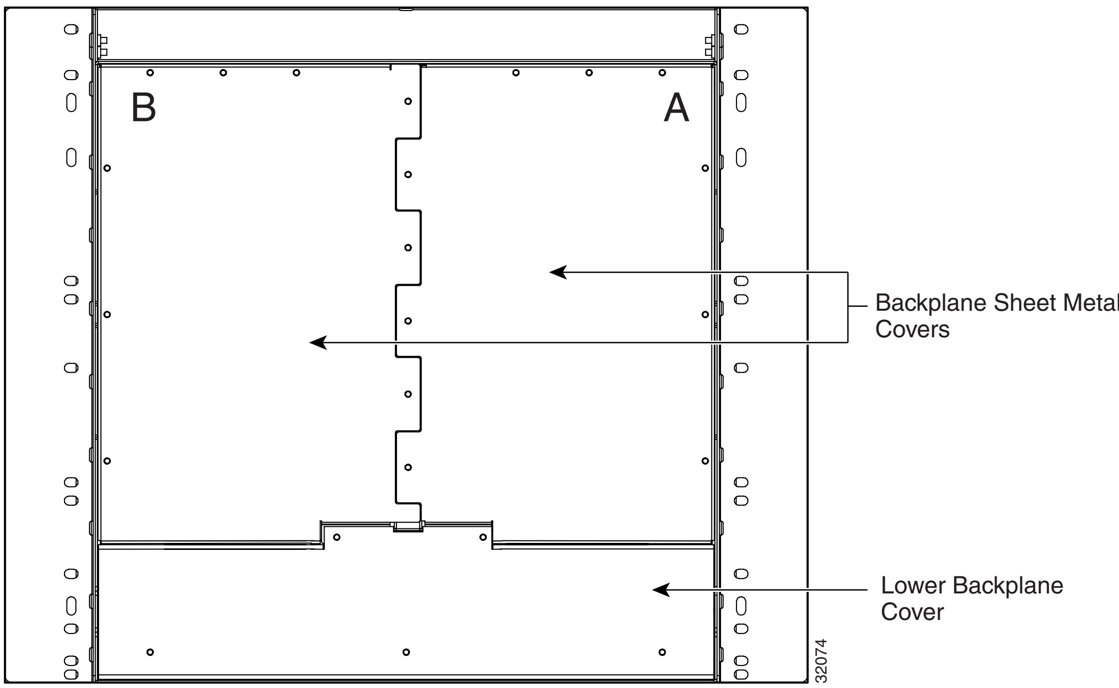


1.4 Backplane Covers

If a backplane does not have an EIA panel installed, it should have two sheet metal backplane covers (one on each side of the backplane). See Figure 1-9. Each cover is held in place with nine 6-32 x 3/8 inch Phillips screws.

Note See the "1.5 Electrical Interface Assemblies" section on page 1-15 for information on EIAs.

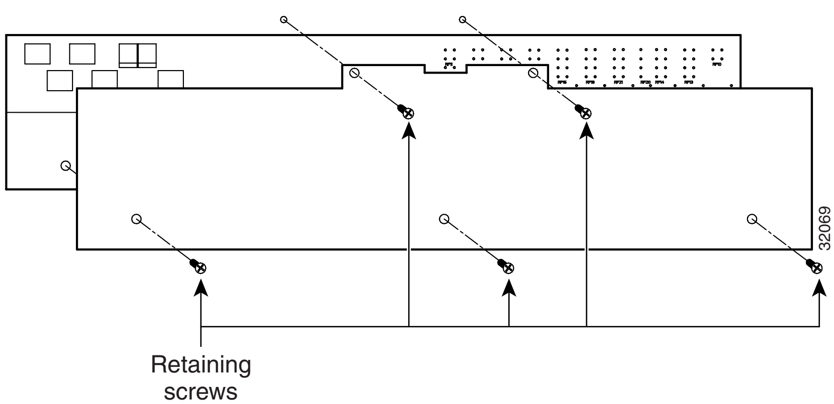
Figure 1-9 Backplane Covers



1.4.1 Lower Backplane Cover

The lower section of the ONS 15454 backplane is covered by a clear plastic protector, which is held in place by five 6-32 x 1/2 inch screws. Remove the lower backplane cover to access the alarm interface panel (AIP), alarm pin fields, frame ground, and power terminals (Figure 1-10).

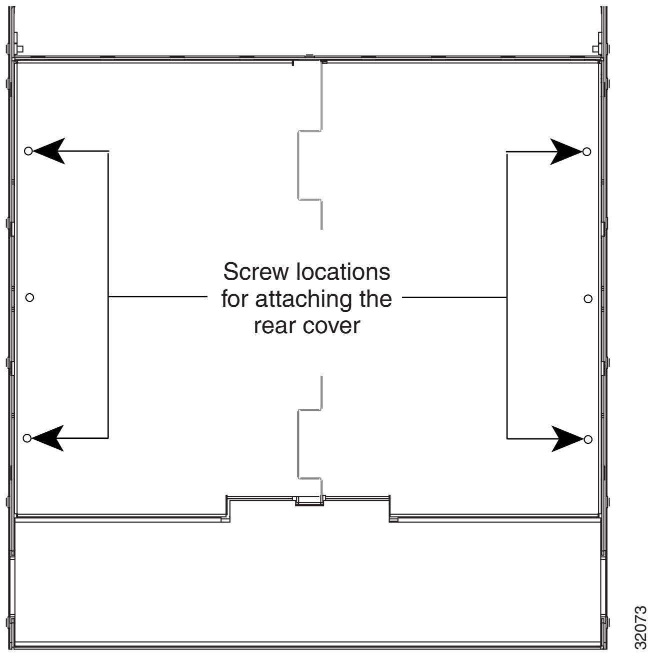
Figure 1-10 Removing the Lower Backplane Cover



1.4.2 Rear Cover

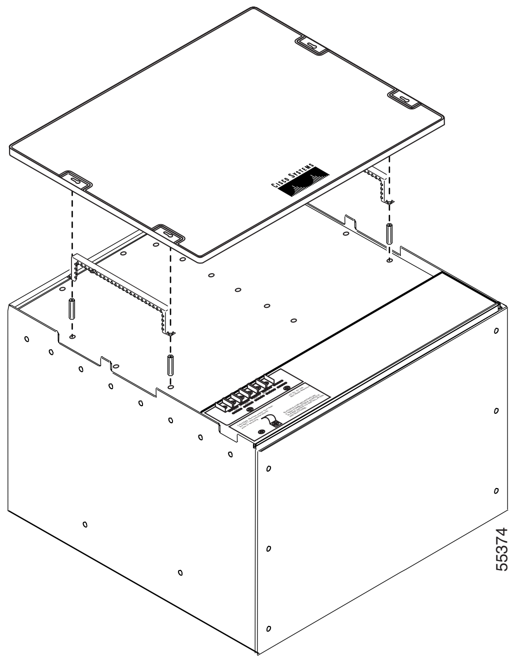
The ONS 15454 has an optional clear plastic rear cover. This clear plastic cover provides additional protection for the cables and connectors on the backplane. Figure 1-11 shows the rear cover screw locations.

Figure 1-11 Backplane Attachment for Cover



You can also install the optional spacers if more space is needed between the cables and rear cover (Figure 1-12).

Figure 1-12 Installing the Plastic Rear Cover with Spacers



1.4.3 Alarm Interface Panel

The AIP is located above the alarm contacts on the lower section of the backplane. The AIP provides surge protection for the ONS 15454. It also provides an interface from the backplane to the fan-tray assembly and LCD. The AIP plugs into the backplane using a 96-pin DIN connector and is held in place with two retaining screws. The panel has a nonvolatile memory chip that stores the unique node address (MAC address).

Note The 5-A AIP (73-7665-XX) is required when installing the new fan-tray assembly (15454-FTA3), which comes preinstalled on the shelf assembly (15454-SA-ANSI or 15454-SA-HD).

Note The MAC address identifies the nodes that support circuits. It allows Cisco Transport Controller (CTC) to determine circuit sources, destinations, and spans. The TCC2 cards in the ONS 15454 also use the MAC address to store the node database.

Note A blown fuse on the AIP board can cause the LCD display to go blank.

1.4.4 Alarm Interface Panel Replacement

If the alarm interface panel (AIP) fails, a MAC Fail alarm displays on the CTC Alarms menu and/or the LCD display on the fan-tray assembly goes blank. To perform an in-service replacement of the AIP, you must contact Cisco Technical Assistance Center (TAC). For contact information, go to the TAC website at http://www.cisco.com/tac.

You can replace the AIP on an in-service system without affecting traffic (except Ethernet traffic on nodes running a software release earlier than Release 4.0). The circuit repair feature allows you to repair circuits affected by MAC address changes on one node at a time. Circuit repair works when all nodes are running the same software version. Each individual AIP upgrade requires an individual circuit repair; if AIPs are replaced on two nodes, the circuit repair must be performed twice.

Caution Do not use a 2-A AIP with a 5-A fan-tray assembly; doing so causes a blown fuse on the AIP.

Note Ensure that all nodes in the affected network are running the same software version before replacing the AIP and repairing circuits. If you need to upgrade nodes to the same software version, no hardware should be changed or circuit repair performed until after the software upgrade is complete.

Note Replace an AIP during a maintenance window. Resetting the active TCC2 can cause a service disruption of less then 50 ms to optical (OC-N) or electrical (DS-N) traffic. Resetting the active TCC2 causes a service disruption of three to five minutes on all E-Series Ethernet traffic due to spanning tree reconvergence.

1.5 Electrical Interface Assemblies

Optional EIA backplane covers are typically preinstalled when ordered with the ONS 15454. EIAs must be ordered when using DS-1, DS-3, DS3XM-6, or EC-1 cards. This section describes each EIA.

Four different EIA backplane covers are available for the ONS 15454: BNC, High-Density BNC, SMB, and AMP Champ. If the shelf was not shipped with the correct EIA interface, you must order and install the correct EIA.

EIAs are attached to the shelf assembly backplane to provide electrical interface cable connections. EIAs are available with SMB and BNC connectors for DS-3 or EC-1 cards. EIAs are available with AMP Champ connectors for DS-1 cards. You must use SMB EIAs for DS-1 twisted-pair cable installation. You can install EIAs on one or both sides of the ONS 15454 backplane in any combination (in other words, AMP Champ on Side A and BNC on Side B or High-Density BNC on side A and SMB on side B, and so forth).

As you face the rear of the ONS 15454 shelf assembly, the right side is the A side and the left side is the B side. The top of the EIA connector columns are labeled with the corresponding slot number, and EIA connector pairs are marked transmit (Tx) and receive (Rx) to correspond to transmit and receive cables.

1.5.1 EIA Installation

Optional EIA backplane covers are typically preinstalled when ordered with the ONS 15454. A minimum amount of assembly might be required when EIAs are ordered separately from the ONS 15454. If you are installing EIAs after the shelf assembly is installed, plug the EIA into the backplane. The EIA has six electrical connectors that plug into six corresponding backplane connectors. The EIA backplane must replace the standard sheet metal cover to provide access to the coaxial cable connectors. The EIA sheet metal covers use the same screw holes as the solid backplane panels, but they have 12 additional 6-32 x 1/2 inch Phillips screw holes so you can screw down the cover and the board using standoffs on the EIA board.

When using the RG-179 coaxial cable on an EIA, the maximum distance available (122 feet [37 meters]) is less than the maximum distance available with standard RG-59 (735A) cable (306 feet [93 meters]). The maximum distance when using the RG-59 (734A) cable is 450 feet (137 meters). The shorter maximum distance available with the RG179 is due to a higher attenuation rate for the thinner cable. Attenuation rates are calculated using a DS-3 signal:

- For RG-179, the attenuation rate is 59 dB/kft at 22 MHz.
- For RG-59 (735A) the attenuation rate is 23 dB/kft at 22 MHz.

1.5.2 EIA Configurations

Table 1-1 gives the product numbers and common names for EIAs.

Table 1-1 EIA Configurations

EIA Type	Cards Supported	A-Side Hosts	A-Side Columns Map to	A-Side Product Number	B-Side Hosts	B-Side Columns Map to	B-Side Product Number
BNC	DS-3 DS3XM-6 EC-1	24 pairs of BNC connectors	Slot 2 Slot 4	15454-EIA-BNC-A24	24 pairs of BNC connectors	Slot 14 Slot 16	15454-EIA-BNC-B24
High-Density BNC	DS-3 DS3XM-6 EC-1	48 pairs of BNC connectors	Slot 1 Slot 2 Slot 4 Slot 5	15454-EIA-BNC-A48	48 pairs of BNC connectors	Slot 13 Slot 14 Slot 16 Slot 17	15454-EIA-BNC-B48

Table 1-1 EIA Configurations (continued)

EIA Type	Cards Supported	A-Side Hosts	A-Side Columns Map to	A-Side Product Number	B-Side Hosts	B-Side Columns Map to	B-Side Product Number
SMB	DS-1 DS-3 EC-1 DS3XM-6	84 pairs of SMB connectors	Slot 1 Slot 2 Slot 3 Slot 4 Slot 5 Slot 6	15454-EIA-SMB-A84	84 pairs of SMB connectors	Slot 12 Slot 13 Slot 14 Slot 15 Slot 16 Slot 17	15454-EIA-SMB-B84
AMP Champ	DS-1	6 AMP Champ connectors	Slot 1 Slot 2 Slot 3 Slot 4 Slot 5 Slot 6	15454-EIA-AMP-A84	6 AMP Champ connectors	Slot 12 Slot 13 Slot 14 Slot 15 Slot 16 Slot 17	15454-EIA-AMP-B84

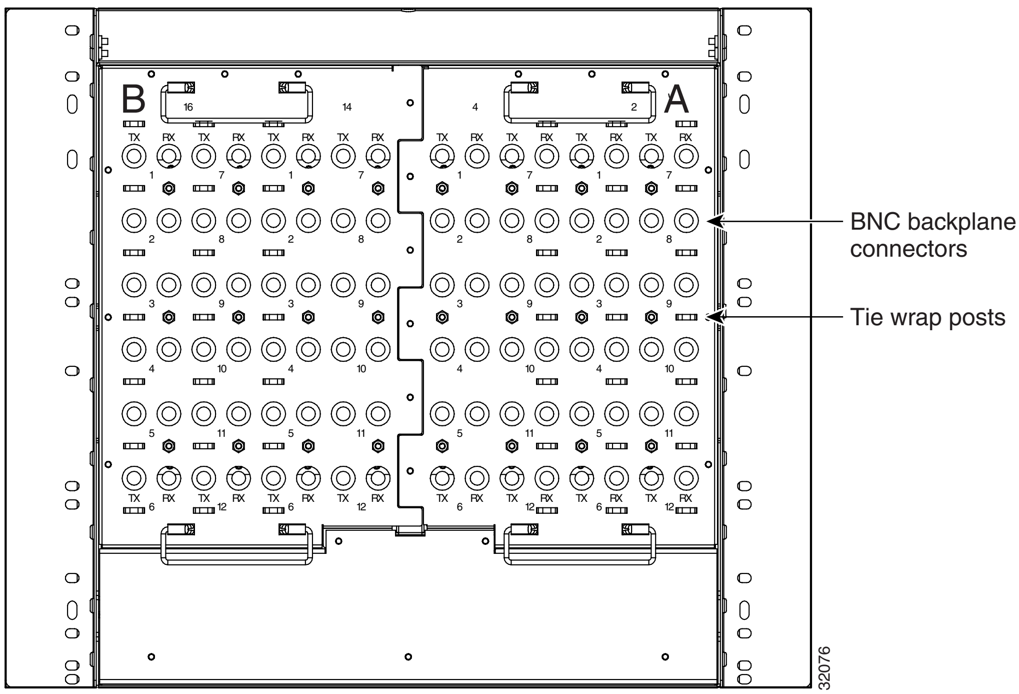
1.5.3 BNC EIA

The ONS 15454 BNC EIA supports 24 DS-3 circuits on each side of the ONS 15454 (24 transmit and 24 receive connectors). If you install BNC EIAs on both sides of the shelf assembly, the ONS 15454 hosts up to 48 circuits. The BNC connectors on the EIA supports Trompeter UCBJ224 (75-ohm) 4-leg connectors (King or ITT are also compatible). Right-angle mating connectors for the connecting cable are AMP 413588-2 (75-ohm) connectors. If preferred, you can also use a straight connector of the same type. Use RG-59/U cable to connect to the ONS 15454 BNC EIA. These cables are recommended to connect to a patch panel and are designed for long runs. You can use BNC EIAs for DS-3 (including the DS3XM-6) or EC-1 cards.

Figure 1-13 shows the ONS 15454 with preinstalled BNC EIAs.

To install coaxial cable with BNC connectors, refer to the *Cisco ONS 15454 Procedure Guide*.

Figure 1-13 BNC Backplane for Use in 1:1 Protection Schemes



1.5.3.1 BNC Connectors

The EIA side marked "A" has 24 pairs of BNC connectors. The first 12 pairs of BNC connectors correspond to Ports 1 to 12 for a 12-port card and map to Slot 2 on the shelf assembly. The BNC connector pairs are marked "Tx" and "Rx" to indicate transmit and receive cables for each port. You can install an additional card in Slot 1 as a protect card for the card in Slot 2. The second 12 BNC connector pairs correspond to Ports 1 to 12 for a 12-port card and map to Slot 4 on the shelf assembly. You can install an additional card in Slot 3 as a protect card for the card in Slot 4. Slots 5 and 6 do not support DS-3 cards when the standard BNC EIA panel connectors are used.

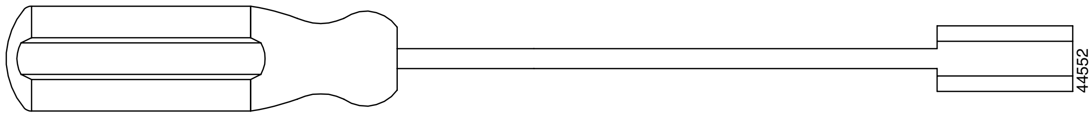
The EIA side marked "B" provides an additional 24 pairs of BNC connectors. The first 12 BNC connector pairs correspond to Ports 1 to 12 for a 12-port card and map to Slot 14 on the shelf assembly. The BNC connector pairs are marked "Tx" and "Rx" to indicate transmit and receive cables for each port. You can install an additional card in Slot 15 as a protect card for the card in Slot 14. The second 12 BNC connector pairs correspond to Ports 1 to 12 for a 12-port card and map to Slot 16 on the shelf assembly. You can install an additional card in Slot 17 as a protect card for the card in Slot 16. Slots 12 and 13 do not support DS-3 cards when the standard BNC EIA panel connectors are used.

When BNC connectors are used with a DS3N-12 card in Slot 3 or 15, the 1:N card protection extends only to the two slots adjacent to the 1:N card due to BNC wiring constraints.

1.5.3.2 BNC Insertion and Removal Tool

Due to the large number of BNC connectors on the High-Density BNC EIA, you might require a special tool for inserting and removing BNC EIAs (Figure 1-14). This tool also helps with ONS 15454 patch panel connections.

Figure 1-14 BNC Insertion and Removal Tool



This tool can be obtained with P/N 227-T1000 from:

Amphenol USA (www.amphenol.com)
One Kennedy Drive
Danbury, CT 06810
Phone: 203 743-9272 Fax: 203 796-2032

This tool can be obtained with P/N RT-1L from:

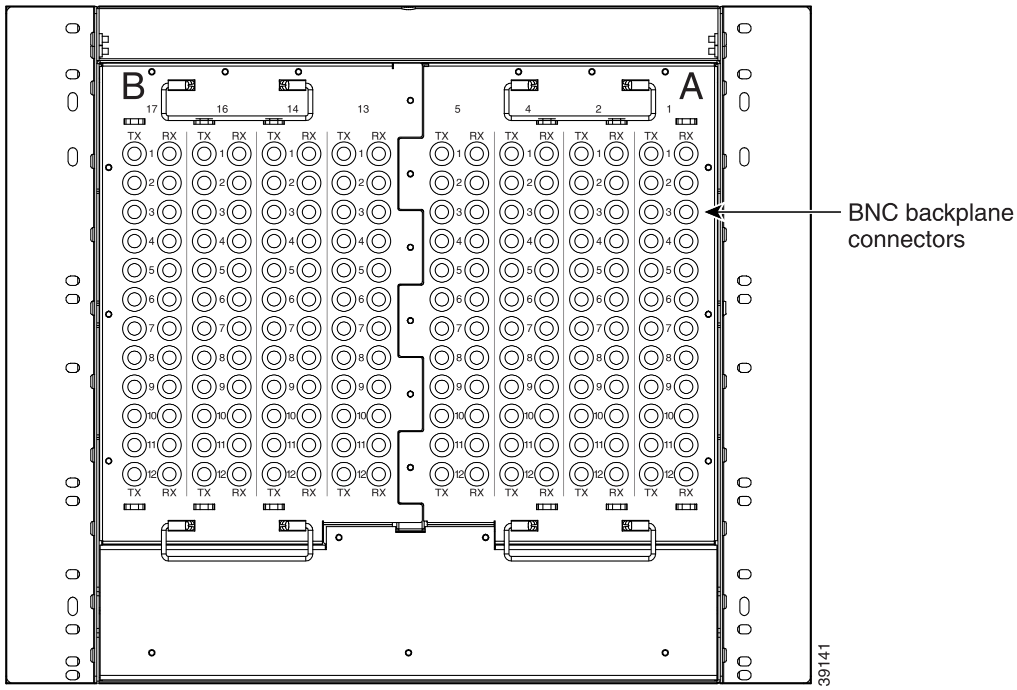
Trompeter Electronics Inc. (www.trompeter.com)
31186 La Baya Drive
Westlake Village, CA 91362-4047
Phone: 800 982-2629 Fax: 818 706-1040

1.5.4 High-Density BNC EIA

The ONS 15454 high-density BNC EIA supports 48 DS-3 circuits on each side of the ONS 15454 (48 transmit and 48 receive connectors). If you install BNC EIAs on both sides of the unit, the ONS 15454 hosts up to 96 circuits. The high-density BNC EIA supports Trompeter UCBJ224 (75-ohm) 4-leg connectors (King or ITT are also compatible). Use straight connectors on RG-59/U cable to connect to the high-density BNC EIA. Cisco recommends these cables for connection to a patch panel; they are designed for long runs. You can use high-density BNC EIAs for DS-3 (including the DS3XM-6) or EC-1 cards. Figure 1-15 shows the ONS 15454 with preinstalled high-density BNC EIAs.

To install coaxial cable with high-density BNC connectors, refer to the *Cisco ONS 15454 Procedure Guide*.

Figure 1-15 High-Density BNC Backplane for Use in 1:N Protection Schemes



The EIA side marked "A" hosts 48 pairs of BNC connectors. Each column of connector pairs is numbered and corresponds to the slot of the same number. The first column (12 pairs) of BNC connectors corresponds to Slot 1 on the shelf assembly, the second column to Slot 2, the third column to Slot 4, and the fourth column to Slot 5. The rows of connectors correspond to Ports 1 to 12 of a 12-port card.

The EIA side marked "B" provides an additional 48 pairs of BNC connectors. The first column (12 pairs) of BNC connectors corresponds to Slot 13 on the shelf assembly, the second column to Slot 14, the third column to Slot 16, and the fourth column to Slot 17. The rows of connectors correspond to Ports 1 to 12 of a 12-port card. The BNC connector pairs are marked "Tx" and "Rx" to indicate transmit and receive cables for each port. The High-Density BNC EIA supports both 1:1 and 1:N protection across all slots except Slots 6 and 12.

1.5.5 SMB EIA

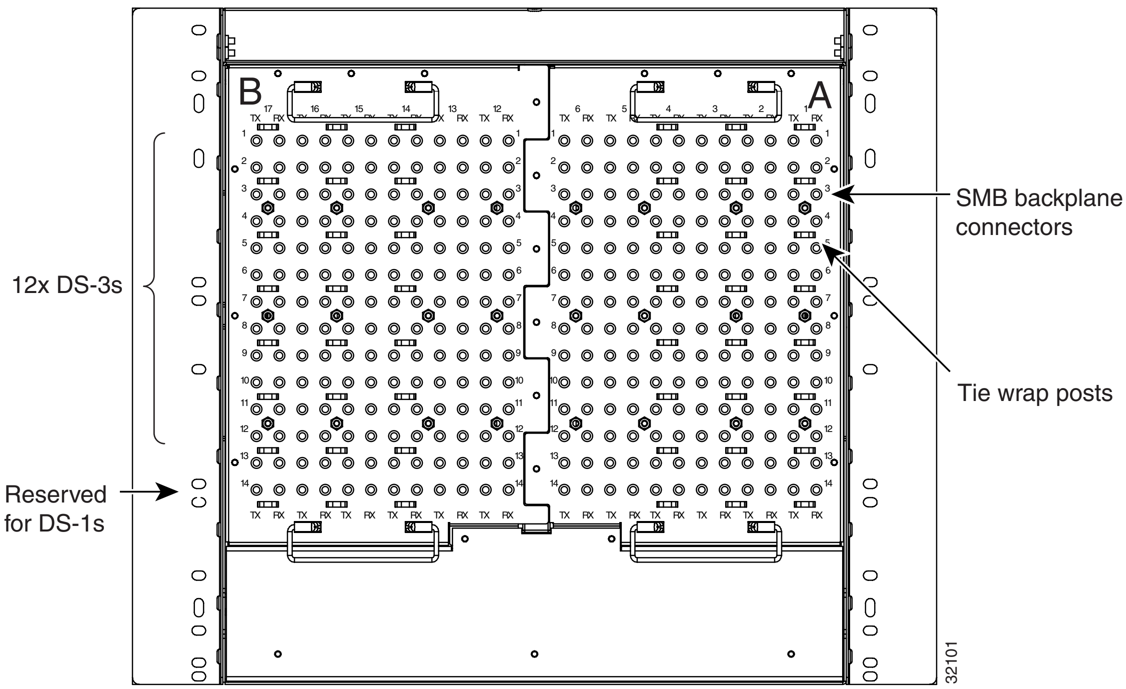
The ONS 15454 SMB EIA supports AMP 415484-1 75-ohm 4-leg connectors. Right-angle mating connectors for the connecting cable are AMP 415484-2 (75-ohm) connectors. Use RG-179/U cable to connect to the ONS 15454 EIA. Cisco recommends these cables for connection to a patch panel; they are not designed for long runs. Range does not affect loopback testing.

You can use SMB EIAs with DS-1, DS-3 (including the DS3XM-6), and EC-1 cards. If you use DS-1 cards, use the DS-1 electrical interface adapter (balun) to terminate the twisted pair DS-1 cable to the SMB EIA (see the "1.7.2 Electrical Interface Adapters" section on page 1-25). SMB EIAs support 14 ports per slot when used with a DS-1 card, 12 ports per slot when used with a DS-3 or EC-1 card, and 6 ports per slot when used with a DS3XM-6 card.

Figure 1-16 shows the ONS 15454 with preinstalled SMB EIAs and the sheet metal cover and screw locations for the EIA. The SMB connectors on the EIA are AMP 415504-3 (75-ohm) 4-leg connectors.

To install SMB connectors, refer to the *Cisco ONS 15454 Procedure Guide*.

Figure 1-16 SMB EIA Backplane



The SMB EIA has 84 transmit and 84 receive connectors on each side of the ONS 15454 for a total of 168 SMB connectors (84 circuits).

The EIA side marked "A" hosts 84 SMB connectors in six columns of 14 connectors. The "A" side columns are numbered 1 to 6 and correspond to Slots 1 to 6 on the shelf assembly. The EIA side marked "B" hosts an additional 84 SMB connectors in six columns of 14 connectors. The "B" side columns are numbered 12 to 17 and correspond to Slots 12 to 17 on the shelf assembly. The connector rows are numbered 1 to 14 and correspond to the 14 ports on a DS-1 card.

For DS-3 or EC-1 cards, the EIA supports 72 transmit and 72 receive connectors, for a total of 144 SMB connectors (72 circuits). If you use a DS-3 or EC-1 card, only Ports 1 to 12 are active. If you use a DS3XM-6 card, only Ports 1 to 6 are active. The SMB connector pairs are marked "Tx" and "Rx" to identify transmit and receive cables for each port. If you use SMB connectors, you can install DS-1, DS-3, or EC-1 cards in Slots 1 to 4 or 14 to 17.

1.5.6 AMP Champ EIA

The ONS 15454 AMP Champ EIA supports 64-pin (32 pair) AMP Champ connectors for each slot on both sides of the shelf assembly where the EIA is installed. Cisco AMP Champ connectors are female AMP # 552246-1 with AMP # 552562-2 bail locks. Each AMP Champ connector supports 14 DS-1 ports. You can use AMP Champ EIAs with DS-1 cards only. Figure 1-17 shows the ONS 15454 with preinstalled AMP Champ EIAs and the corresponding sheet metal cover and screw locations for the EIA.

To install AMP Champ connector DS-1 cables, you must use 64-pin bundled cable connectors with a 64-pin male AMP Champ connector. You need an AMP Champ connector #552276-1 for the receptacle side and #1-552496-1 (for cable diameter 0.475 in. to 0.540 in.) or #2-552496-1 (for cable diameter 0.540 in. to 0.605 in.) for the right-angle shell housing (or their functional equivalent). The corresponding 64-pin female AMP Champ connector on the AMP Champ EIA supports one receive and one transmit for each DS-1 port for the corresponding card slot.

Because each DS1-14 card supports 14 DS-1 ports, only 56 pins (28 pairs) of the 64-pin connector are used. Prepare one 56-wire cable for each DS-1 facility installed.

Figure 1-17 AMP Champ EIA Backplane

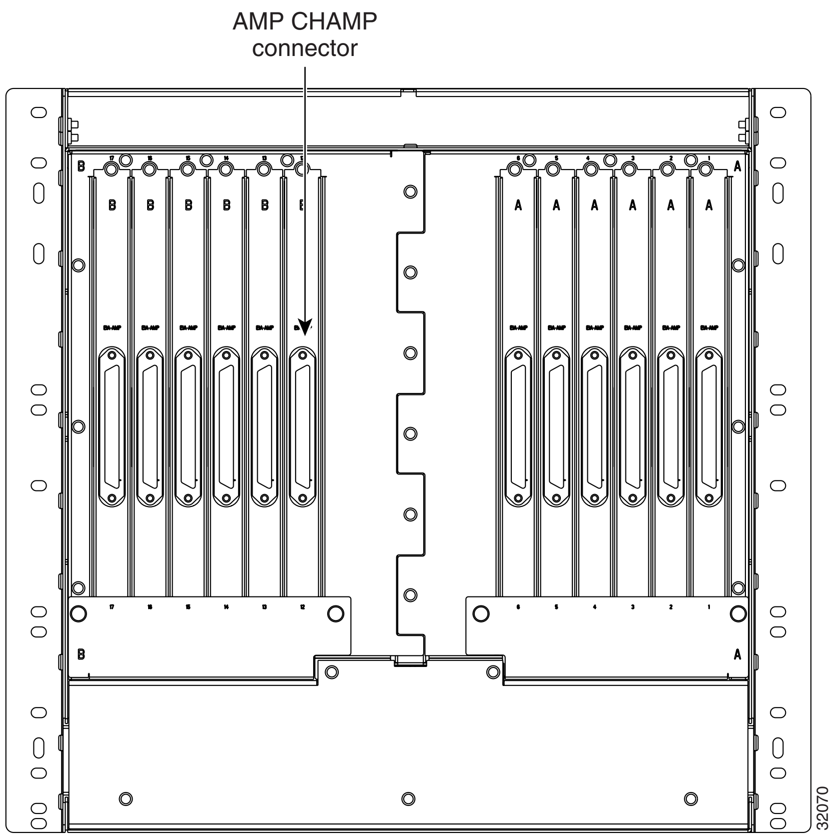


Table 1-2 shows the pin assignments for the AMP Champ connectors on the ONS 15454 AMP Champ EIA. The EIA side marked "A" hosts six AMP Champ connectors. The connectors are numbered 1 to 6 for the corresponding slots on the shelf assembly. Each AMP Champ connector on the backplane supports 14 DS-1 ports for a DS1-14 card, and each connector features 28 live pairs—one transmit pair and one receive pair—for each DS-1 port.

The EIA side marked "B" hosts six AMP Champ connectors. The connectors are labeled 12 to 17 for the corresponding slots on the shelf assembly. Each AMP Champ connector on the backplane supports 14 DS-1 ports for a DS1-14 card, and each connector features 28 live pairs—one transmit pair and one receive pair—for each DS-1 port.

Note EIAs are hot-swappable. You do not need to disconnect power to install or remove EIAs.

Caution Always use an electrostatic discharge (ESD) wristband when working with a powered ONS 15454. Plug the wristband cable into the ESD jack located on the lower-right outside edge of the shelf assembly.

Table 1-2 AMP Champ Connector Pin Assignments

Signal/Wire	Pin	Pin	Signal/Wire	Signal/Wire	Pin	Pin	Signal/Wire
Tx Tip 1 white/blue	1	33	Tx Ring 1 blue/white	Rx Tip 1 yellow/orange	17	49	Rx Ring 1 orange/yellow
Tx Tip 2 white/orange	2	34	Tx Ring 2 orange/white	Rx Tip 2 yellow/green	18	50	Rx Ring 2 green/yellow
Tx Tip 3 white/green	3	35	Tx Ring 3 green/white	Rx Tip 3 yellow/brown	19	51	Rx Ring 3 brown/yellow
Tx Tip 4 white/brown	4	36	Tx Ring 4 brown/white	Rx Tip 4 yellow/slate	20	52	Rx Ring 4 slate/yellow
Tx Tip 5 white/slate	5	37	Tx Ring 5 slate/white	Rx Tip 5 violet/blue	21	53	Rx Ring 5 blue/violet
Tx Tip 6 red/blue	6	38	Tx Ring 6 blue/red	Rx Tip 6 violet/orange	22	54	Rx Ring 6 orange/violet
Tx Tip 7 red/orange	7	39	Tx Ring 7 orange/red	Rx Tip 7 violet/green	23	55	Rx Ring 7 green/violet
Tx Tip 8 red/green	8	40	Tx Ring 8 green/red	Rx Tip 8 violet/brown	24	56	Rx Ring 8 brown/violet
Tx Tip 9 red/brown	9	41	Tx Ring 9 brown/red	Rx Tip 9 violet/slate	25	57	Rx Ring 9 slate/violet
Tx Tip 10 red/slate	10	42	Tx Ring 10 slate/red	Rx Tip 10 white/blue	26	58	Rx Ring 10 blue/white
Tx Tip 11 black/blue	11	43	Tx Ring 11 blue/black	Rx Tip 11 white/orange	27	59	Rx Ring 11 orange/white
Tx Tip 12 black/orange	12	44	Tx Ring 12 orange/black	Rx Tip 12 white/green	28	60	Rx Ring 12 green/white
Tx Tip 13 black/green	13	45	Tx Ring 13 green/black	Rx Tip 13 white/brown	29	61	Rx Ring 13 brown/white
Tx Tip 14 black/brown	14	46	Tx Ring 14 brown/black	Rx Tip 14 white/slate	30	62	Rx Ring 14 slate/white
Tx Spare0+ N/A	15	47	Tx Spare0– N/A	Rx Spare0+ N/A	31	63	Rx Spare0– N/A
Tx Spare1+ N/A	16	48	Tx Spare1– N/A	Rx Spare1+ N/A	32	64	Rx Spare1– N/A

Table 1-3 shows the pin assignments for the AMP Champ connectors on the ONS 15454 AMP Champ EIA for a shielded DS-1 cable.

Table 1-3 AMP Champ Connector Pin Assignments (Shielded DS-1 Cable)

64-Pin Blue Bundle				64-Pin Orange Bundle			
Signal/Wire	**Pin**	**Pin**	**Signal/Wire**	**Signal/Wire**	**Pin**	**Pin**	**Signal/Wire**
Tx Tip 1 white/blue	1	33	Tx Ring 1 blue/white	Rx Tip 1 white/blue	17	49	Rx Ring 1 blue/white
Tx Tip 2 white/orange	2	34	Tx Ring 2 orange/white	Rx Tip 2 white/orange	18	50	Rx Ring 2 orange/white

Table 1-3 AMP Champ Connector Pin Assignments (Shielded DS-1 Cable) (continued)

64-Pin Blue Bundle				64-Pin Orange Bundle			
Signal/Wire	**Pin**	**Pin**	**Signal/Wire**	**Signal/Wire**	**Pin**	**Pin**	**Signal/Wire**
Tx Tip 3 white/green	3	35	Tx Ring 3 green/white	Rx Tip 3 white/green	19	51	Rx Ring 3 green/white
Tx Tip 4 white/brown	4	36	Tx Ring 4 brown/white	Rx Tip 4 white/brown	20	52	Rx Ring 4 brown/white
Tx Tip 5 white/slate	5	37	Tx Ring 5 slate/white	Rx Tip 5 white/slate	21	53	Rx Ring 5 slate/white
Tx Tip 6 red/blue	6	38	Tx Ring 6 blue/red	Rx Tip 6 red/blue	22	54	Rx Ring 6 blue/red
Tx Tip 7 red/orange	7	39	Tx Ring 7 orange/red	Rx Tip 7 red/orange	23	55	Rx Ring 7 orange/red
Tx Tip 8 red/green	8	40	Tx Ring 8 green/red	Rx Tip 8 red/green	24	56	Rx Ring 8 green/red
Tx Tip 9 red/brown	9	41	Tx Ring 9 brown/red	Rx Tip 9 red/brown	25	57	Rx Ring 9 brown/red
Tx Tip 10 red/slate	10	42	Tx Ring 10 slate/red	Rx Tip 10 red/slate	26	58	Rx Ring 10 slate/red
Tx Tip 11 black/blue	11	43	Tx Ring 11 blue/black	Rx Tip 11 black/blue	27	59	Rx Ring 11 blue/black
Tx Tip 12 black/orange	12	44	Tx Ring 12 orange/black	Rx Tip 12 black/orange	28	60	Rx Ring 12 orange/black
Tx Tip 13 black/green	13	45	Tx Ring 13 green/black	Rx Tip 13 black/green	29	61	Rx Ring 13 green/black
Tx Tip 14 black/brown	14	46	Tx Ring 14 brown/black	Rx Tip 14 black/brown	30	62	Rx Ring 14 brown/black
Tx Tip 15 black/slate	15	47	Tx Tip 15 slate/black	Rx Tip 15 black/slate	31	63	Rx Tip 15 slate/black
Tx Tip 16 yellow/blue	16	48	Tx Tip 16 blue/yellow	Rx Tip 16 yellow/blue	32	64	Rx Tip 16 blue/yellow

When using DS-1 AMP Champ cables, you must equip the ONS 15454 with an AMP Champ connector EIA on each side of the backplane where DS-1 cables will terminate. Each AMP Champ connector on the EIA corresponds to a slot in the shelf assembly and is numbered accordingly. The AMP Champ connectors have screw-down tooling at each end of the connector.

1.5.7 EIA Replacement

The replacement procedure is the same for all the EIA types. However, installing the AMP Champ EIA requires the additional step of attaching the fastening plate to the bottom of the connector row. Before you attach a new EIA, you must remove the backplane cover or EIA already attached to the ONS 15454.

1.6 Coaxial Cable

Caution Always use the supplied ESD wristband when working with a powered ONS 15454. Plug the wristband cable into the ESD jack located on the lower-right outside edge of the shelf assembly.

When using ONS 15454 DS-3 electrical cables, the cables must terminate on an EIA installed on the ONS 15454 backplane. All DS-3 cables connected to the ONS 15454 DS-3 card must terminate with coaxial cables using the desired connector type to connect to the specified EIA.

The electromagnetic compatibility (EMC) performance of the node depends on good-quality DS-3 coaxial cables, such as Shuner Type G 03233 D, or the equivalent.

1.7 DS-1 Cable

DS-1 cables support AMP Champ connectors and twisted-pair wire-wrap cabling. Twisted-pair wire-wrap cables require SMB EIAs.

1.7.1 Twisted Pair Wire-Wrap Cables

Installing twisted-pair, wire-wrap DS-1 cables requires separate pairs of grounded twisted-pair cables for receive (in) and transmit (out). Prepare four cables, two for receive and two for transmit, for each DS-1 facility to be installed.

Caution Always use the supplied ESD wristband when working with a powered ONS 15454. Plug the wristband cable into the ESD jack located on the lower-right outside edge of the shelf assembly.

If you use DS-1 electrical twisted-pair cables, equip the ONS 15454 with an SMB EIA on each side of the backplane where DS-1 cables will terminate. You must install special DS-1 electrical interface adapters, commonly referred to as a balun, on every transmit and receive connector for each DS-1 termination.

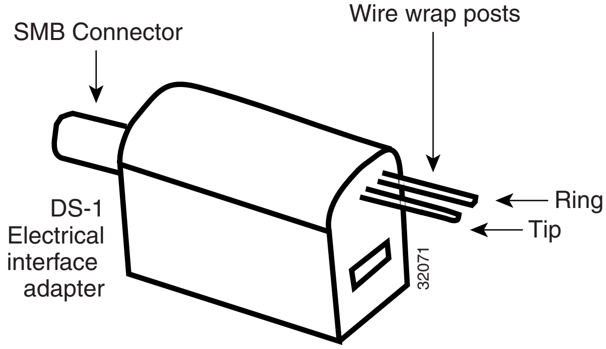
1.7.2 Electrical Interface Adapters

Note DS-1 electrical interface adapters project an additional 1.72 inches (43.7 mm) from the ONS 15454 backplane.

If you install DS-1 cards in the ONS 15454, you must fit the corresponding transmit and receive SMB connectors on the EIA with a DS-1 electrical interface adapter. You can install the adapter on the SMB connector for the port. The adaptor has wire-wrap posts for DS-1 transmit and receive cables. Figure 1-18 shows the DS-1 electrical interface adapter.

Note "EIA" refers to electrical interface assemblies and not electrical interface adapters. Electrical interface adapters are also known as baluns.

Figure 1-18 DS-1 Electrical Interface Adapter (Balun)



Each DS-1 electrical interface adapter has a female SMB connector on one end and a pair of 0.045 inch (1.14 mm) square wire-wrap posts on the other end. The wire-wrap posts are 0.200 inches (5.08 mm) apart.

Caution Always use the supplied ESD wristband when working with a powered ONS 15454. Plug the wristband cable into the ESD jack located on the lower-right outside edge of the shelf assembly.

1.8 Cable Routing and Management

The ONS 15454 cable management facilities include the following:

- A cable-routing channel (behind the fold-down door) that runs the width of the shelf assembly (Figure 1-19)
- Plastic horseshoe-shaped fiber guides at each side opening of the cable-routing channel that ensure the proper bend radius is maintained in the fibers (Figure 1-20)

  Note You can remove the fiber guide if necessary to create a larger opening (if you need to route CAT-5 Ethernet cables out the side, for example). To remove the fiber guide, take out the three screws that anchor it to the side of the shelf assembly.

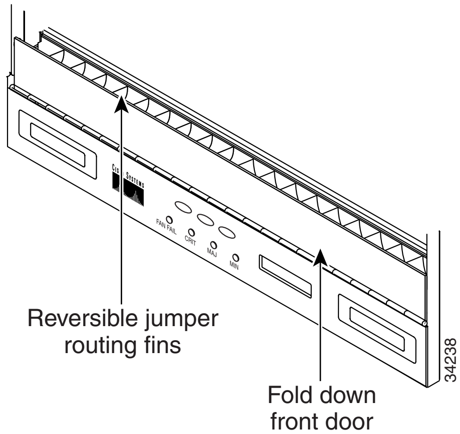
- A fold-down door that provides access to the cable-management tray
- Cable tie-wrap facilities on EIAs that secure cables to the cover panel
- Reversible jumper routing fins that enable you to route cables out either side by positioning the fins as desired
- Jumper slack storage reels (2) on each side panel that reduce the amount of slack in cables that are connected to other devices

Note To remove the jumper slack storage reels, take out the screw in the center of each reel.

- Optional fiber management tray (recommended for DWDM nodes)
- Optional tie-down bar

Figure 1-19 shows the cable management facilities that you can access through the fold-down front door, including the cable-routing channel and the jumper routing fins.

Figure 1-19 Managing Cables on the Front Panel



1.8.1 Fiber Management

The jumper routing fins are designed to route fiber jumpers out of both sides of the shelf. Slots 1 to 6 exit to the left, and Slots 12 to 17 exit to the right. Figure 1-20 shows fibers routed from cards in the left slots, down through the fins, then exiting out the fiber channel to the left. The maximum capacity of the fiber routing channel depends on the size of the fiber jumpers. Table 1-4 gives the maximum capacity of the fiber channel for each side of the shelf, for the different fiber sizes.

Figure 1-20 Fiber Capacity

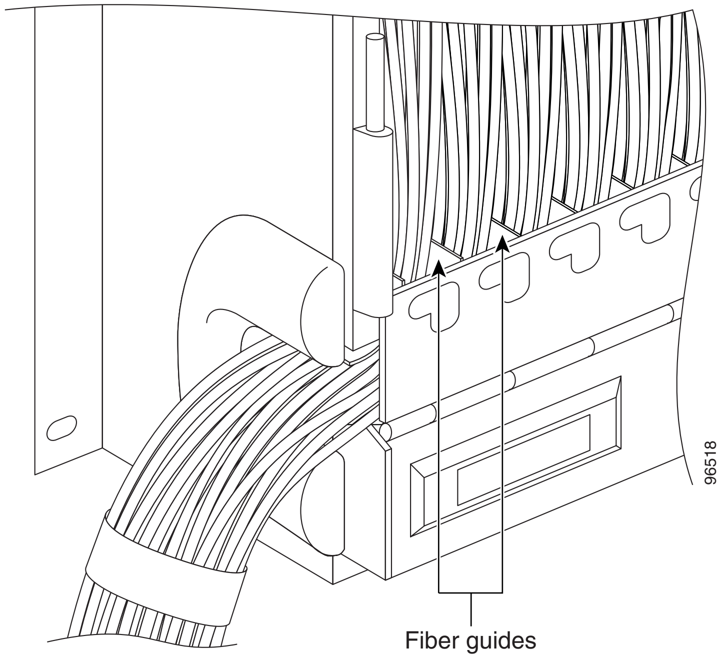


Table 1-4 Fiber Capacity

Fiber Diameter	Maximum Number of Fibers Exiting Each Side
1.6 mm (0.6 inch)	224
2 mm (0.7 inch)	144
3 mm (0.11 inch)	64

Plan your fiber size according to the number of cards/ports installed in each side of the shelf. For example, if your port combination requires 36 fibers, 3 mm (0.11 inch) fiber is adequate. If your port combination requires 68 fibers, you must use 2 mm(0.7 inch) or smaller fibers.

1.8.2 Fiber Management Using the Optional DWDM Fiber Tray

Cisco recommends installing a fiber storage tray in multinode racks to facilitate fiber management for DWDM applications. Refer to Figure 1-3 for typical mounting locations.

The fiber capacity for each tray is listed in Table 1-5.

Table 1-5 Fiber Tray Capacity

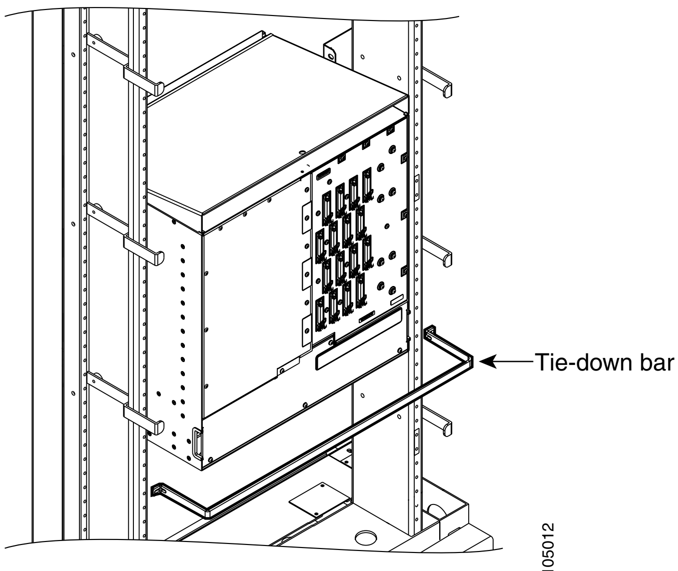
Fiber Diameter	Maximum Number of Fibers Exiting Each Side
1.6 mm (0.6 inch)	62
2 mm (0.7 inch)	48
3 mm (0.11 inch)	32

1.8.3 Fiber Management Using the Optional Tie-Down Bar

You can install a 5-inch (127 mm) tie-down bar on the rear of the ANSI chassis. You can use tie-wraps or other site-specific material to bundle the cabling and attach it to the bar so that you can more easily route the cable away from the rack.

Figure 1-21 shows the tie-down bar, the ONS 15454, and the rack.

Figure 1-21 Tie-Down Bar



1.8.4 Coaxial Cable Management

Coaxial cables connect to EIAs on the ONS 15454 backplane using cable connectors. EIAs feature cable-management eyelets for tie wrapping or lacing cables to the cover panel.

1.8.5 DS-1 Twisted-Pair Cable Management

Connect twisted pair/DS-1 cables to SMB EIAs on the ONS 15454 backplane using cable connectors and DS-1 EIAs (baluns).

1.8.6 AMP Champ Cable Management

EIAs have cable management eyelets to tiewrap or lace cables to the cover panel. Tie wrap or lace the AMP Champ cables according to local site practice and route the cables. If you configure the ONS 15454 for a 23-inch (584.2 mm) rack, two additional inches (50.8 mm) of cable management area is available on each side of the shelf assembly.

1.9 Alarm Expansion Panel

The optional ONS 15454 alarm expansion panel (AEP) can be used with the Alarm Interface Controller—International card (AIC-I) card to provide an additional 48 dry alarm contacts for the ONS 15454, 32 of which are inputs and 16 are outputs. The AEP is a printed circuit board assembly that is installed on the backplane. Figure 1-22 shows the AEP board. In Figure 1-22, the left connector is the input connector and the right connector is the output connector.

The AIC-I without an AEP already contains direct alarm contacts. These direct AIC-I alarm contacts are routed through the backplane to wire-wrap pins accessible from the back of the shelf. If you install an AEP, you cannot use the alarm contacts on the wire-wrap pins. For further information about the AIC-I, see the "2.7 AIC-I Card" section on page 2-26.

Figure 1-22 AEP Printed Circuit Board Assembly

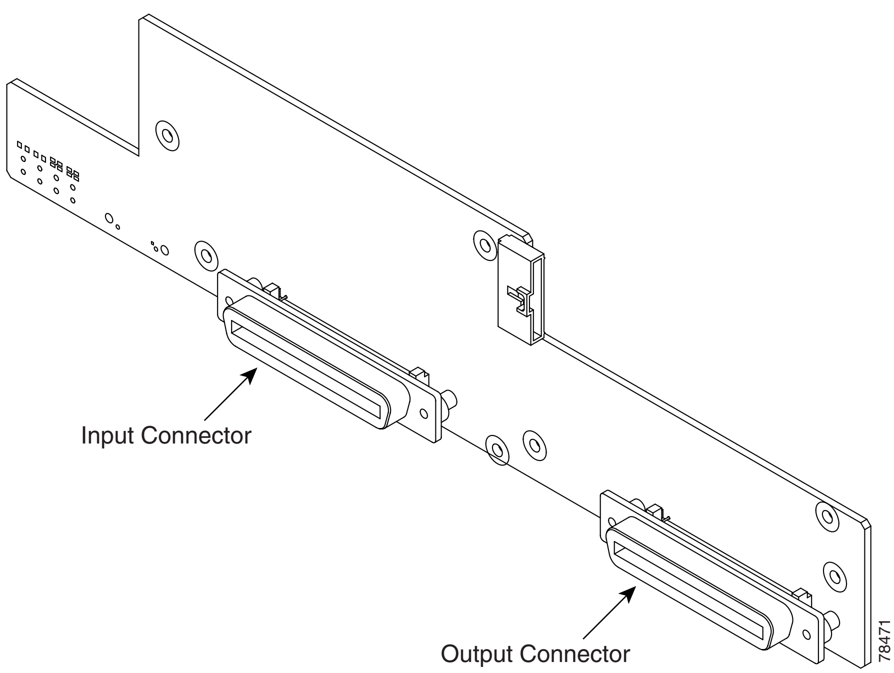
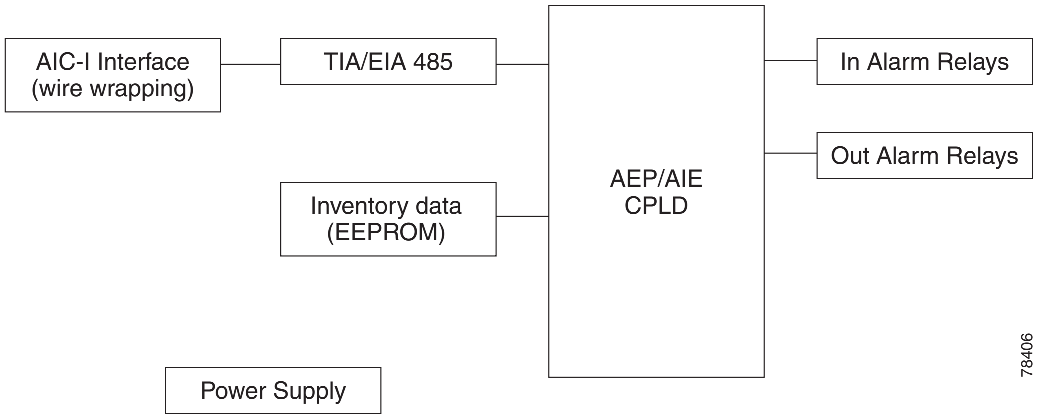


Figure 1-23 shows the AEP block diagram.

Figure 1-23 AEP Block Diagram



Each AEP alarm input port has provisionable label and severity. The alarm inputs have optocoupler isolation. They have one common 48-VDC output and a maximum of 2 mA per input. Each opto metal oxide semiconductor (MOS) alarm output can operate by definable alarm condition, a maximum open circuit voltage of 60 VDC, anda maximum current of 100 mA. See the "2.7.2 External Alarms and Controls" section on page 2-27 for further information.

1.9.1 Wire-Wrap and Pin Connections

Figure 1-24 shows the wire-wrapping connections on the backplane.

Figure 1-24 AEP Wire-Wrap Connections to Backplane Pins

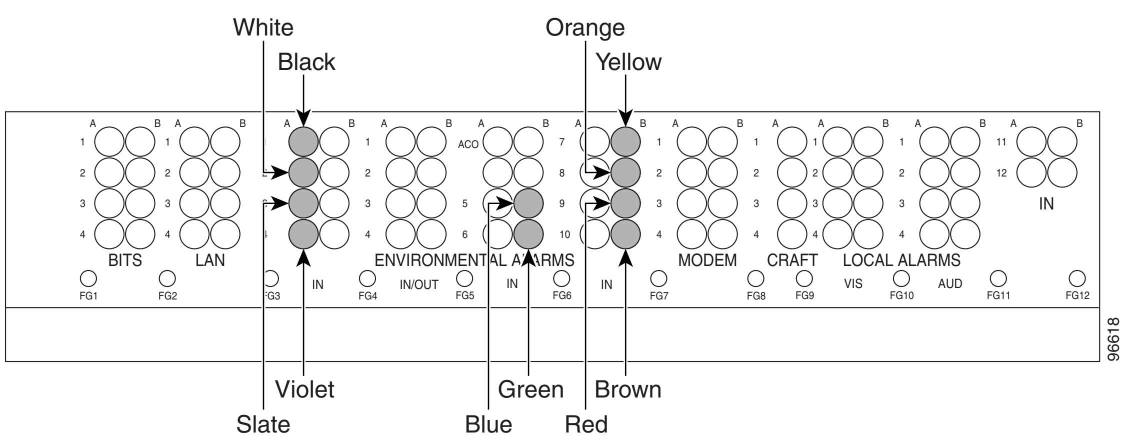


Table 1-6 shows the backplane pin assignments and corresponding signals on the AIC-I and AEP.

Table 1-6 Pin Assignments for the AEP

AEP Cable Wire	Backplane Pin	AIC-I Signal	AEP Signal
Black	A1	GND	AEP_GND
White	A2	AE_+5	AEP_+5
Slate	A3	VBAT–	VBAT–
Violet	A4	VB+	VB+
Blue	A5	AE_CLK_P	AE_CLK_P
Green	A6	AE_CLK_N	AE_CLK_N
Yellow	A7	AE_DIN_P	AE_DOUT_P
Orange	A8	AE_DIN_N	AE_DOUT_N
Red	A9	AE_DOUT_P	AE_DIN_P
Brown	A10	AE_DOUT_N	AE_DIN_N

Figure 1-25 is a circuit diagram of the alarm inputs (Inputs 1 and 32 are shown in the example).

Figure 1-25 Alarm Input Circuit Diagram

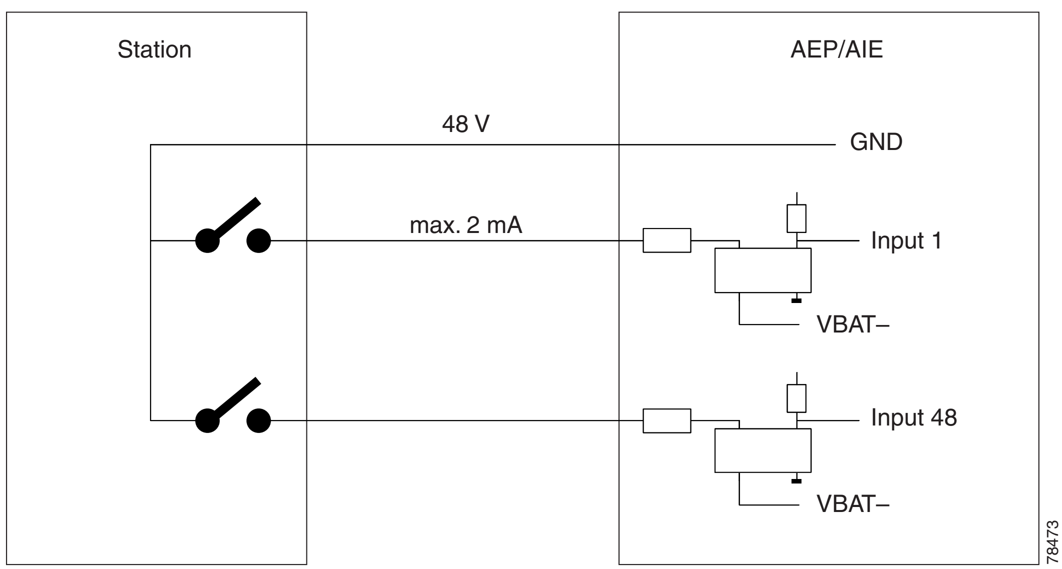


Table 1-7 lists the connections to the external alarm sources.

Table 1-7 Alarm Input Pin Association

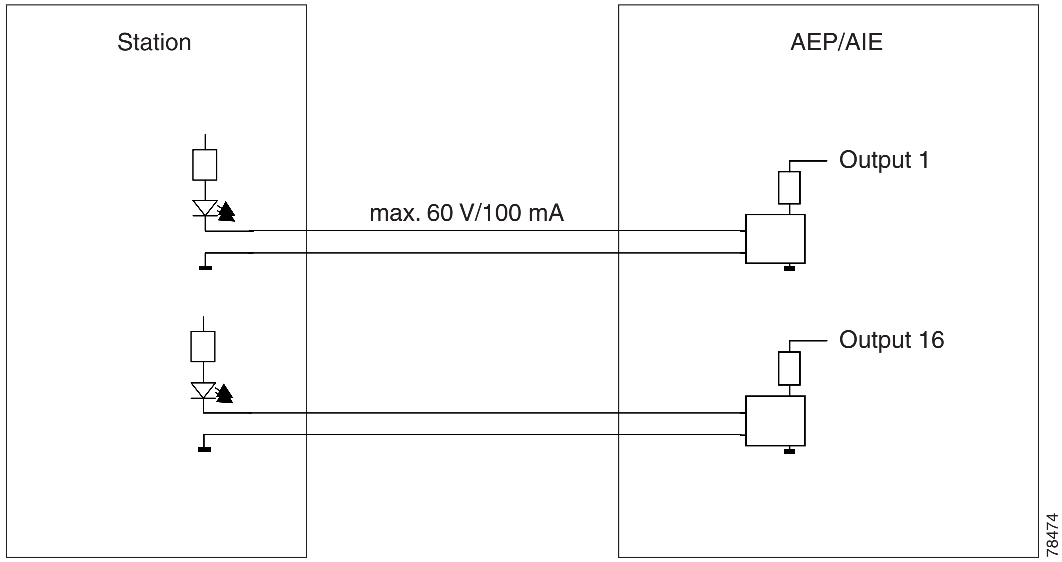
AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
1	ALARM_IN_1–	27	GND
2	GND	28	ALARM_IN_2–
3	ALARM_IN_3–	29	ALARM_IN_4–
4	ALARM_IN_5–	30	GND

Table 1-7 Alarm Input Pin Association (continued)

AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
5	GND	31	ALARM_IN_6–
6	ALARM_IN_7–	32	ALARM_IN_8–
7	ALARM_IN_9–	33	GND
8	GND	34	ALARM_IN_10–
9	ALARM_IN_11–	35	ALARM_IN_12–
10	ALARM_IN_13–	36	GND
11	GND	37	ALARM_IN_14–
12	ALARM_IN_15–	38	ALARM_IN_16–
13	ALARM_IN_17–	39	GND
14	GND	40	ALARM_IN_18–
15	ALARM_IN_19–	41	ALARM_IN_20–
16	ALARM_IN_21–	42	GND
17	GND	43	ALARM_IN_22–
18	ALARM_IN_23–	44	ALARM_IN_24–
19	ALARM_IN_25–	45	GND
20	GND	46	ALARM_IN_26–
21	ALARM_IN_27–	47	ALARM_IN_28–
22	ALARM_IN_29–	48	GND
23	GND	49	ALARM_IN_30–
24	ALARM_IN_31–	50	N.C.
25	ALARM_IN_+	51	GND1
26	ALARM_IN_0–	52	GND2

Figure 1-26 is a circuit diagram of the alarm outputs (Outputs 1 and 16 are shown in the example).

Figure 1-26 Alarm Output Circuit Diagram



Use the pin numbers in Table 1-8 to connect to the external elements being switched by external alarms.

Table 1-8 Pin Association for Alarm Output Pins

AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
1	N.C.	27	COM_0
2	COM_1	28	N.C.
3	NO_1	29	NO_2
4	N.C.	30	COM_2
5	COM_3	31	N.C.
6	NO_3	32	NO_4
7	N.C.	33	COM_4
8	COM_5	34	N.C.
9	NO_5	35	NO_6
10	N.C.	36	COM_6
11	COM_7	37	N.C.
12	NO_7	38	NO_8
13	N.C.	39	COM_8
14	COM_9	40	N.C.
15	NO_9	41	NO_10
16	N.C.	42	COM_10
17	COM_11	43	N.C.
18	NO_11	44	NO_12
19	N.C.	45	COM_12

Table 1-8 Pin Association for Alarm Output Pins (continued)

AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
20	COM_13	46	N.C.
21	NO_13	47	NO_14
22	N.C.	48	COM_14
23	COM_15	49	N.C.
24	NO_15	50	N.C.
25	N.C.	51	GND1
26	NO_0	52	GND2

1.9.2 AEP Specifications

The AEP has the following specifications:

- Alarm inputs
  - Number of inputs: 32
  - Optocoupler isolated
  - Label customer provisionable
  - Severity customer provisionable
  - Common 32 V output for all alarm inputs
  - Each input limited to 2 mA
  - Termination: 50-pin AMP champ connector
- Alarm outputs
  - Number of outputs: 16
  - Switched by opto MOS (metal oxide semiconductor)
  - Triggered by definable alarm condition
  - Maximum allowed open circuit voltage: 60 VDC
  - Maximum allowed closed circuit current: 100 mA
  - Termination: 50-pin AMP champ connector
- Environmental
  - Overvoltage protection: as in ITU-T G.703 Annex B
  - Operating temperature: –40 to +65 degrees Celsius
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 3.00 W max., from +5 VDC from AIC-I, 10.2 BTU/hr max.
- Dimensions of AEP board
  - Height: 20 mm (0.79 in.)
  - Width: 330 mm (13.0 in.)
  - Depth: 89 mm (3.5 in.)

  - Weight: 0.18 kg (0.4 lb)
- Compliance: Installed ONS 15454 cards comply with these standards:
  - Safety: IEC 60950, EN 60950, UL 60950, CSA C22.2 No. 60950, TS 001, AS/NZS 3260

1.10 Fan-Tray Assembly

The fan-tray assembly is located at the bottom of the ONS 15454 bay assembly. The fan tray is a removable drawer that holds fans and fan-control circuitry for the ONS 15454. The front door can be left in place or removed before installing the fan-tray assembly. After you install the fan tray, you should only need to access it if a fan failure occurs or if you need to replace or clean the fan-tray air filter.

The front of the fan-tray assembly has an LCD screen that provides slot- and port-level information for all ONS 15454 card slots, including the number of Critical, Major, and Minor alarms. For optical cards, you can use the LCD to determine if a port is in working or protect mode and is active or standby. The LCD also tells you whether the software load is SONET or SDH and the software version number.

The fan-tray assembly features an air filter at the bottom of the tray that you can install and remove by hand. Remove and visually inspect this filter every 30 days and keep spare filters in stock. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for information about cleaning and maintaining the fan-tray air filter.

Note The 15454-SA-ANSI or 15454-SA-HD shelf assembly and 15454-FTA3 fan-tray assembly are required with any ONS 15454 that has XC10G cards.

Caution Do not operate an ONS 15454 without the mandatory fan-tray air filter.

Caution The 15454-FTA3-T fan-tray assembly can only be installed in ONS 15454 Release 3.1 and later shelf assemblies (15454-SA-ANSI, P/N: 800-19857; 15454-SA-HD, P/N: 800-24848). It includes a pin that does not allow it to be installed in ONS 15454 shelf assemblies released before ONS 15454 Release 3.1 (15454-SA-NEBS3E, 15454-SA-NEBS3, and 15454-SA-R1, P/N: 800-07149). Equipment damage can result from attempting to install the 15454-FTA3 in a noncompatible shelf assembly.

Note The 15454-FTA3 is not I-temp compliant. To obtain an I-temp fan tray, install the 15454-FTA3-T fan-tray assembly in an ONS 15454 Release 3.1 shelf assembly (15454-SA-ANSI or 15454-SA-HD). However, do not install the ONS 15454 XC10G cross-connect cards with the 15454-FTA2 fan-tray assembly.

1.10.1 Fan Speed and Power Requirements

Fan speed is controlled by TCC2 card temperature sensors. The sensors measure the input air temperature at the fan-tray assembly. Fan speed options are low, medium, and high. If the TCC2 card fails, the fans automatically shift to high speed. The temperature measured by the TCC2 sensors is displayed on the LCD screen.

Table 1-9 lists power requirements for the fan-tray assembly.

Table 1-9 Fan Tray Assembly Power Requirements

Fan Tray Assembly	Watts	Amps	BTU/Hr
FTA2	53	1.21	198
FTA3 -T	86.4	1.8	295

1.10.2 Fan Failure

If one or more fans fail on the fan-tray assembly, replace the entire assembly. You cannot replace individual fans. The red Fan Fail LED on the front of the fan tray illuminates when one or more fans fail. For fan tray replacement instructions, refer to the *Cisco ONS 15454 Troubleshooting Guide*. The red Fan Fail LED clears after you install a working fan tray.

1.10.3 Air Filter

The ONS 15454 contains a reusable air filter; Model 15454-FTF2, that is installed either beneath the fan-tray assembly or in the optional external filter brackets. Earlier versions of the ONS 15454 used a disposable air filter that is installed beneath the fan-tray assembly only. However, the reusable air filter is backward compatible.

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

The reusable filter is made of a gray, open-cell, polyurethane foam that is specially coated to provide fire and fungi resistance. All versions of the ONS 15454 can use the reusable air filter. Spare filters should be kept in stock.

1.11 Power and Ground Description

Ground the equipment according to Telcordia standards or local practices.

Cisco recommends the following wiring conventions, but customer conventions prevail:

- Red wire for battery connections (–48 VDC)
- Black wire for battery return connections (0 VDC)
- The battery return connection is treated as DC-I, as defined in GR-1089-CORE, issue 3.

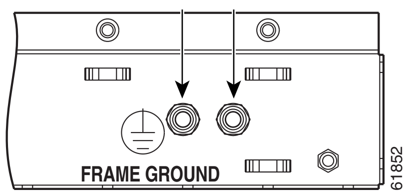
The ONS 15454 has redundant –48 VDC #8 power terminals on the shelf-assembly backplane. The terminals are labeled BAT1, RET1, BAT2, and RET2 and are located on the lower section of the backplane behind a clear plastic cover.

To install redundant power feeds, use four power cables and one ground cable. For a single power feed, only two power cables (#10 AWG, 2.588 mm² [0.1018 inch], copper conductor, 194°F [90°C]) and one ground cable (#6 AWG, 4.115 mm² [0.162 inch]) are required. Use a conductor with low impedance to ensure circuit overcurrent protection. However, the conductor must have the capability to safely conduct any faulty current that might be imposed.

Note If you are installing power on a Release 3.0 ONS 15454 shelf assembly (15454-SA-NEBS3E, 15454-SA-NEBS3, and 15454-SA-R1, P/N: 800-07149), the #12 to #14 AWG (2.053 to 1.628 mm²) power cable and #14 AWG (1.628 mm²) ground cable are required.

The existing ground post is a #10-32 bolt. The nut provided for a field connection is also a #10 AWG (2.588 mm² [0.1018 inch]), with an integral lock washer. The lug must be a dual-hole type and rated to accept the #6 AWG (4.115 mm² [0.162 inch]) cable. Two posts are provided on the Cisco ONS 15454 to accommodate the dual-hole lug. Figure 1-27 shows the location of the ground posts.

Figure 1-27 Ground Posts on the ONS 15454 Backplane



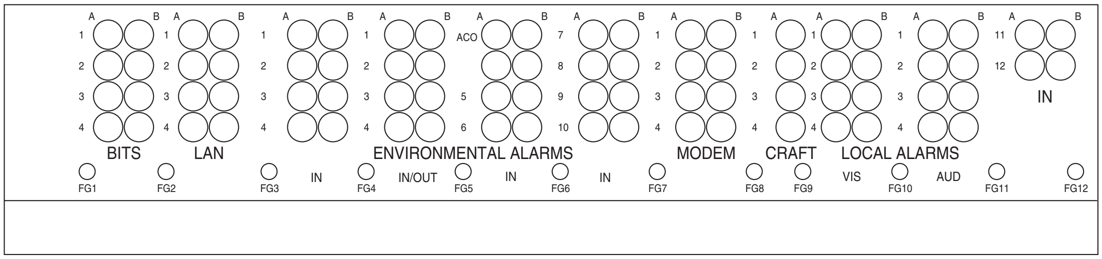
1.12 Alarm, Timing, LAN, and Craft Pin Connections

Caution Always use the supplied ESD wristband when working with a powered ONS 15454. Plug the wristband cable into the ESD jack located on the lower-right outside edge of the shelf assembly.

The ONS 15454 has a backplane pin field located at the bottom of the backplane. The backplane pin field provides 0.045 square inch (29 mm^2) wire-wrap pins for enabling external alarms, timing input and output, and craft interface terminals. This section describes the backplane pin field and the pin assignments for the field. Figure 1-28 shows the wire-wrap pins on the backplane pin field. Beneath each wire-wrap pin is a frame ground pin. Frame ground pins are labeled FG1, FG2, FG3, etc. Install the ground shield of the cables connected to the backplane to the ground pin that corresponds to the pin field used.

Note The AIC-I requires a shelf assembly running Software Release 3.4.0 or later. The backplane of the ANSI shelf contains a wire-wrap field with pin assignment according to the layout in Figure 1-28. The shelf assembly might be an existing shelf that has been upgraded to R3.4 or later. In this case the backplane pin labeling appears as indicated in Figure 1-29 on page 1-40. But you must use the pin assignments provided by the AIC-I as shown in Figure 1-28.

Figure 1-28 ONS 15454 Backplane Pinouts (Release 3.4 or Later)



Field	Pin	Function
BITS	A1	BITS Output 2 negative (–)
	B1	BITS Output 2 positive (+)
	A2	BITS Input 2 negative (–)
	B2	BITS Input 2 positive (+)
	A3	BITS Output 1 negative (–)
	B3	BITS Output 1 positive (+)
	A4	BITS Input 1 negative (–)
	B4	BITS Input 1 positive (+)
LAN	Connecting to a hub, or switch	
	A1	RJ-45 pin 6 RX–
	B1	RJ-45 pin 3 RX+
	A2	RJ-45 pin 2 TX–
	B2	RJ-45 pin 1 TX+
	Connecting to a PC/Workstation or router	
	A1	RJ-45 pin 2 RX–
	B1	RJ-45 pin 1 RX+
	A2	RJ-45 pin 6 TX–
	B2	RJ-45 pin 3 TX+
ENVIR ALARMS IN	A1, B1	Alarm input pair number 1: Reports closure on connected wires.
	A2, B2	Alarm input pair number 2: Reports closure on connected wires.
	A3, B3	Alarm input pair number 3: Reports closure on connected wires.
	A4, B4	Alarm input pair number 4: Reports closure on connected wires.
	A5, B5	Alarm input pair number 5: Reports closure on connected wires.
	A6, B6	Alarm input pair number 6: Reports closure on connected wires.
	A7, B7	Alarm input pair number 7: Reports closure on connected wires.
	A8, B8	Alarm input pair number 8: Reports closure on connected wires.
	A9, B9	Alarm input pair number 9: Reports closure on connected wires.
	A10, B10	Alarm input pair number 10: Reports closure on connected wires.
	A11, B11	Alarm input pair number 11: Reports closure on connected wires.
	A12, B12	Alarm input pair number 12: Reports closure on connected wires.

Field	Pin	Function
ENVIR ALARMS IN/OUT N/O	A1/A13, B1/B13	Normally open output pair number 1
	A2/A14, B2/B14	Normally open output pair number 2
	A3/A15, B3/B15	Normally open output pair number 3
	A4/A16, B4/B16	Normally open output pair number 4
ACO	A1, B1	Normally open ACO pair
CRAFT	A1	Receive (PC pin #2)
	A2	Transmit (PC pin #3)
	A3	Ground (PC pin #5)
	A4	DTR (PC pin #4)
LOCAL ALARMS AUD (Audible) N/O	A1, B1	Alarm output pair number 1: Remote audible alarm.
	A2, B2	Alarm output pair number 2: Critical audible alarm.
	A3, B3	Alarm output pair number 3: Major audible alarm.
	A4, B4	Alarm output pair number 4: Minor audible alarm.
LOCAL ALARMS VIS (Visual) N/O	A1, B1	Alarm output pair number 1: Remote visual alarm.
	A2, B2	Alarm output pair number 2: Critical visual alarm.
	A3, B3	Alarm output pair number 3: Major visual alarm.
	A4, B4	Alarm output pair number 4: Minor visual alarm.

If you are using an AIC-I card, contacts provisioned as OUT are 1-4. Contacts provisioned as IN are 13-16.

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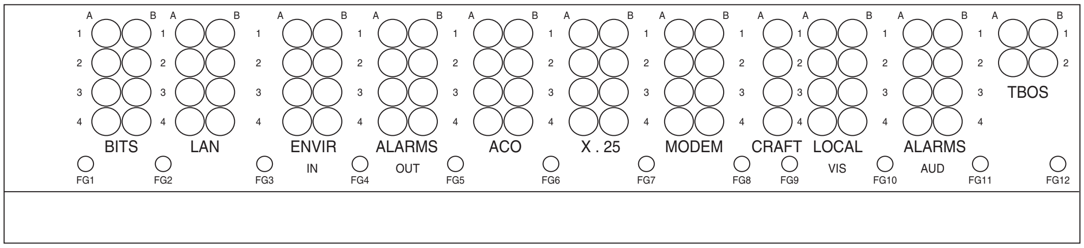
Figure 1-29 ONS 15454 Backplane Pinouts



Field	Pin	Function
BITS	A1	BITS Output 2 negative (-)
	B1	BITS Output 2 positive (+)
	A2	BITS Input 2 negative (-)
	B2	BITS Input 2 positive (+)
	A3	BITS Output 1 negative (-)
	B3	BITS Output 1 positive (+)
	A4	BITS Input 1 negative (-)
	B4	BITS Input 1 positive (+)
LAN	Connecting to a hub, or switch	
	A1	RJ-45 pin 6 RX-
	B1	RJ-45 pin 3 RX+
	A2	RJ-45 pin 2 TX-
	B2	RJ-45 pin 1 TX+
	Connecting to a PC/Workstation or router	
	A1	RJ-45 pin 2 RX-
	B1	RJ-45 pin 1 RX+
	A2	RJ-45 pin 6 TX-
	B2	RJ-45 pin 3 TX+
ENVIR ALARMS IN	A1	Alarm input pair number 1: Reports closure on connected wires.
	B1	
	A2	Alarm input pair number 2: Reports closure on connected wires.
	B2	
	A3	Alarm input pair number 3: Reports closure on connected wires.
	B3	
	A4	Alarm input pair number 4: Reports closure on connected wires.
	B4	

Field	Pin	Function
ENVIR ALARMS OUT N/O	A1	Normally open output pair number 1
	B1	
	A2	Normally open output pair number 2
	B2	
	A3	Normally open output pair number 3
	B3	
	A4	Normally open output pair number 4
	B4	
ACO	A1	Normally open ACO pair
	B1	
CRAFT	A1	Receive (PC pin #2)
	A2	Transmit (PC pin #3)
	A3	Ground (PC pin #5)
	A4	DTR (PC pin #4)
LOCAL ALARMS AUD (Audible) N/O	A1	Alarm output pair number 1: Remote audible alarm.
	B1	
	A2	Alarm output pair number 2: Critical audible alarm.
	B2	
	A3	Alarm output pair number 3: Major audible alarm.
	B3	
	A4	Alarm output pair number 4: Minor audible alarm.
	B4	
LOCAL ALARMS VIS (Visual) N/O	A1	Alarm output pair number 1: Remote visual alarm.
	B1	
	A2	Alarm output pair number 2: Critical visual alarm.
	B2	
	A3	Alarm output pair number 3: Major visual alarm.
	B3	
	A4	Alarm output pair number 4: Minor visual alarm.
	B4	

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1.12.1 Alarm Contact Connections

The alarm pin field supports up to 17 alarm contacts, including four audible alarms, four visual alarms, one alarm cutoff (ACO), and four user-definable alarm input and output contacts.

Audible alarm contacts are in the LOCAL ALARM AUD pin field and visual contacts are in the LOCAL ALARM VIS pin field. Both of these alarms are in the LOCAL ALARMS category. User-definable contacts are in the ENVIR ALARM IN (external alarm) and ENVIR ALARM OUT (external control) pin fields. These alarms are in the ENVIR ALARMS category; you must have the AIC card installed to use the ENVIR ALARMS. Alarm contacts are Normally Open (N/O), meaning that the system closes the alarm contacts when the corresponding alarm conditions are present. Each alarm contact consists of two wire-wrap pins on the shelf assembly backplane. Visual and audible alarm contacts are classified as critical, major, minor, and remote. Figure 1-29 on page 1-40 shows alarm pin assignments.

Visual and audible alarms are typically wired to trigger an alarm light or bell at a central alarm collection point when the corresponding contacts are closed. You can use the Alarm Cutoff pins to activate a remote ACO for audible alarms. You can also activate the ACO function by pressing the ACO button on the TCC2 card faceplate. The ACO function clears all audible alarm indications. After clearing the audible alarm indication, the alarm is still present and viewable in the Alarms tab in CTC.

1.12.2 Timing Connections

The ONS 15454 backplane supports two building integrated timing supply (BITS) clock pin fields. The first four BITS pins, rows 3 and 4, support output and input from the first external timing device. The last four BITS pins, rows 1 and 2, perform the identical functions for the second external timing device. Table 1-10 lists the pin assignments for the BITS timing pin fields.

Note For timing connection, use 100-ohm shielded BITS clock cable pair #22 or #24 AWG (0.51 mm² [0.020 inch] or 0.64 mm² [0.0252 inch]), twisted-pair T1-type.

Table 1-10 BITS External Timing Pin Assignments

External Device	Contact	Tip and Ring	Function
First external device	A3 (BITS 1 Out)	Primary ring (–)	Output to external device
	B3 (BITS 1 Out)	Primary tip (+)	Output to external device
	A4 (BITS 1 In)	Secondary ring (–)	Input from external device
	B4 (BITS 1 In)	Secondary tip (+)	Input from external device
Second external device	A1 (BITS 2 Out)	Primary ring (–)	Output to external device
	B1 (BITS 2 Out)	Primary tip (+)	Output to external device
	A2 (BITS 2 In)	Secondary ring (–)	Input from external device
	B2 (BITS 2 In)	Secondary tip (+)	Input from external device

Note Refer to Telcordia SR-NWT-002224 for rules about provisioning timing references.

1.12.3 LAN Connections

Use the LAN pins on the ONS 15454 backplane to connect the ONS 15454 to a workstation or Ethernet LAN, or to a LAN modem for remote access to the node. You can also use the LAN port on the TCC2 faceplate to connect a workstation or to connect the ONS 15454 to the network. Table 1-11 shows the LAN pin assignments.

Before you can connect an ONS 15454 to other ONS 15454s or to a LAN, you must change the default IP address that is shipped with each ONS 15454 (192.1.0.2).

Table 1-11 LAN Pin Assignments

Pin Field	Backplane Pins	RJ-45 Pins
LAN 1 Connecting to data circuit-terminating equipment (DCE[1], a hub or switch)	B2	1
	A2	2
	B1	3
	A1	6
LAN 1 Connecting to data terminal equipment (DTE) (a PC/workstation or router)	B1	1
	A1	2
	B2	3
	A2	6

1. The Cisco ONS 15454 is DCE.

1.12.4 TL1 Craft Interface Installation

You can use the craft pins on the ONS 15454 backplane or the EIA/TIA-232 port on the TCC2 faceplate to create a VT100 emulation window to serve as a TL1 craft interface to the ONS 15454. Use a straight-through cable to connect to the EIA/TIA-232 port. Table 1-12 shows the pin assignments for the CRAFT pin field.

Note You cannot use the craft backplane pins and the EIA/TIA-232 port on the TCC2 card simultaneously.

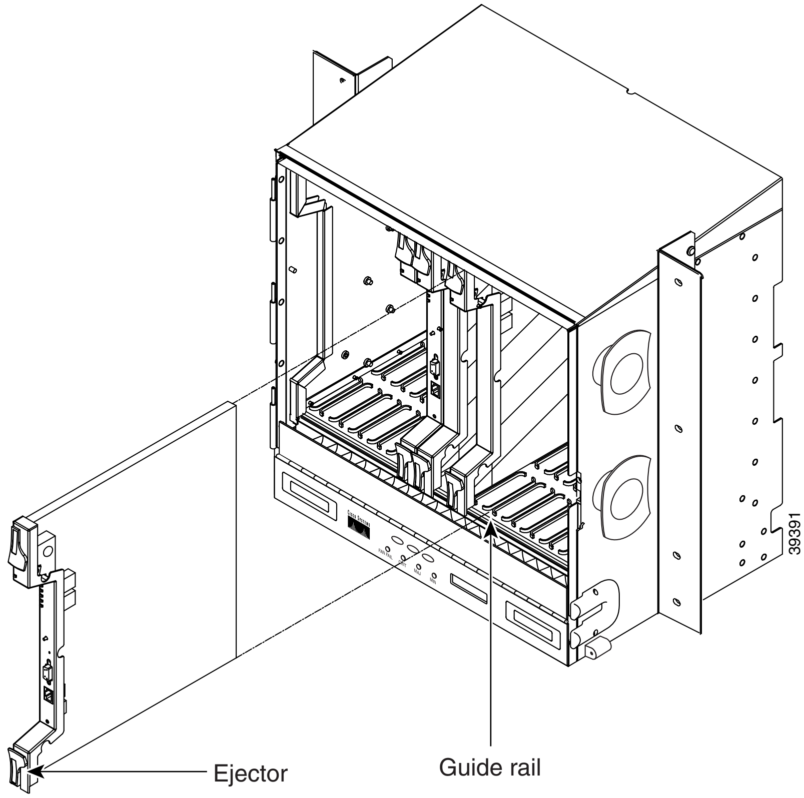
Table 1-12 Craft Interface Pin Assignments

Pin Field	Contact	Function
Craft	A1	Receive
	A2	Transmit
	A3	Ground
	A4	DTR

1.13 Cards and Slots

ONS 15454 cards have electrical plugs at the back that plug into electrical connectors on the shelf-assembly backplane. When the ejectors are fully closed, the card plugs into the assembly backplane. Figure 1-30 shows card installation.

Figure 1-30 Installing Cards in the ONS 15454



1.13.1 Card Slot Requirements

The ONS 15454 shelf assembly has 17 card slots numbered sequentially from left to right. Slots 1 to 4 and 14 to 17 can host any ONS 15454 card, except the OC48 IR 1310, OC48 LR 1550, OC48 ELR 1550, and OC192 LR 1550 cards, depending on the EIA and cross-connect card type. Slots 5, 6, 12, and 13 can host all ONS 15454 cards, except the OC12/STM4-4 and OC3-8 cards, depending on the EIA and cross-connect card type. You can install the OC48 IR/STM16 SH AS 1310 and the OC48 LR/STM16 LH AS 1550 cards in any traffic card slot.

Slots 7 and 11 are dedicated to TCC2 cards. Slots 8 and 10 are dedicated to cross-connect (XC, XCVT, XC10G) cards. Slot 9 is reserved for the optional AIC or AIC-I card. Slots 3 and 15 can also host DS1N-14 and DS3N-12 cards that are used in 1:N protection.

Caution Do not operate the ONS 15454 with a single TCC2 card or a single XC/XCVT/XC10G card installed. Always operate the shelf assembly with one working and one protect card of the same type.

Shelf assembly slots have symbols indicating the type of cards that you can install in them. Each ONS 15454 card has a corresponding symbol. The symbol on the card must match the symbol on the slot.

Table 1-13 shows the slot and card symbol definitions.

Note Protection schemes and EIA types can affect slot compatibility. Refer to "2.1.2 Card Compatibility" section on page 2-2 for more detailed compatibility information.

Table 1-13 Slot and Card Symbols

Symbol Color/Shape	Definition
Orange/Circle	Slots 1 to 6 and 12 to 17. Only install ONS 15454 cards with a circle symbol on the faceplate.
Blue/Triangle	Slots 5, 6, 12, and 13. Only install ONS 15454 cards with circle or a triangle symbol on the faceplate.
Purple/Square	TCC2 slot, Slots 7 and 11. Only install ONS 15454 cards with a square symbol on the faceplate.
Green/Cross	Cross-connect (XC/XCVT/XC10G) slot, Slots 8 and 10. Only install ONS 15454 cards with a cross symbol on the faceplate.
Red/P	Protection slot in 1:N protection schemes.
Red/Diamond	AIC/AIC-I slot, that is Slot 9. Only install ONS 15454 cards with a diamond symbol on the faceplate.
Gold/Star	Slots 1 to 4 and 14 to 17. Only install ONS 15454 cards with a star symbol on the faceplate.
Blue/Hexagon	(Only used with the 15454-SA-HD shelf assembly) Slots 3 and 15. Only install ONS 15454 cards with a blue hexagon symbol on the faceplate.

Table 1-14 lists the number of ports, line rates, connector options, and connector locations for ONS 15454 optical and electrical cards.

Table 1-14 Card Ports, Line Rates, and Connectors

Card	Ports	Line Rate per Port	Connector Types	Connector Location
DS1-14	14	1.544 Mbps	SMB w/wire wrap adapter, AMP Champ connector	Backplane
DS1N-14	14	1.544 Mbps	SMB w/wire wrap[1] adapter, AMP Champ connector	—
DS3-12	12	44.736 Mbps	SMB or BNC[1]	Backplane
DS3N-12	12	44.736 Mbps	SMB or BNC[1]	—
DS3-12E	12	44.736 Mbps	SMB or BNC[1]	Backplane
DS3N-12E	12	44.736 Mbps	SMB or BNC[1]	—
DS3XM-6	6	44.736 Mbps	SMB or BNC[1]	Backplane
EC1-12	12	51.84 Mbps	SMB or BNC[1]	Backplane

Table 1-14 Card Ports, Line Rates, and Connectors (continued)

Card	Ports	Line Rate per Port	Connector Types	Connector Location
E100T-12	12	100 Mbps	RJ-45	Faceplate
E1000-2	2	1 Gbps	SC (GBIC)	Faceplate
E100T-G	12	100 Mbps	RJ-45	Faceplate
E1000-2-G	2	1 Gbps	SC (GBIC)	Faceplate
G1000-4	4	1 Gbps	SC (GBIC)	Faceplate
G1K-4	4	1 Gbps	SC (GBIC)	Faceplate
ML100T-12	12	100 Mbps	RJ-45	Faceplate
ML1000-2	2	1 Gbps	LC (SFP)	Faceplate
OC-3 IR	4	155.52 Mbps (STS-3)	SC	Faceplate
OC3 IR/STM4 SH 1310-8	8	155.52 Mbps (STS-3)	LC	Faceplate
OC-12/STM4-4 (IR/LR)	4	622.08 Mbps (STS-12)	SC	Faceplate
OC-12 (IR/LR)	1	622.08 Mbps (STS-12)	SC	Faceplate
OC-48 (IR/LR/ELR)	1	2488.32 Mbps (STS-48)	SC	Faceplate
OC-48 AS (IR/LR)	1	2488.32 Mbps (STS-48)	SC	Faceplate
OC-48 ELR (100GHz, 200GHz)	1	2488.32 Mbps (STS-48)	SC	Faceplate
OC192 SR/STM64 IO 1310	1	9.95 Gbps (STS-192)	SC	Faceplate
OC192 IR/STM64 SH 1550	1	9.95 Gbps (STS-192)	SC	Faceplate
OC192 LR/STM64 LH 1550	1	9.95 Gbps (STS-192)	SC	Faceplate
OC192 LR/STM64 LH ITU 15xx.xx	1	9.95 Gbps (STS-192)	SC	Faceplate
TXP_MR_10G	1 (client) 1 (trunk)	9.95 Gbps (STS-192) 9.95 Gbps (STS-192)	SC SC	Faceplate
MXP_2.5G_10G	4 (client) 1 (trunk)	2488.32 Mbps (STS-48) 9.95 Gbps (STS-192)	LC SFP SC	Faceplate
FC_MR-4	4 (only 2 available in R4.6)	1.0625 Gbps	SC	Faceplate

1. When used as a protect card, the card does not have a physical external connection. The protect card connects to the working card(s) through the backplane and becomes active when the working card fails. The protect card then uses the physical connection of the failed card.

1.13.2 Card Replacement

To replace an ONS 15454 card with another card of the same type, you do not need to make any changes to the database; remove the old card and replace it with a new card. To replace a card with a card of a different type, physically remove the card and replace it with the new card, then delete the original card from CTC. For specifics, refer to the *Cisco ONS 15454 Procedure Guide.*

Caution Removing any active card from the ONS 15454 can result in traffic interruption. Use caution when replacing cards and verify that only inactive or standby cards are being replaced. If the active card needs to be replaced, switch it to standby prior to removing the card from the node. For traffic switching procedures, refer to the *Cisco ONS 15454 Procedure Guide*.

Note An improper removal (IMPROPRMVL) alarm is raised whenever a card pull (reseat) is performed, unless the card is deleted in CTC first. The alarm clears after the card replacement is complete.

Note In a path protection, pulling the active XC/XCVT/XC10G without a lockout causes path protection circuits to switch.

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

1.14 Ferrites

Place third-party ferrites on certain cables to dampen electromagnetic interference (EMI) from the ONS 15454. Ferrites must be added to meet the requirements of Telcordia GR-1089-CORE. Refer to the ferrite manufacturer documentation for proper use and installation of the ferrites. Ferrite placements on the ONS 15454 can include power cables, AMP Champ connectors, baluns, BNC/SMB connectors, and the wire-wrap pin field.

1.14 Software and Hardware Compatibility

Table 1-15 shows ONS 15454 software and hardware compatibility for systems configured with XC/XCVT cards for Releases 2.2.0, 3.0, 3.1, 3.2, 3.3, 3.4, 4.0, 4.1, and 4.6.

Note The XC10G card is not supported before Release 3.1.

Table 1-15 ONS 15454 Software and Hardware Compatibility—XC/XCVT Configurations

Hardware	2.20.0x (2.2.0)	3.00.0x (3.0)	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0) 4.1.0x (4.1)	4.6.0x (4.6)
XC[1]	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
XCVT	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
TCC	Fully compatible	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
TCC+	Fully compatible	Required	Required	Required	Required	Required	Fully compatible	Not supported
TCC2	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
AIC	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
AIC-I	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible	Fully compatible
DS1-14	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
DS1N-14	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
DS3-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
DS3N-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
DS3-12E	Supported [2]	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
DS3N-12E		Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
DS3XM-6	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
EC1-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
E100T-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
E1000-2	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
E100T-12-G	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
E1000-2-G	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
G1000-4	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
G1K-4	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Supported in Slots 5, 6, 12, 13	Supported in Slots 5, 6, 12, 13

Table 1-15 ONS 15454 Software and Hardware Compatibility—XC/XCVT Configurations (continued)

Hardware	2.20.0x (2.2.0)	3.00.0x (3.0)	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0) 4.1.0x (4.1)	4.6.0x (4.6)
ML100T-12	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Supported in Slots 5, 6, 12, 13	Supported in Slots 5, 6, 12, 13
ML1000-2	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Supported in Slots 5, 6, 12, 13	Supported in Slots 5, 6, 12, 13
OC3 IR 4/STM1 SH 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC3IR/STM 1SH 1310-8	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
OC12 IR 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC12 IR/4 1310	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
OC12 LR 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC12 LR 1550	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC48 IR 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC48 LR 1550	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC48 ELR DWDM	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC48 IR/STM16 SH AS 1310	Supported[3]		Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC48 LR/STM16 LH AS 1550			Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible
OC192 SR/STM64 IO 1310	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
OC192 IR/STM64 SH 1550	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
OC192 LH/STM64 LH 1550	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
OC192 LR/STM64 LH ITU 15xx.xx	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
TXP_MR_2.5G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported	Fully supported

Table 1-15 ONS 15454 Software and Hardware Compatibility—XC/XCVT Configurations (continued)

Hardware	2.20.0x (2.2.0)	3.00.0x (3.0)	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0) 4.1.0x (4.1)	4.6.0x (4.6)
TXPP_MR_ 2.5G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported	Fully supported
TXP_MR_ 10G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported	Fully supported
TXPP_MR_ 10G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported	Fully supported

Table 1-15 ONS 15454 Software and Hardware Compatibility—XC/XCVT Configurations (continued)

Hardware	2.20.0x (2.2.0)	3.00.0x (3.0)	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0) 4.1.0x (4.1)	4.6.0x (4.6)
MXP_2.5G_10G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported	Fully supported
FC_MR-4	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully supported

1. VT 1.5 provisioning is not supported for the XC.
2. In Software R2.2, extended features are not supported for the DS3-12E and DS3N-12E cards.
3. You must use the XC10G card (Table 1-16), the TCC+/TCC2 card, and Software R3.1 or later to enable the any slot function on the OC48 IR/STM16 SH AS 1310 and OC48 LR/STM16 LH AS 1550 cards.

Table 1-16 shows ONS 15454 software and hardware compatibility for systems configured with XC10G cards for Releases 3.1, 3.2, 3.3, 3.4, 4.0, 4.1, 4.5, and 4.6. The 15454-SA-ANSI or 15454-SA-HD shelf assembly is required to operate the XC10G card.

Table 1-16 ONS 15454 Software and Hardware Compatibility—XC10G Configurations

Hardware	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0)	4.1.0x (4.1)	4.5.0x (4.5)	4.6.0x (4.6)
TCC+	Required	Required	Required	Required	TCC+ or TCC2 required	TCC+ or TCC2 required	Not supported	Not supported
TCC2	Not supported	Not supported	Not supported	Not supported	TCC+ or TCC2 required	TCC+ or TCC2 required	Required	Required
XC10G	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
AIC	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
AIC-I	Not supported	Not supported	Not supported	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS1-14	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS1N-14	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS3-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS3N-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS3-12E	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS3N-12E	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
DS3XM-6	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible

Table 1-16 ONS 15454 Software and Hardware Compatibility—XC10G Configurations (continued)

Hardware	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0)	4.1.0x (4.1)	4.5.0x (4.5)	4.6.0x (4.6)
EC1-12	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
E100T	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
E1000	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported
E100T-12-G	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
E1000-2-G	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
G1000-4	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
G1K-4	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
ML100T-12	Not supported	Not supported	Not supported	Not supported	Fully supported	Fully supported	Not supported	Fully supported
ML1000-2	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible	Not supported	Fully compatible
OC3 IR 4/STM1 SH 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC3IR/STM1SH 1310-8	Not supported	Not supported	Not supported	Not supported	Fully compatible Slots 1-4, 14-17	Fully compatible Slots 1-4, 14-17	Not supported	Fully compatible Slots 1-4, 14-17
OC12/STM4-4	Not supported	Not supported	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC12 IR 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC12 LR 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC12 LR 1550	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC48 IR 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC48 LR 1550	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC48 ELR DWDM	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC48 IR/STM16 SH AS 1310	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC48LR/STM16 LH AS 1550	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible

Table 1-16 ONS 15454 Software and Hardware Compatibility—XC10G Configurations (continued)

Hardware	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0)	4.1.0x (4.1)	4.5.0x (4.5)	4.6.0x (4.6)
OC192 SR/STM64 IO 1310	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible	Not supported	Fully compatible
OC192 IR/STM64 SH 1550	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible	Not supported	Fully compatible
OC192 LR/STM64 LH 1550	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Fully compatible	Not supported	Fully compatible
OC192 LR/STM64 LH ITU 15xx.xx	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible	Not supported	Fully compatible
TXP_MR_10G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible
MXP_2.5G_10G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible
TXPP_MR_10G	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible
FC_MR-4	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible
MR-L1-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
MRP-L1-xx.xx	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
OSC	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
OSC-CSM	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
OPT-PRE	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
OPT-BST	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
32MUX-O	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
32DMX-O	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
4MD-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
AD-1C-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
AD-2C-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible

Table 1-16 ONS 15454 Software and Hardware Compatibility—XC10G Configurations (continued)

Hardware	3.10.0x (3.1)	3.20.0x (3.2)	3.30.0x (3.3)	3.40.0x (3.4)	4.0.0x (4.0)	4.1.0x (4.1)	4.5.0x (4.5)	4.6.0x (4.6)
AD-4C-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
AD-1B-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible
AD-4B-xx.x	Not supported	Not supported	Not supported	Not supported	Not supported	Not supported	Fully compatible	Fully compatible

If an upgrade is required for compatibility, contact the Cisco Technical Assistance Center (TAC). For contact information, go to http://www.cisco.com/tac.

CHAPTER 2

Common Control Cards

This chapter describes Cisco ONS 15454 common control card functions. For installation and turn-up procedures, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

2.1 Common Control Card Overview

The card overview section summarizes card functions and compatibility.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. See the "1.13.1 Card Slot Requirements" section on page 1-43 for a list of slots and symbols.

2.1.1 Common Control Cards

Table 2-1 lists seven common control cards for the Cisco ONS 15454 and summarizes card functions.

Table 2-1 Common Control Card Functions

Card	Description	For Additional Information...
TCC2	The TCC2 is the main processing center for the ONS 15454 and provides system initialization, provisioning, alarm reporting, maintenance, and diagnostics. It has additional features including supply voltage monitoring, support for up to 84 data communication channel/generic communication channel (DCC/GCC) terminations, and an on-card lamp test.	See the "2.2 TCC2 Card" section on page 2-7.
XC	The XC card is the central element for switching; it establishes connections and performs time division switching (TDS).	See the "2.3 XC Card" section on page 2-12.
XCVT	The XCVT card is the central element for switching; it establishes connections and performs TDS. The XCVT can manage STS and VT circuits up to 48c.	See the "2.4 XCVT Card" section on page 2-14.
XC10G	The XC10G card is the central element for switching; it establishes connections and performs TDS. The XC10G can manage STS and VT circuits up to 192c. The XC10G allows up to four times the bandwidth of XC and XCVT cards.	See the "2.5 XC10G Card" section on page 2-18.
AIC	The AIC card provides customer-defined (environmental) alarms with its additional input/output alarm contact closures. It also provides orderwire.	See the "2.6 AIC Card" section on page 2-22.
AIC-I	The AIC-I card provides customer-defined (environmental) alarms with its additional input/output alarm contact closures. It also provides orderwire, user-data channels, and supply voltage monitoring.	See the "2.7 AIC-I Card" section on page 2-26.
AEP	The AEP board provides 48 dry alarm contacts: 32 inputs and 16 outputs. It can be used with the AIC-I card.	See the "1.9 Alarm Expansion Panel" section on page 1-30.

2.1.2 Card Compatibility

This sections lists ONS 15454 cards, compatible software versions, and compatible cross-connect cards. In the tables below, "Yes" means cards are compatible with the listed software versions and cross-connect cards. Table cells with dashes mean cards are not compatible with the listed software versions or cross-connect cards.

Table 2-2 lists the Cisco Transport Controller (CTC) software release compatibility for each common-control card.

Table 2-2 Common-Control Card Software Release Compatibility

Card	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
TCC+	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	—
TCC2	—	—	—	—	—	—	—	Yes	Yes	Yes	Yes
XC	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
XCVT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
XC10G	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
AIC	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AIC-I	—	—	—	—	—	—	Yes	Yes	Yes	Yes	Yes
AEP	—	—	—	—	—	—	Yes	Yes	Yes	Yes	Yes

Table 2-3 lists the cross-connect card compatibility for each common-control card.

Table 2-3 Common-Control Card Cross-Connect Compatibility

Card	XC Card	XCVT Card	XC10G Card
TCC+	Yes	Yes	Yes
TCC2	Yes	Yes	Yes
XC	Yes	—	—
XCVT	—	Yes	—
XC10G	—	—	Yes[1]
AIC	Yes	Yes	Yes
AIC-I	Yes	Yes	Yes
AEP	Yes	Yes	Yes

1. The XC10G card requires a TCC+/TCC2 card, Software R3.1 or later, and the 15454-SA-ANSI or 15454-SA-HD shelf assembly to operate.

Table 2-4 lists the CTC software compatibility for each electrical card.

Table 2-4 Electrical Card Software Release Compatibility

Electrical Card	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
EC1-12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS1-14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS1N-14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS3-12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS3N-12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes

Table 2-4 Electrical Card Software Release Compatibility (continued)

Electrical Card	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
DS3-12E	—	Yes[1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS3N-12E	—	Yes[1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS3XM-6 (Transmux)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
DS3i-N-12	—	—	—	—	—	—	—	—	Yes (4.1.2)	—	Yes

1. Use Software R3.0 or later to enable all enhanced performance monitoring functions on the DS-3E cards. With Software R2.2.2, the DS-3E cards operate as the older DS-3 cards without enhanced performance monitoring.

Table 2-5 lists the cross-connect card compatibility for each electrical card.

Table 2-5 Electrical Card Cross-Connect Compatibility

Electrical Card	XC Card	XCVT Card	XC10G Card[1]
EC1-12	Yes	Yes	Yes
DS1-14	Yes	Yes	Yes
DS1N-14	Yes	Yes	Yes
DS3-12	Yes	Yes	Yes
DS3N-12	Yes	Yes	Yes
DS3-12E	Yes	Yes	Yes
DS3N-12E	Yes	Yes	Yes
DS3XM-6 (Transmux)	Yes	Yes	Yes
DS3i-N-12	No	Yes	Yes

1. The XC10G card requires a TCC2 card, Software R3.1 or later, and the 15454-SA-ANSI or 154545-SA-HD shelf assembly to operate.

Table 2-6 lists the CTC software compatibility for each optical card.

Table 2-6 Optical Card Software Release Compatibility

Optical Card	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
OC3 IR 4 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC3 IR 4/STM1 SH 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC3 IR /STM1 SH 1310-8	—	—	—	—	—	—	—	Yes	Yes	—	Yes
OC12 IR/STM4 SH 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC12 IR 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes

Table 2-6 Optical Card Software Release Compatibility (continued)

Optical Card	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
OC12 LR 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC12 LR 1550	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC12 LR/STM4 LH 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC12 LR/STM4 LH 1550	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC12 IR/STM4 SH 1310-4	—	—	—	—	—	Yes	Yes	Yes	Yes	—	Yes
OC48 IR 1310	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC48 LR 1550	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC48 IR/STM16 SH AS 1310[1]	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC48 LR/STM16 LH AS 1550[2]	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC48 ELR/STM16 EH 100 GHz	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC48 ELR 200 GHz	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC192 SR/STM64 IO 1310	—	—	—	—	—	—	—	Yes	Yes	—	Yes
OC192 IR/STM64 SH 1550	—	—	—	—	—	—	—	Yes	Yes	—	Yes
OC192 LR/STM64 LH 1550	—	—	—	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
OC192 LR/STM64 LH ITU 15xx.xx	—	—	—	—	—	—	—	Yes	Yes	—	Yes
TXP_MR_ 10G	—	—	—	—	—	—	—	Yes	Yes	Yes	Yes
MXP_2.5G_10G	—	—	—	—	—	—	—	Yes	Yes	Yes	Yes
TXP_MR_2.5G	—	—	—	—	—	—	—	Yes	Yes	Yes	Yes
TXPP_MR_2.5G	—	—	—	—	—	—	—	Yes	Yes	Yes	Yes
FC_MR-4[3]	—	—	—	—	—	—	—	—	—	—	Yes

1. To enable OC-192 and OC-48 any-slot card operation, use the XC10G card, the TCC+/TCC2 card, Software R3.1 or later, and the 15454-SA-ANSI or 154545-SA-HD shelf assembly. Do not pair an XC or XCVT with an XC10G.
2. To enable OC-192 and OC-48 any-slot card operation, use the XC10G card, the TCC+/TCC2 card, Software R3.1 or later, and the 15454-SA-ANSI or 154545-SA-HD shelf assembly. Do not pair an XC or XCVT with an XC10G.
3. The FC_MR-4 card requires an XC10G card; it is not compatible with the XC or XCVT.

Table 2-7 lists the cross-connect card compatibility for each optical card.

Table 2-7 Optical Card Cross-Connect Compatibility

Optical Card	XC Card	XCVT Card	XC10G Card[1]
OC3 IR 4 1310	Yes	Yes	Yes
OC3 IR 4/STM1 SH 1310	Yes	Yes	Yes

Table 2-7 Optical Card Cross-Connect Compatibility (continued)

Optical Card	XC Card	XCVT Card	XC10G Card[1]
OC3 IR /STM1SH 1310-8	—	—	Yes
OC12 IR 1310	Yes	Yes	Yes
OC12 LR 1310	Yes	Yes	Yes
OC12 LR 1550	Yes	Yes	Yes
OC12 IR/STM4 SH 1310	Yes	Yes	Yes
OC12 LR/STM4 LH 1310	Yes	Yes	Yes
OC12 LR/STM4 LH 1550	Yes	Yes	Yes
OC12 IR/STM4 SH 1310-4	—	—	Yes
OC48 IR 1310	Yes	Yes	Yes
OC48 LR 1550	Yes	Yes	Yes
OC48 IR/STM16 SH AS 1310	Yes (R3.2 and later in Slots 5, 6, 12, 13)	Yes (R3.2 and later in Slots 5, 6, 12, 13)	Yes
OC48 LR/STM16 LH AS 1550	Yes (R3.2 and later in Slots 5, 6, 12, 13)	Yes (R3.2 and later in Slots 5, 6, 12, 13)	Yes
OC48 ELR/STM16 EH 100 GHz	Yes	Yes	Yes
OC48 ELR 200 GHz	Yes	Yes	Yes
OC192 SR/STM64 IO 1310	—	—	Yes
OC192 IR/STM64 SH 1550	—	—	Yes
OC192 LR/STM64 LH 1550	—	—	Yes
OC192 LR/STM64 LH ITU 15xx.xx	—	—	Yes
TXP_MR_ 10G	Yes	Yes	Yes
MXP_2.5G_10G	Yes	Yes	Yes
TXP_MR_2.5G	Yes	Yes	Yes
TXPP_MR_2.5G	Yes	Yes	Yes
FC_MR_4	—	Yes (only in trunk slots, for operation in Fiber Channel mode only)	Yes

1. The XC10G card requires a TCC+/TCC2 card, Software R3.1 or later , and the 15454-SA-ANSI or 15454-SA-HD shelf assembly to operate.

Table 2-8 lists the CTC software compatibility for each Ethernet card.

Table 2-8 Ethernet Card Software Compatibility

Ethernet Cards	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
E100T-12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
E1000-2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
E100T-G	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes

Table 2-8 Ethernet Card Software Compatibility (continued)

Ethernet Cards	R2.2.1	R2.2.2	R3.0.1	R3.1	R3.2	R3.3	R3.4	R4.0	R4.1	R4.5	R4.6
E1000-2-G	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
G1000-4	—	—	—	—	Yes	Yes	Yes	Yes	Yes	—	Yes
G1K-4	—	—	—	—	Yes	Yes	Yes	Yes	Yes	—	Yes
ML100T-12	—	—	—	—	—	—	—	Yes	Yes	—	Yes
ML1000-2	—	—	—	—	—	—	—	Yes	Yes	—	Yes

Table 2-9 lists the cross-connect card compatibility for each Ethernet card.

Table 2-9 Ethernet Card Cross-Connect Compatibility

Ethernet Cards	XC Card	XCVT Card	XC10G Card[1]
E100T-12	Yes	Yes	—
E1000-2	Yes	Yes	—
E100T-G	Yes	Yes	Yes
E1000-2-G	Yes	Yes	Yes
G1000-4	—	—	Yes
G1K-4	Yes, in Slots 5, 6, 12, 13	Yes, in Slots 5, 6, 12, 13	Yes
ML100T-12	Yes, in Slots 5, 6, 12, 13	Yes, in Slots 5, 6, 12, 13	Yes
ML1000-2	Yes, in Slots 5, 6, 12, 13	Yes, in Slots 5, 6, 12, 13	Yes

1. The XC10G card requires a TCC+/TCC2 card, Software R3.1 or later and the 15454-SA-ANSI or 154545-SA-HD shelf assembly to operate.

DWDM cards are compatible with Software R4.5 and 4.6. In Software R4.5, DWDM cards are not compatible with XC, XCVT, or XC10G cards.

2.2 TCC2 Card

The Advanced Timing Communications and Control (TCC2) card performs system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection/resolution, SONET section overhead (SOH) data communication channel/generic communication channel (DCC/GCC) termination, and system fault detection for the ONS 15454. The TCC2 also ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing requirements. It monitors the supply voltage of the system.

Note The TCC2 card requires Software Release 4.0.0 or later.

Note The LAN interface of the TCC2 card meets the standard Ethernet specifications by supporting a cable length of 328 ft (100 m) at temperatures from 32 to 149 degrees Fahrenheit (0 to 65 degrees Celsius). The interfaces can operate with a cable length of 32.8 ft (10 m) maximum at temperatures from –40 to 32 degrees Fahrenheit (–40 to 0 degrees Celsius).

Figure 2-1 shows the TCC2 faceplate.

Figure 2-1 TCC2 Faceplate

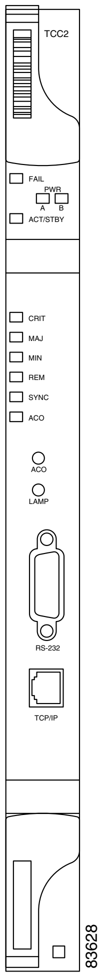
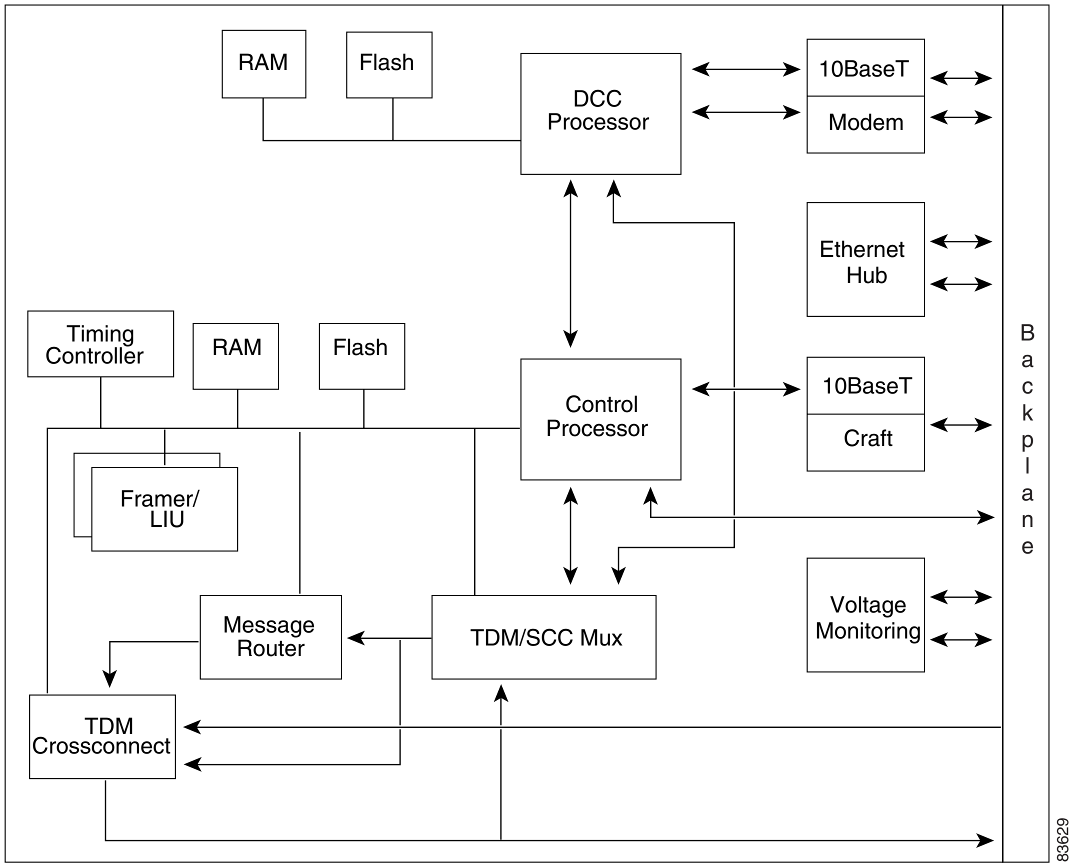


Figure 2-2 shows a block diagram of the card.

Figure 2-2 TCC2 Block Diagram



2.2.1 TCC2 Functionality

The TCC2 card supports multichannel, high-level data link control (HDLC) processing for the DCC. Up to 32 DCCs can be routed over the TCC2 card and up to 32 DCCs can be terminated at the TCC2 card (subject to the available optical digital communication channels). The TCC2 selects and processes 32 DCCs to facilitate remote system management interfaces. The TCC2 hardware is prepared for 84 DCCs, which will be available in a future software release.

The TCC2 also originates and terminates a cell bus carried over the module. The cell bus supports links between any two cards in the node, which is essential for peer-to-peer communication. Peer-to-peer communication accelerates protection switching for redundant cards.

The node database, IP address, and system software are stored in TCC2 nonvolatile memory, which allows quick recovery in the event of a power or card failure.

The TCC2 performs all system-timing functions for each ONS 15454. The TCC2 monitors the recovered clocks from each traffic card and two BITS ports for frequency accuracy. The TCC2 selects a recovered clock, a BITS, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as primary or secondary timing sources. A slow-reference tracking loop allows the TCC2 to synchronize with the recovered clock, which provides holdover if the reference is lost.

The TCC2 monitors both supply voltage inputs on the shelf. An alarm is generated if one of the supply voltage inputs has a voltage out of the specified range.

Install TCC2 cards in Slots 7 and 11 for redundancy. If the active TCC2 fails, traffic switches to the protect TCC2. All TCC2 protection switches conform to protection switching standards when the bit error rate (BER) counts are not in excess of 1 * 10 exp – 3 and completion time is less than 50 ms.

The TCC2 card has two built-in interface ports for accessing the system: an RJ-45 10baseT LAN interface and an EIA/TIA-232 ASCII interface for local craft access. It also has a 10baseT LAN port for user interfaces via the backplane.

Note Cisco does not support operation of the ONS 15454 with only one TCC2 card. For full functionality and to safeguard your system, always operate with two TCC2 cards.

Note When a second TCC2 card is inserted into a node, it synchronizes its software, its backup software, and its database with the active TCC2. If the software version of the new TCC2 does not match the version on the active TCC2, the newly inserted TCC2 copies from the active TCC2, taking about 15 to 20 minutes to complete. If the backup software version on the new TCC2 does not match the version on the active TCC2, the newly inserted TCC2 copies the backup software from the active TCC2 again, taking about 15 to 20 minutes. Copying the database from the active TCC2 takes about 3 minutes. Depending on the software version and backup version the new TCC2 started with, the entire process can take between 3 and 40 minutes.

2.2.2 TCC2 Card-Level Indicators

The TCC2 faceplate has eight LEDs. Table 2-10 describes the two card-level LEDs on the TCC2 faceplate.

Table 2-10 TCC2 Card-Level Indicators

Card-Level LEDs	Definition
Red FAIL LED	This LED is on during reset. The FAIL LED flashes during the boot and write process. Replace the card if the FAIL LED persists.
ACT/STBY LED Green (Active) Yellow (Standby)	Indicates the TCC2 is active (green) or in standby (yellow) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TCC2 is writing to its database or to the standby TCC2 database, the card LEDs blink. To avoid memory corruption, do not remove the TCC2 when the active or standby LED is blinking.

2.2.3 Network-Level Indicators

Table 2-11 describes the six network-level LEDs on the TCC2 faceplate.

Table 2-11 TCC2 Network-Level Indicators

System-Level LEDs	Definition
Red CRIT LED	Indicates critical alarms in the network at the local terminal.
Red MAJ LED	Indicates major alarms in the network at the local terminal.
Yellow MIN LED	Indicates a minor alarm in the network at the local terminal.

Table 2-11 TCC2 Network-Level Indicators (continued)

System-Level LEDs	Definition
Red REM LED	Provides first-level alarm isolation. The remote (REM) LED turns red when an alarm is present in one or more of the remote terminals.
Green SYNC LED	Indicates that node timing is synchronized to an external reference.
Green ACO LED	After pressing the ACO button, the ACO LED turns green. The ACO button opens the audible alarm closure on the backplane. ACO is stopped if a new alarm occurs. After the originating alarm is cleared, the ACO LED and audible alarm control are reset.

2.2.4 TCC2 Card Specifications

The TCC2 card has the following specifications:

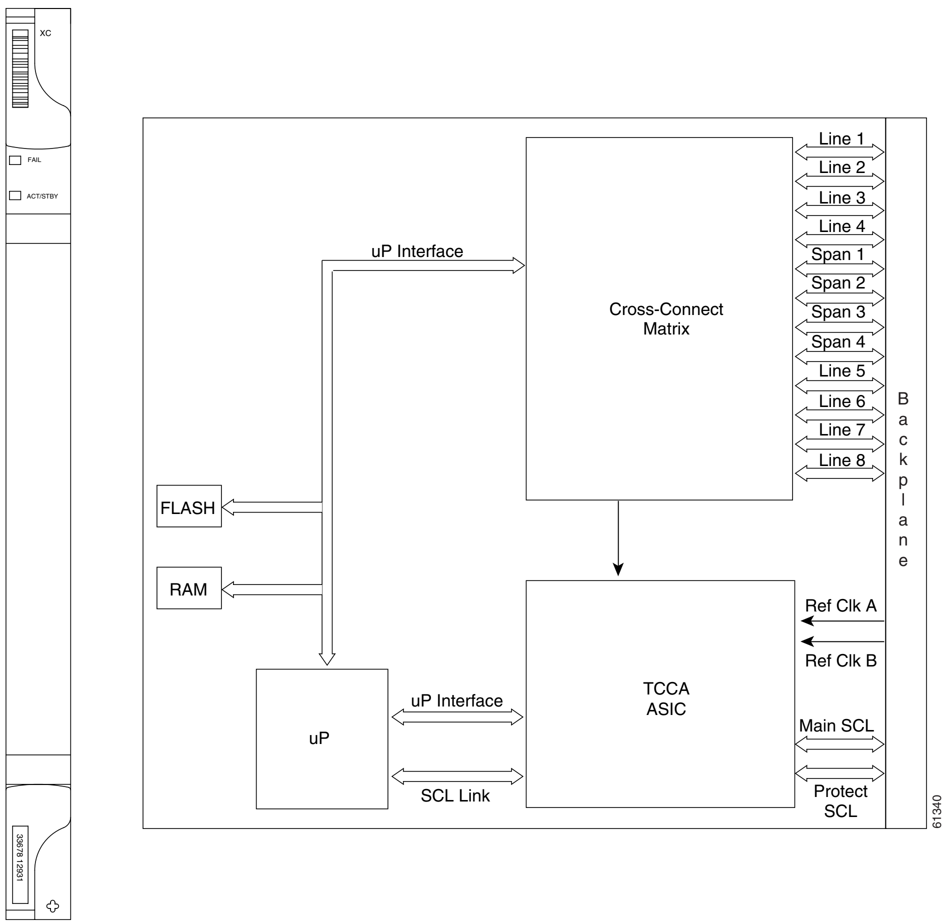
- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TCC2 faceplate)
  - Interface: 10baseT LAN (on TCC2 faceplate)
  - Interface: 10baseT LAN (via backplane)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/–4.6 ppm
  - Holdover stability: 3.7 * 10 exp – 7 per day including temperature (< 255 slips in first 24 hours)
  - Reference: External BITS, line, internal
- Supply voltage monitoring
  - Both supply voltage inputs are monitored.
  - Normal operation: –40.5 to –56.7 V
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Environmental
  - Operating temperature: –40 to +149 degrees Fahrenheit (–40 to +65 degrees Celsius)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 26.00 W, 0.54 A at –48 V, 88.8 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 235 mm (9.250 in.)
  - Weight not including clam shell: 0.7 kg (1.5 lb)

- Compliance: For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

2.3 XC Card

The cross-connect (XC) card is the central element for ONS 15454 switching. Available cross-connect cards are the XC, XCVT, and XC10G cards. The XC establishes connections and performs time division switching (TDS) at the STS-1 level between ONS 15454 traffic cards. Figure 2-3 shows the XC card faceplate and block diagram.

Figure 2-3 XC Card Faceplate and Block Diagram

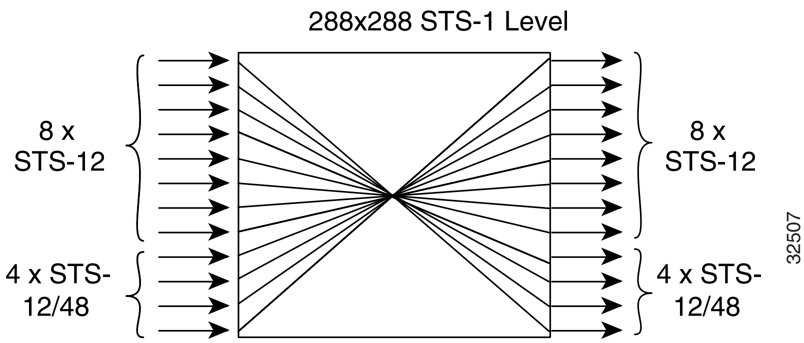


2.3.1 XC Functionality

The switch matrix on the XC card consists of 288 bidirectional ports (Figure 2-4).When creating bidirectional STS-1 cross-connects, each cross-connect uses two STS-1 ports. This results in 144 bidirectional STS-1 cross-connects. The switch matrix is fully crosspoint and broadcast supporting. Any

STS-1 on any port can be connected to any other port, meaning that the STS cross-connections are nonblocking. Network operators can concentrate or groom low-speed traffic from traffic cards onto high-speed transport spans and drop low-speed traffic from transport spans onto traffic cards.

Figure 2-4 XC Cross-Connect Matrix



The XC card has 12 input ports and 12 output ports. Four input and output ports operate at either STS-12 or STS-48 rates. The remaining eight input and output ports operate at the STS-12 rate. An STS-1 on any of the input ports can be mapped to an STS-1 output port, thus providing full STS-1 time slot assignments (TSA).

The XC card works with the TCC2 card to maintain connections and set up cross-connects within the ONS 15454. The XC, XCVT, or XC10G is required to operate the ONS 15454. You establish cross-connect and provisioning information through CTC. The TCC2 establishes the proper internal cross-connect information and relays the setup information to the cross-connect card.

Caution Do not operate the ONS 15454 with only one XC, XCVT, or XC10G card. Two cross-connect cards of the same type (either two XC, two XCVT, or two XC10G cards) must always be installed.

The card has no external interfaces. All cross-connect card interfaces are provided through the ONS 15454 backplane.

2.3.2 XC Card-Level Indicators

Table 2-12 describes the two card-level LEDs on the XC faceplate.

Table 2-12 XC Card-Level Indicators

Card-Level Indicators	Definition
Red FAIL LED	Indicates that the card's processor is not ready. If the FAIL LED persists, replace the card.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	Indicates whether the XC card is active and carrying traffic (green) or in standby mode as a protect card (amber).

2.3.3 XC Card Specifications

The XC card has the following specifications:

- Cross-connect functionality
  - Connection setup time: 5 ms
  - Latency: 270 ns
- Environmental
  - Operating temperature:

    C-Temp (15454-XC): 32 to 131 degrees Fahrenheit (0 to +55 degrees Celsius)

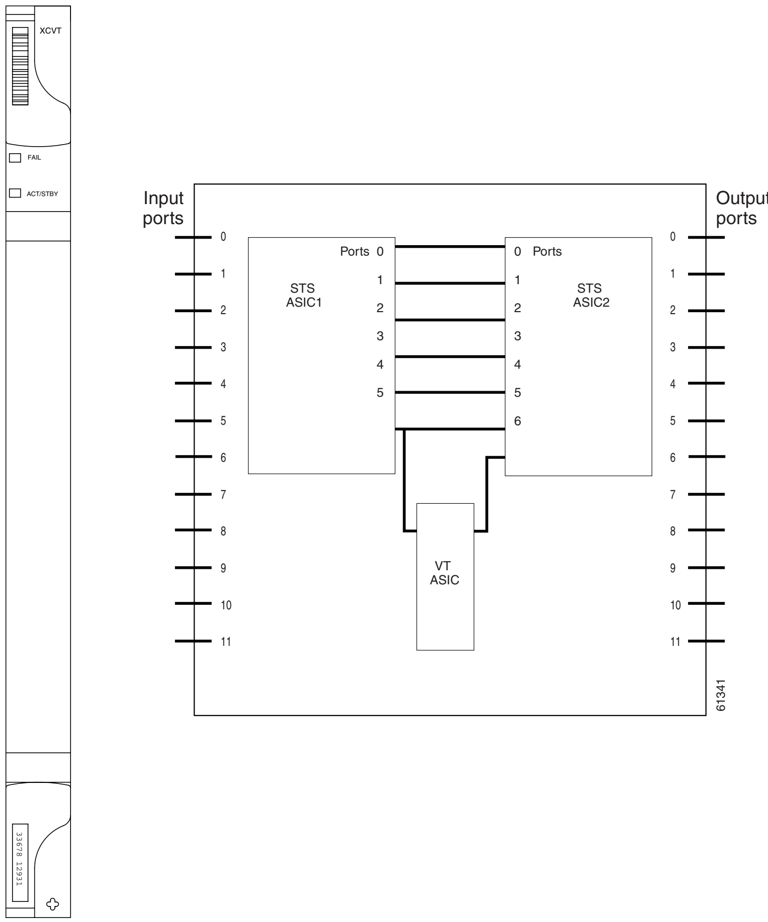
    I-Temp (15454-XC-T): –40 to 149 degrees Fahrenheit (–40 to +65 degrees Celsius)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 29 W, 0.6 A, 99 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Card weight: 1.5 lb (0.7 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

2.4 XCVT Card

The XCVT card provides the same STS capability as a standard XC card and also provides VT cross-connection. The XCVT provides nonblocking STS-48 capacity to Slots 5, 6, 12, and 13, and nonbidirectional blocking STS-12 capacity to Slots 1 to 5 and 14 to 17. Any STS-1 on any port can be connected to any other port, meaning that the STS cross-connections are nonblocking.

Figure 2-5 shows the XCVT faceplate and block diagram.

Figure 2-5 XCVT Faceplate and Block Diagram



2.4.1 XCVT Functionality

The STS-1 switch matrix on the XCVT card consists of 288 bidirectional ports and adds a VT matrix that can manage up to 336 bidirectional VT1.5 ports or the equivalent of a bidirectional STS-12. The VT1.5-level signals can be cross connected, dropped, or rearranged. The TCC2 assigns bandwidth to each slot on a per STS-1 or per VT1.5 basis. The switch matrices are fully crosspoint and broadcast supporting.

The XCVT card provides:

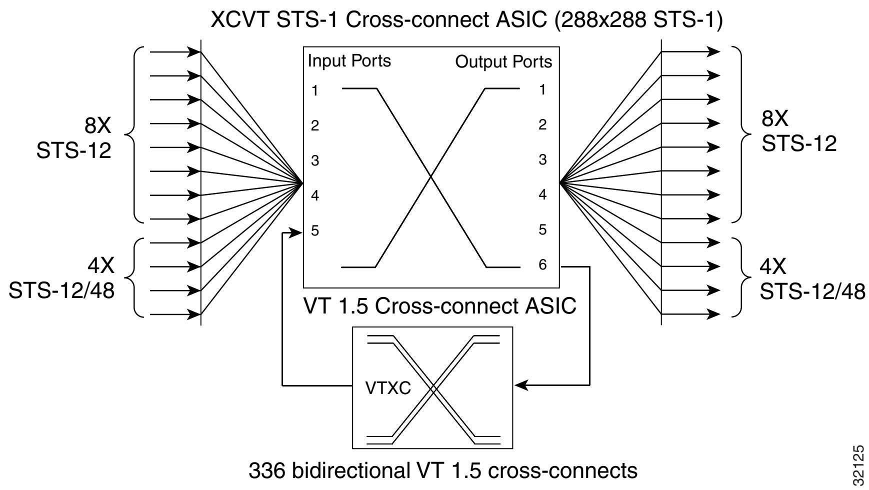
- 288 STS bidirectional ports
- 144 STS bidirectional cross-connects
- 672 VT1.5 ports via 24 logical STS ports
- 336 VT1.5 bidirectional cross-connects
- Nonblocking at the STS level
- STS-1/3c/6c/12c/48c cross-connects

The XCVT card works with the TCC2 card to maintain connections and set up cross-connects within the node. The XCVT, XC10G, or XC is required to operate the ONS 15454. You can establish cross-connect (circuit) information through CTC. The TCC2 establishes the proper internal cross-connect information and relays the setup information to the XCVT card.

Caution Do not operate the ONS 15454 with only one XC, XCVT, or XC10G card. Two cross-connect cards of the same type (either two XC, two XCVT, or two XC10G cards) must always be installed.

Figure 2-6 shows the cross-connect matrix.

Figure 2-6 XCVT Cross-Connect Matrix



2.4.2 VT Mapping

The VT structure is designed to transport and switch payloads below the DS-3 rate. The ONS 15454 performs Virtual Tributary (VT) mapping according to Telcordia GR-253-CORE standards. Table 2-13 shows the VT numbering scheme for the ONS 15454 as it relates to the Telcordia standard.

Table 2-13 VT Mapping

ONS 15454 VT Number	Telcordia Group/VT Number
VT1	Group1/VT1
VT2	Group2/VT1
VT3	Group3/VT1
VT4	Group4/VT1
VT5	Group5/VT1
VT6	Group6/VT1
VT7	Group7/VT1
VT8	Group1/VT2
VT9	Group2/VT2

Table 2-13 VT Mapping (continued)

ONS 15454 VT Number	Telcordia Group/VT Number
VT10	Group3/VT2
VT11	Group4/VT2
VT12	Group5/VT2
VT13	Group6/VT2
VT14	Group7/VT2
VT15	Group1/VT3
VT16	Group2/VT3
VT17	Group3/VT3
VT18	Group4/VT3
VT19	Group5/VT3
VT20	Group6/VT3
VT21	Group7/VT3
VT22	Group1/VT4
VT23	Group2/VT4
VT24	Group3/VT4
VT25	Group4/VT4
VT26	Group5/VT4
VT27	Group6/VT4
VT28	Group7/VT4

2.4.3 XCVT Hosting DS3XM-6

A single DS3XM-6 can demultiplex (map down to a lower rate) six DS-3 signals into 168 VT1.5s that the XCVT card manages and cross connects. XCVT cards host a maximum of 336 bidirectional VT1.5s. In most network configurations, two DS3XM-6 cards are paired as working and protect cards.

2.4.4 XCVT Card-Level Indicators

Table 2-14 shows the two card-level LEDs on the XCVT card faceplate.

Table 2-14 XCVT Card-Level Indicators

Card-Level Indicators	Definition
Red FAIL LED	Indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	Indicates whether the XCVT card is active and carrying traffic (green) or in standby mode to the active XCVT card (amber).

2.4.5 XC/XCVT Compatibility

The XCVT card is compatible with the XC cards. The XCVT card supports run-time compatibility with the XC cross-connect both within a single node and within a ring of mixed XCVT and XC nodes. However, working and protect cards within a single ONS 15454 must be either two XC cards or two XCVT cards.

The XC and XCVT cards are supported in path protection and bidirectional line switched ring (BLSR) configurations. VT and STS-level cross-connect and protection management are also supported in either type of ring. Nodes that rearrange or drop VTs must use an XCVT. Nodes that only rearrange or drop STSs can use an XC. You do not need to upgrade STS-only nodes to XCVT in a ring that can handle both VT and STS drop/rearrangement.

When upgrading from XC to XCVT cards, the first XCVT card installed acts as an XC card until the second XCVT card is installed.

2.4.6 XCVT Card Specifications

The XCVT card has the following specifications:

- Environmental
  - Operating temperature:

    C-Temp (15454-XC-VT): 32 to 131 degrees Fahrenheit (0 to +55 degrees Celsius)

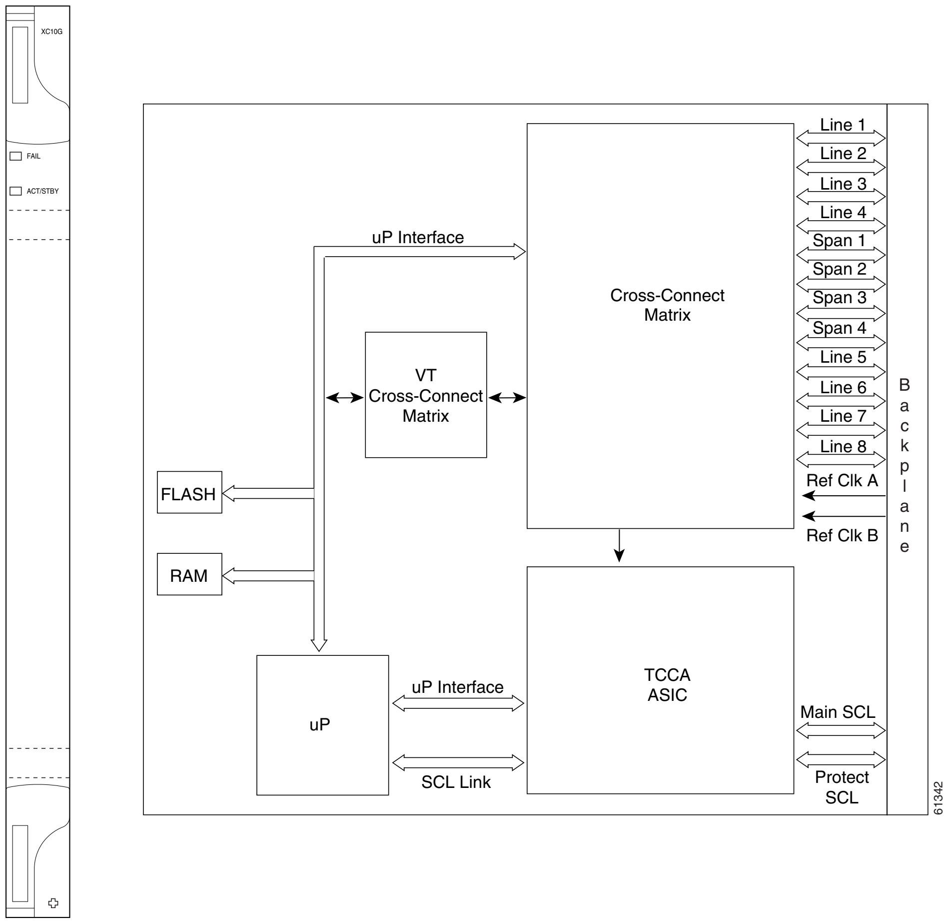
    I-Temp (15454-XC-VT-T): –40 to 149 degrees Fahrenheit (–40 to +65 degrees Celsius)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 34.40 W, 0.72 A, 117.46 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Card weight: 1.9 lb (0.8 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

2.5 XC10G Card

The XC10G card cross connects STS-12, STS-48, and STS-192 signal rates. The XC10G allows up to four times the bandwidth of the XC and XCVT cards. The XC10G provides a maximum of 576 STS-1 cross-connections through 1152 STS-1 ports. Any STS-1 on any port can be connected to any other port, meaning that the STS cross-connections are nonblocking.

Figure 2-7 shows the XC10G faceplate and block diagram.

Figure 2-7 XC10G Faceplate and Block Diagram



2.5.1 XC10G Functionality

The XC10G card manages up to 672 bidirectional VT1.5 ports and 1152 bidirectional STS-1 ports. The TCC2 assigns bandwidth to each slot on a per STS-1 or per VT1.5 basis.

The XC10G, XCVT, or XC is required to operate the ONS 15454. You can establish cross-connect (circuit) information through the Cisco Transport Controller (CTC). The TCC2 establishes the proper internal cross-connect information and sends the setup information to the cross-connect card.

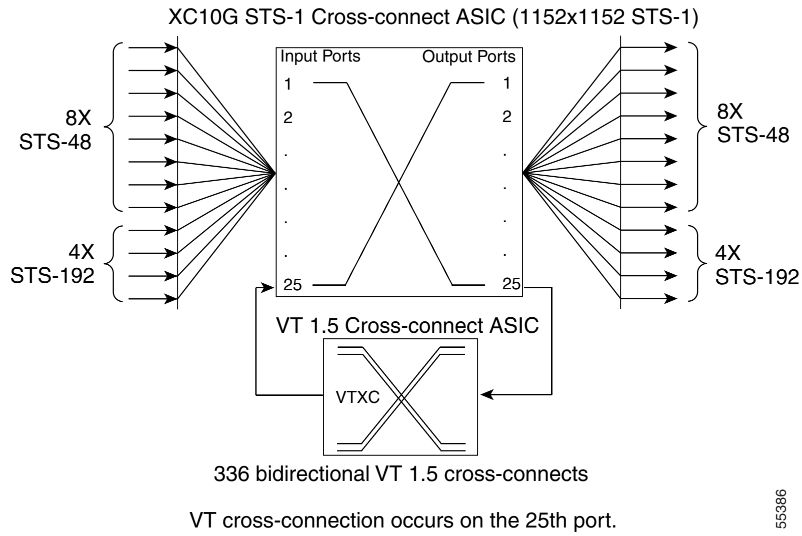
The XC10G card provides:

- 1152 STS bidirectional ports
- 576 STS bidirectional cross-connects
- 672 VT1.5 ports via 24 logical STS ports
- 336 VT1.5 bidirectional cross-connects
- Nonblocking at STS level
- STS-1/3c/6c/12c/48c/192c cross-connects

Caution Do not operate the ONS 15454 with only one XC, XCVT, or XC10G card. Two cross-connect cards of the same type (either two XC, two XCVT, or two XC10G cards) must always be installed.

Figure 2-8 shows the cross-connect matrix.

Figure 2-8 XC10G Cross-Connect Matrix



2.5.2 VT Mapping

The VT structure is designed to transport and switch payloads below the DS-3 rate. The ONS 15454 performs VT mapping according to Telcordia GR-253-CORE standards. Table 2-15 shows the VT numbering scheme for the ONS 15454 as it relates to the Telcordia standard.

Table 2-15 VT Mapping

ONS 15454 VT Number	Telcordia Group/VT Number
VT1	Group1/VT1
VT2	Group2/VT1
VT3	Group3/VT1
VT4	Group4/VT1
VT5	Group5/VT1
VT6	Group6/VT1
VT7	Group7/VT1
VT8	Group1/VT2
VT9	Group2/VT2
VT10	Group3/VT2
VT11	Group4/VT2

Table 2-15 VT Mapping (continued)

ONS 15454 VT Number	Telcordia Group/VT Number
VT12	Group5/VT2
VT13	Group6/VT2
VT14	Group7/VT2
VT15	Group1/VT3
VT16	Group2/VT3
VT17	Group3/VT3
VT18	Group4/VT3
VT19	Group5/VT3
VT20	Group6/VT3
VT21	Group7/VT3
VT22	Group1/VT4
VT23	Group2/VT4
VT24	Group3/VT4
VT25	Group4/VT4
VT26	Group5/VT4
VT27	Group6/VT4
VT28	Group7/VT4

2.5.3 XC10G Hosting DS3XM-6

A single DS3XM-6 can demultiplex (map down to a lower rate) six DS-3 signals into 168 VT1.5s that the XC10G card manages and cross connects. XC10G cards host a maximum of 336 bidirectional VT1.5 ports. In most network configurations two DS3XM-6 cards are paired as working and protect cards.

2.5.4 XC10G Card-Level Indicators

Table 2-16 describes the two card-level LEDs on the XC10G faceplate.

Table 2-16 XC10G Card-Level Indicators

Card-Level Indicators	Definition
Red FAIL LED	Indicates that the card's processor is not ready. This LED illuminates during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	Indicates whether the XC10G is active and carrying traffic (green), or in standby mode to the active XC10G card (amber).

2.5.5 XC/XCVT/XC10G Compatibility

The XC10G supports the same features as the XC and XCVT cards. The XC10G card is required for OC-192 operation and OC-48 any-slot operation. Do not use the XCVT or XC cards if you are using the OC-192 card, or if you install an OC-48 any-slot cards in Slots 1 to 4 or 14 to 17.

Note A configuration mismatch alarm occurs when an XC or XCVT cross-connect card co-exists with an OC-192 card placed in Slots 5, 6, 12, or 13, or with an OC-48 card placed in Slots 1 to 4 or 14 to 17.

The TCC2 card, Software R3.1 or later, and the 15454-SA-ANSI or 15454-SA-HD shelf assembly are required for the operation of the XC10G. If you are using Ethernet cards, the E1000-2-G or the E100T-G must be used when the XC10G cross-connect card is in use. Do not pair an XC or XCVT with an XC10G. When upgrading from XC or XCVT to the XC10G card, refer to the *Cisco ONS 15454 Procedure Guide* for more information.

The upgrade procedure from the XC/XCVT cards to the XC10G card only applies to XC/XCVT cards that are installed in the 15454-SA-ANSI or 15454-SA-HD (Software R3.1 and later). You cannot perform this upgrade from shelves released prior to Software R3.1.

2.5.6 XC10G Card Specifications

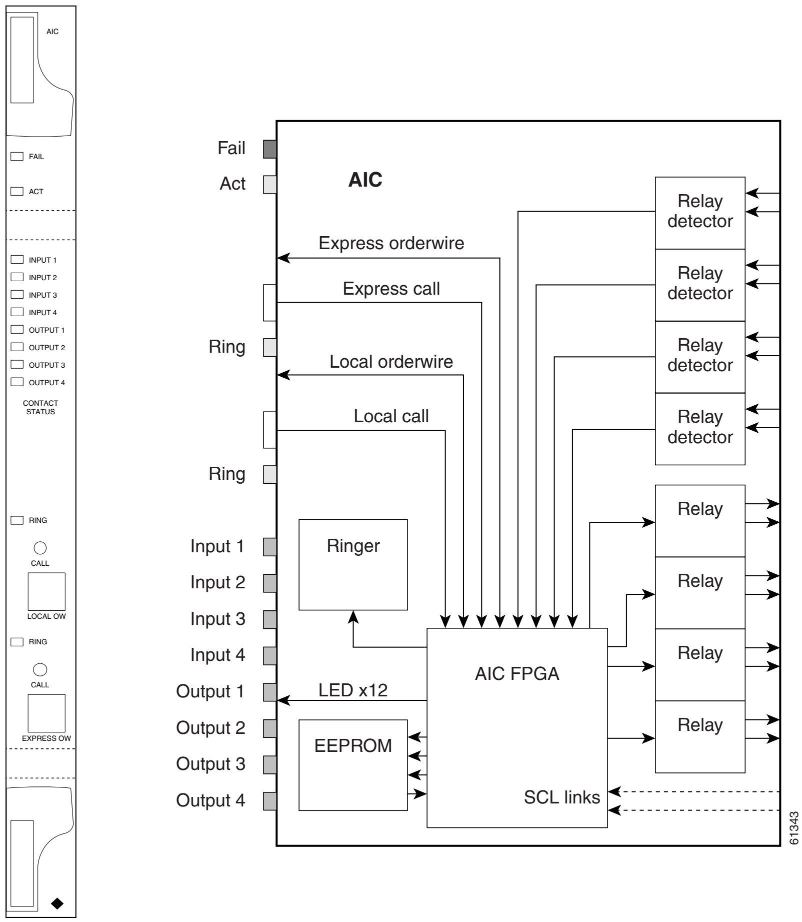
The XC10G card has the following specifications:

- Environmental
  - Operating temperature:
    C-Temp (15454-XC-10G): 32 to 131 degrees Fahrenheit (0 to +55 degrees Celsius)
  - Operating humidity: 5 to 85%, noncondensing
  - Power consumption: 48 W, 1.64 A, 268.4 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Card weight: 1.5 lb (0.6 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

2.6 AIC Card

The optional Alarm Interface Controller (AIC) card provides customer-defined alarm input/output (I/O) and supports local and express orderwire. Figure 2-9 shows the AIC faceplate and a block diagram of the card.

Figure 2-9 AIC Faceplate and Block Diagram



2.6.1 External Alarms and Controls

The AIC card provides provisionable input/output alarm contact closures for up to four external alarms and four external controls. The physical connections are made using the backplane wire-wrap pins. The alarms are defined using CTC and TL1. For instructions, refer to the *Cisco ONS 15454 Procedure Guide*.

Each alarm contact has a corresponding LED on the front panel of the AIC that indicates the status of the alarm. External alarms (input contacts) are typically used for external sensors such as open doors, temperature sensors, flood sensors, and other environmental conditions. External controls (output contacts) are typically used to drive visual or audible devices such as bells and lights, but they can control other devices such as generators, heaters, and fans.

You can program each of the four input alarm contacts separately. Choices include:

- Alarm on Closure or Alarm on Open
- Alarm severity of any level (Critical, Major, Minor, Not Alarmed, Not Reported)
- Service Affecting or Non-Service Affecting alarm-service level

- 63-character alarm description for CTC display in the alarm log. You cannot assign the fan-tray abbreviation for the alarm; the abbreviation reflects the generic name of the input contacts. The alarm condition remains raised until the external input stops driving the contact or you provision the alarm input.

The output contacts can be provisioned to close on a trigger or to close manually. The trigger can be a local alarm severity threshold, a remote alarm severity, or a virtual wire:

- Local NE alarm severity: A hierarchy of non-reported, non-alarmed, minor, major or critical alarm severities that you set to cause output closure. For example, if the trigger is set to minor, a minor alarm or above is the trigger.
- Remote NE alarm severity: Same as the Local NE alarm severity but applies to remote alarms only.
- Virtual wire entities: You can provision any environmental alarm input to raise a signal on any virtual wire on external outputs 1 through 4 when the alarm input is an event. You can provision a signal on any virtual wire as a trigger for an external control output.

You can also program the output alarm contacts (external controls) separately. In addition to provisionable triggers, you can manually force each external output contact to open or close. Manual operation takes precedence over any provisioned triggers that might be present.

2.6.2 Orderwire

Orderwire allows a craftsperson to plug a phoneset into an ONS 15454 and communicate with craftspeople working at other ONS 15454s or other facility equipment. The orderwire is a pulse code modulation (PCM) encoded voice channel that uses E1 or E2 bytes in section/line overhead.

The AIC allows simultaneous use of both local (section overhead signal) and express (line overhead channel) orderwire channels on a SONET ring or particular optics facility. Local orderwire also allows communication at regeneration sites when the regenerator is not a Cisco device.

You can provision orderwire functions with CTC similar to the current provisioning model for DCC/GCC channels. In CTC you provision the orderwire communications network during ring turn-up so that all NEs on the ring can reach one another. Orderwire terminations (that is, the optics facilities that receive and process the orderwire channels) are provisionable. Both express and local orderwire can be configured as on or off on a particular SONET facility. The ONS 15454 supports up to four orderwire channel terminations per shelf, which allow linear, single ring, dual ring, and small hub-and-spoke configurations. Orderwire is not protected in ring topologies such as BLSR and path protection.

Caution Do not configure orderwire loops. Orderwire loops cause feedback that disables the orderwire channel.

The ONS 15454 implementation of both local and express orderwire is broadcast in nature. The line acts as a party line. There is no signaling for private point-to-point connections. Anyone who picks up the orderwire channel can communicate with all other participants on the connected orderwire subnetwork. The local orderwire party line is separate from the express orderwire party line. Up to four OC-N facilities for each local and express orderwire are provisionable as orderwire paths.

The AIC supports a “call” button on the module front panel which, when pressed, causes all ONS 15454 AICs on the orderwire subnetwork to “ring.” The ringer/buzzer resides on the AIC. There is also a “ring” LED that mimics the AIC ringer. It flashes when any “call” button is pressed on the orderwire subnetwork. The “call” button and ringer LED allow a remote craftsperson to get the attention of craftspeople across the network.

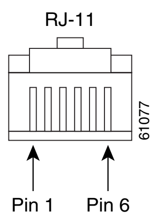
Table 2-17 shows the pins on the orderwire ports that correspond to the tip and ring orderwire assignments.

Table 2-17 Orderwire Pin Assignments

RJ-11 Pin Number	Description
1	Four-wire receive ring
2	Four-wire transmit tip
3	Two-wire ring
4	Two-wire tip
5	Four-wire transmit ring
6	Four-wire receive tip

When provisioning the orderwire subnetwork, make sure that an orderwire loop does not exist. Loops cause oscillation and an unusable orderwire channel. Figure 2-10 shows the standard RJ-11 orderwire pins.

Figure 2-10 RJ-11 Connector



2.6.3 AIC Card Specifications

The AIC card has the following specifications:

- Environmental
  - Operating temperature:

    C-Temp (15454-AIC): 32 to 131 degrees Fahrenheit (0 to +55 degrees Celsius)

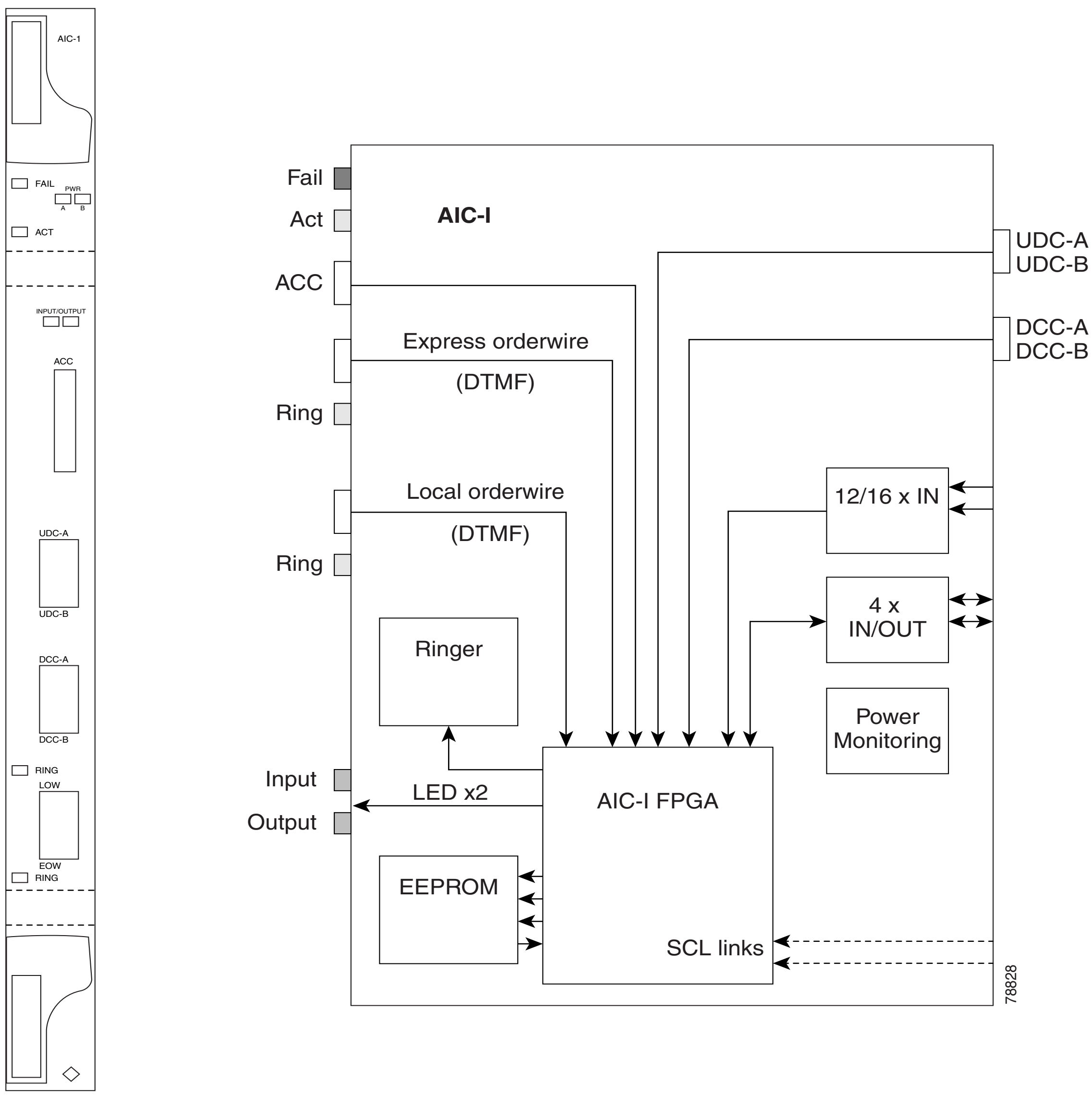
    I-Temp (15454-AIC-T): –40 to 149 degrees Fahrenheit (–40 to +65 degrees Celsius)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 6.01 W, 0.12 A, 20.52 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Card weight: 1.6 lb (0.7 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

2.7 AIC-I Card

The optional Alarm Interface Controller-International (AIC-I) card provides customer-defined (environmental) alarms and controls and supports local and express orderwire. It provides 12 customer-defined input and 4 customer-defined input/output contacts. The physical connections are via the backplane wire-wrap pin terminals. If you use the additional alarm expansion panel (AEP), the AIC-I card can support up to 32 inputs and 16 outputs, which are connected on the AEP connectors. A power monitoring function monitors the supply voltage (–48 VDC). Figure 2-11 shows the AIC-I faceplate and a block diagram of the card.

Note After you have upgraded a shelf to the AIC-I card and set new attributes, you cannot downgrade the shelf back to the AIC card.

Figure 2-11 AIC-I Faceplate and Block Diagram



2.7.1 AIC-I Card-Level Indicators

Table 2-18 describes the eight card-level LEDs on the AIC-I card faceplate.

Table 2-18 AIC-I Card-Level Indicators

Card-Level LEDs	Description
Red FAIL LED	Indicates that the card's processor is not ready. The FAIL LED is on during Reset and flashes during the boot process. Replace the card if the red FAIL LED persists.
Green ACT LED	Indicates the AIC-I card is provisioned for operation.
Green/red PWR A LED	The PWR A LED is green when a supply voltage within specified range has been sensed on supply input A. It is red when the input voltage on supply input A is out of range.
Green/red PWR B LED	The PWR B LED is green when a supply voltage within specified range has been sensed on supply input B. It is red when the input voltage on supply input B is out of range.
Yellow INPUT LED	The INPUT LED is yellow when there is an alarm condition on at least one of the alarm inputs.
Yellow OUTPUT LED	The OUTPUT LED is yellow when there is an alarm condition on at least one of the alarm outputs.
Green RING LED	The RING LED on the local orderwire (LOW) side is flashing green when a call is received on the LOW.
Green RING LED	The RING LED on the express orderwire (EOW) side is flashing green when a call is received on the EOW.

2.7.2 External Alarms and Controls

The AIC-I card provides input/output alarm contact closures. You can define up to 12 external alarm inputs and 4 external alarm inputs/outputs (user configurable). The physical connections are made using the backplane wire-wrap pins. See the "1.9 Alarm Expansion Panel" section on page 1-30 for information about increasing the number of input/output contacts.

LEDs on the front panel of the AIC-I indicate the status of the alarm lines, one LED representing all of the inputs and one LED representing all of the outputs. External alarms (input contacts) are typically used for external sensors such as open doors, temperature sensors, flood sensors, and other environmental conditions. External controls (output contacts) are typically used to drive visual or audible devices such as bells and lights, but they can control other devices such as generators, heaters, and fans.

You can program each of the twelve input alarm contacts separately. You can program each of the sixteen input alarm contacts separately. Choices include:

- Alarm on Closure or Alarm on Open
- Alarm severity of any level (Critical, Major, Minor, Not Alarmed, Not Reported)
- Service Affecting or Non-Service Affecting alarm-service level

- 63-character alarm description for CTC display in the alarm log. You cannot assign the fan-tray abbreviation for the alarm; the abbreviation reflects the generic name of the input contacts. The alarm condition remains raised until the external input stops driving the contact or you unprovision the alarm input.

You cannot assign the fan-tray abbreviation for the alarm; the abbreviation reflects the generic name of the input contacts. The alarm condition remains raised until the external input stops driving the contact or you provision the alarm input.

The output contacts can be provisioned to close on a trigger or to close manually. The trigger can be a local alarm severity threshold, a remote alarm severity, or a virtual wire:

- Local NE alarm severity: A hierarchy of non-reported, non-alarmed, minor, major or critical alarm severities that you set to cause output closure. For example, if the trigger is set to minor, a minor alarm or above is the trigger.
- Remote NE alarm severity: Same as the Local NE alarm severity but applies to remote alarms only.
- Virtual wire entities: You can provision any environmental alarm input to raise a signal on any virtual wire on external outputs 1 through 4 when the alarm input is an event. You can provision a signal on any virtual wire as a trigger for an external control output.

You can also program the output alarm contacts (external controls) separately. In addition to provisionable triggers, you can manually force each external output contact to open or close. Manual operation takes precedence over any provisioned triggers that might be present.

Note The number of inputs and outputs can be increased using the AEP. The AEP is connected to the shelf backplane and requires an external wire-wrap panel.

2.7.3 Orderwire

Orderwire allows a craftsperson to plug a phoneset into an ONS 15454 and communicate with craftspeople working at other ONS 15454s or other facility equipment. The orderwire is a pulse code modulation (PCM) encoded voice channel that uses E1 or E2 bytes in section/line overhead.

The AIC-I allows simultaneous use of both local (section overhead signal) and express (line overhead channel) orderwire channels on a SONET ring or particular optics facility. Express orderwire also allows communication via regeneration sites when the regenerator is not a Cisco device.

You can provision orderwire functions with CTC similar to the current provisioning model for DCC/GCC channels. In CTC you provision the orderwire communications network during ring turn-up so that all NEs on the ring can reach one another. Orderwire terminations (that is, the optics facilities that receive and process the orderwire channels) are provisionable. Both express and local orderwire can be configured as on or off on a particular SONET facility. The ONS 15454 supports up to four orderwire channel terminations per shelf. This allows linear, single ring, dual ring, and small hub-and-spoke configurations. Keep in mind that orderwire is not protected in ring topologies such as BLSR and path protection.

Caution Do not configure orderwire loops. Orderwire loops cause feedback that disables the orderwire channel.

The ONS 15454 implementation of both local and express orderwire is broadcast in nature. The line acts as a party line. Anyone who picks up the orderwire channel can communicate with all other participants on the connected orderwire subnetwork. The local orderwire party line is separate from the express orderwire party line. Up to four OC-N facilities for each local and express orderwire are provisionable as orderwire paths.

Note The OC3 IR 4/STM1 SH 1310 card does not support the express orderwire channel.

The AIC-I supports selective dual tone multifrequency (DTMF) dialing for telephony connectivity, which causes one AIC-I card or all ONS 15454 AIC-I cards on the orderwire subnetwork to "ring." The ringer/buzzer resides on the AIC-I. There is also a "ring" LED that mimics the AIC-I ringer. It flashes when a call is received on the orderwire subnetwork. A party line call is initiated by pressing ***0000** on the DTMF pad. Individual dialing is initiated by pressing ***** and the individual four-digit number on the DTMF pad.

Table 2-19 shows the pins on the orderwire connector that correspond to the tip and ring orderwire assignments. . , shown in .

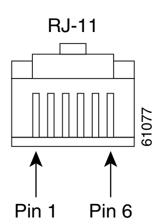
Table 2-19 Orderwire Pin Assignments

RJ-11 Pin Number	Description
1	Four-wire receive ring
2	Four-wire transmit tip
3	Two-wire ring
4	Two-wire tip
5	Four-wire transmit ring
6	Four-wire receive tip

When provisioning the orderwire subnetwork, make sure that an orderwire loop does not exist. Loops cause oscillation and an unusable orderwire channel.

Figure 2-12 shows the standard RJ-11 connectors used for orderwire ports.

Figure 2-12 RJ-11 Connector



2.7.4 Power Monitoring

The AIC-I card provides a power monitoring circuit that monitors the supply voltage of –48 VDC for presence, undervoltage, or overvoltage.

2.7.5 User Data Channel

The user data channel (UDC) features a dedicated data channel of 64 kbps (F1 byte) between two nodes in an ONS 15454 network. Each AIC-I card provides two user data channels, UDC-A and UDC-B, through separate RJ-11 connectors on the front of the AIC-I card. Each UDC can be routed to an individual optical interface in the ONS 15454. For instructions, refer to the *Cisco ONS 15454 Procedure Guide.*

The UDC ports are standard RJ-11 receptacles. Table 2-20 lists the UDC pin assignments.

Table 2-20 UDC Pin Assignments

RJ-11 Pin Number	Description
1	For future use
2	TXN
3	RXN
4	RXP
5	TXP
6	For future use

2.7.6 Data Communications Channel

The DCC features a dedicated data channel of 576 kbps (D4 to D12 bytes) between two nodes in an ONS 15454 network. Each AIC-I card provides two data communications channels, DCC-A and DCC-B, through separate RJ-45 connectors on the front of the AIC-I card. Each DCC can be routed to an individual optical interface in the ONS 15454. For instructions, refer to the *Cisco ONS 15454 Procedure Guide*.

The DCC ports are standard RJ-45 receptacles. Table 2-21 lists the DCC pin assignments.

Table 2-21 DCC Pin Assignments

RJ-45 Pin Number	Description
1	TCLKP
2	TCLKN
3	TXP
4	TXN
5	RCLKP
6	RCLKN
7	RXP
8	RXN

2.7.7 AIC-I Card Specifications

The AIC-I card has the following specifications:

- Alarm inputs

- Number of inputs: 12 without AEP, 32 with AEP
- Opto coupler isolated
- Label customer provisionable
- Severity customer provisionable
- Common 32 V output for all alarm inputs
- Each input limited to 2 mA
- Termination: Wire-wrap on backplane without AEP, on AEP connectors with AEP

- Alarm outputs
  - Number of outputs: 4 (user configurable as inputs) without AEP, 16 with AEP
  - Switched by opto MOS (metal oxide semiconductor)
  - Triggered by definable alarm condition
  - Maximum allowed open circuit voltage: 60 VDC
  - Maximum allowed closed circuit current: 100 mA
  - Termination: Wire-wrap on backplane without AEP, on AEP connectors with AEP
- EOW/LOW
  - ITU-T G.711, ITU-T G.712, Telcordia GR-253-CORE
  - A-law, mu-law

Note Due to the nature of mixed coding, in a mixed-mode configuration A-law/mu-law the orderwire is not ITU-T G.712 compliant.

  - Orderwire party line
  - DTMF signaling
- UDC
  - Bit rate: 64 kbps, codirectional
  - ITU-T G.703
  - Input/output impedance: 120 ohm
  - Termination: RJ-11 connectors
- DCC
  - Bit rate: 576 kbps
  - EIA/TIA-485/V11
  - Input/output impedance: 120 ohm
  - Termination: RJ-45 connectors
- ACC connection for additional alarm interfaces
  - Connection to AEP

- Power monitoring alarming states:
  - Power failure (0 to –38 VDC)
  - Undervoltage (–38 to –40.5 VDC)
  - Overvoltage (beyond –56.7 VDC)
- Environmental
  - Operating temperature: –40 to 149 degrees Fahrenheit (–40 to +65 degrees Celsius)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption (including AEP, if used): 8.00 W, 0.17 A, 27.3 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Card weight: 1.8 lb (0.82 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

CHAPTER 3

Electrical Cards

This chapter describes Cisco ONS 15454 electrical card features and functions. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 Procedure Guide*. For information on the electrical interface assemblies (EIAs), see the "1.5 Electrical Interface Assemblies" section on page 1-15.

Chapter topics include:

3.1 Electrical Card Overview

For software and cross-connect card compatibility information, see the "2.1.2 Card Compatibility" section on page 2-2.

Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. See the "1.13 Cards and Slots" section on page 1-42 for a list of slots and symbols.

Table 3-1 lists the Cisco ONS 15454 electrical cards.

Table 3-1 Cisco ONS 15454 Electrical Cards

Card Name	Description	For Additional Information
EC1-12	The EC1-12 card provides 12 Telcordiacompliant, GR-253 STS-1 electrical ports per card. Each port operates at 51.840 Mbps over a single 750-ohm, 728A or equivalent coaxial span.	See the "3.3 EC1-12 Card" section on page 3-3.
DS1-14	The DS1-14 card provides 14 Telcordiacompliant GR-499 DS-1 ports. Each port operates at 1.544 Mbps over a 100-ohm, twisted-pair copper cable.	See the "3.4 DS1-14 and DS1N-14 Cards" section on page 3-6.
DS1N-14	The DS1N-14 card supports the same features as the DS1-14 card but can also provide 1:N (N <= 5) protection.	See the "3.4 DS1-14 and DS1N-14 Cards" section on page 3-6.
DS3-12	The DS3-12 card provides 12 Telcordiacompliant GR-499 DS-3 ports per card. Each port operates at 44.736 Mbps over a single 75-ohm, 728A or equivalent coaxial span.	See the "3.5 DS3-12 and DS3N-12 Cards" section on page 3-10.
DS3N-12	The DS3N-12 supports the same features as the DS3-12 but can also provide 1:N (N <= 5) protection.	See the "3.5 DS3-12 and DS3N-12 Cards" section on page 3-10.
DS3i-N-12	Provides 12 DS-3 ports and supports 1:1 or 1:N protection. It operates in Slots 1 to 6 and Slots 12 to 17.	See the "3.6 DS3i-N-12 Card" section on page 3-14.
DS3-12E	The DS3-12E card provides 12 Telcordiacompliant ports per card. Each port operates at 44.736 Mbps over a single 75-ohm, 728A or equivalent coaxial span. The DS3-12E card provides enhanced performance monitoring functions.	See the "3.7 DS3-12E and DS3N-12E Cards" section on page 3-17.
DS3N-12E	The DS3N-12E card supports the same features as the DS3-12E but can also provide 1:N (N <= 5) protection.	See the "3.7 DS3-12E and DS3N-12E Cards" section on page 3-17.
DS3XM-6 (Transmux)	The DS3XM-6 card provides six Telcordiacompliant GR-499-CORE M13 multiplexing functions. The DS3XM-6 converts six framed DS-3 network connections to 28x6 or 168 VT1.5s.	See the "3.8 DS3XM-6 Card" section on page 3-22.

3.2 Electrical Card Warnings

Warning **Do not directly touch the backplane with your hand or any metal tool, or you could shock yourself.**

Caution When working with cards, wear the supplied ESD wristband to avoid ESD damage to the card. Plug the wristband cable into the ESD jack located on the lower-right outside edge of the shelf assembly.

3.3 EC1-12 Card

The EC1-12 card provides 12 Telcordiacompliant, GR-253 STS-1 electrical ports per card. Each port operates at 51.840 Mbps over a single 75-ohm, 728A or equivalent coaxial span.

STS path selection for UNEQ-P, AIS-P, and bit error rate (BER) thresholds is done on the SONET ring interfaces (optical cards) in conjunction with the STS cross-connect. The EC1-12 terminates but does not select the 12 working STS-1 signals from the backplane. The EC1-12 maps each of the 12 received EC1 signals into 12 STS-1s with visibility into the SONET path overhead.

An EC1-12 card can be 1:1 protected with another EC1-12 card but cannot protect more than one EC1-12 card. You must install the EC1-12 in an even-numbered slot to serve as a working card and in an odd-numbered slot to serve as a protect card.

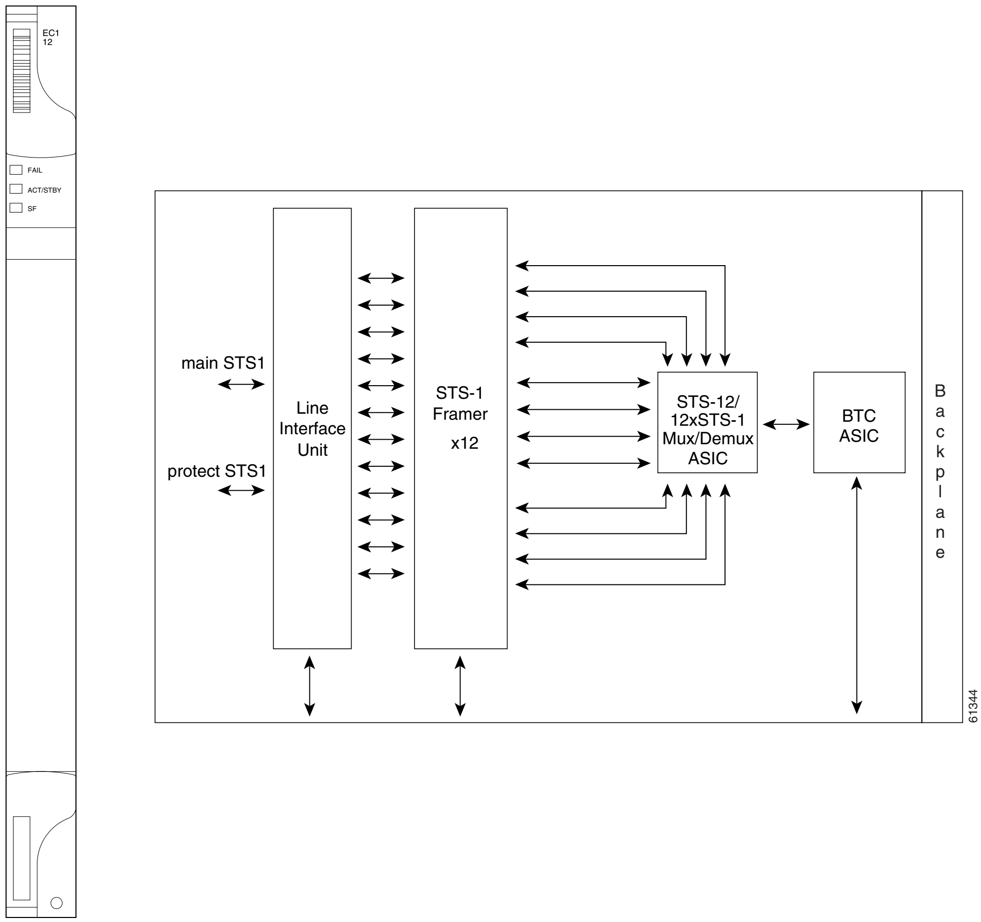
3.3.1 EC1-12 Slots and Connectors

You can install the EC1-12 card in Slots 1 to 6 or 12 to 17 on the ONS 15454. Each EC1-12 interface features DSX-level (digital signal cross-connect frame) outputs supporting distances up to 450 feet (137 meters) depending on facility conditions. See "7.2 Electrical Card Protection and the Backplane" section on page 7-4 for more information about electrical card slot protection and restrictions.

3.3.2 EC1-12 Faceplate and Block Diagram

Figure 3-1 shows the EC1-12 faceplate and a block diagram of the card.

Figure 3-1 EC1-12 Faceplate and Block Diagram



3.3.3 EC1-12 Hosted by XC, XCVT, or XC10G

All 12 STS-1 payloads from an EC1-12 card are carried to the XC, XCVT, or XC10G card where the payload is further aggregated for efficient transport. XC and XCVT cards can host a maximum of 288 bidirectional STS-1s. XC10G can host up to 1152 bidirectional STS-1s.

3.3.4 EC1-12 Card-Level Indicators

Table 3-2 describes the three card-level LEDs on the EC1-12 card.

Table 3-2 EC1-12 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the EC1-12 card's processor is not ready. Replace the unit if the FAIL LED persists.

Table 3-2 EC1-12 Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the EC1-12 card is operational and ready to carry traffic.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as loss of signal (LOS), loss of frame (LOF) or high bit error rate (BER) on one or more of the card's ports.

3.3.5 EC1-12 Port-Level Indicators

You can obtain the status of the EC1-12 card ports using the LCD screen on the ONS 15454 fan tray. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

3.3.6 EC1-12 Card Specifications

The EC1-12 card has the following specifications:

- Input:
  - Bit rate: 51.84 Mbps +/– 20 ppm
  - Frame format: SONET
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/– 5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
- Output:
  - Bit rate: 51.84 Mbps +/– 20 ppm
  - Frame format: SONET
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
  - Power level: –1.8 +/– 5.7 dBm
  - Pulse shape: ANSI T1.102-1988 Figure 8
  - Pulse amplitude: 0.36 to 0.85 V peak to peak
  - Loopback modes: Terminal and facility
  - Line build out: 0 to 225 feet; 226 to 450 feet
- Electrical interface: BNC or SMB connectors

- Operating temperature:
  - C-Temp (15454-EC1-12): 0 to +55 degrees Celsius (0 to 131 degrees Fahrenheit)
  - I-Temp (15454-EC1-12-T): –40 to +65 degrees Celsius (–40 to 149 degrees Fahrenheit)

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

- Operating humidity: 5 to 95%, noncondensing
- Power consumption: 36.60 W, 0.76 A, 124.97 BTU/hr
- Dimensions:
  - Height: 321.3 mm (12.650 inches)
  - Width: 18.2 mm (0.716 inches)
  - Depth: 228.6 mm (9.000 inches)
  - Card weight: 0.9 kg (2.0 lb)
- Compliance:
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

3.4 DS1-14 and DS1N-14 Cards

The ONS 15454 DS1-14 card provides 14 Telcordiacompliant, GR-499 DS-1 ports. Each port operates at 1.544 Mbps over a 100-ohm, twisted-pair copper cable. The DS1-14 card can function as a working or protect card in 1:1 protection schemes and as a working card in 1:N protection schemes.

The DS1-14 card supports 1:1 protection. The DS1-14 can be a working card in a 1:N protection scheme with the proper backplane EIA and wire-wrap or AMP Champ connectors. You can also provision the DS1-14 to monitor for line and frame errors in both directions.

You can group and map DS1-14 card traffic in STS-1 increments to any other card in an ONS 15454 except DS-3 cards. Each DS-1 is asynchronously mapped into a SONET VT1.5 payload and the card carries a DS-1 payload intact in a VT1.5. For performance monitoring purposes, you can gather bidirectional DS-1 frame-level information (loss of frame, parity errors, cyclic redundancy check [CRC] errors, and so on).

3.4.1 DS1N-14 Features and Functions

The DS1N-14 card supports the same features as the DS1-14 card in addition to enhanced protection schemes. The DS1N-14 is capable of 1:N (N <= 5) protection with the proper backplane EIA and wire-wrap or AMP Champ connectors. The DS1N-14 card can function as a working or protect card in 1:1 or 1:N protection schemes.

3.4.2 DS1-14 and DS1N-14 Slots and Connectors

You can install the DS1-14 card in Slots 1 to 6 or 12 to 17 on the ONS 15454. Each DS1-14 port has DSX-level (digital signal cross-connect frame) outputs supporting distances up to 655 feet.

If you use the DS1N-14 as a standard DS-1 card in a 1:1 protection group, you can install the DS1N-14 card in Slots 1 to 6 or 12 to 17 on the ONS 15454. If you use the card's 1:N functionality, you must install a DS1N-14 card in Slots 3 and 15. Each DS1N-14 port features DS-n-level outputs supporting distances of up to 655 feet depending on facility conditions.

3.4.3 DS1-14 and DS1N-14 Faceplate and Block Diagram

Figure 3-2 shows the DS1-14 faceplate and the block diagram of the card.

Figure 3-2 DS1-14 Faceplate and Block Diagram

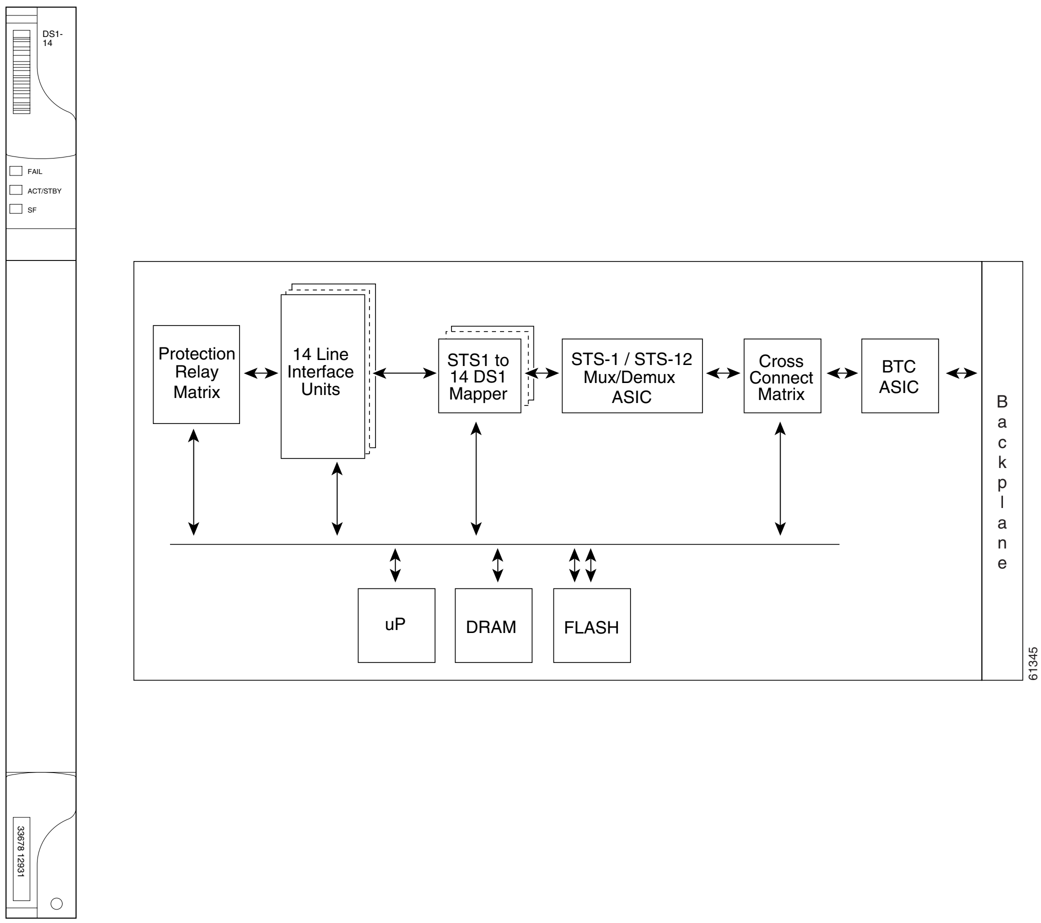
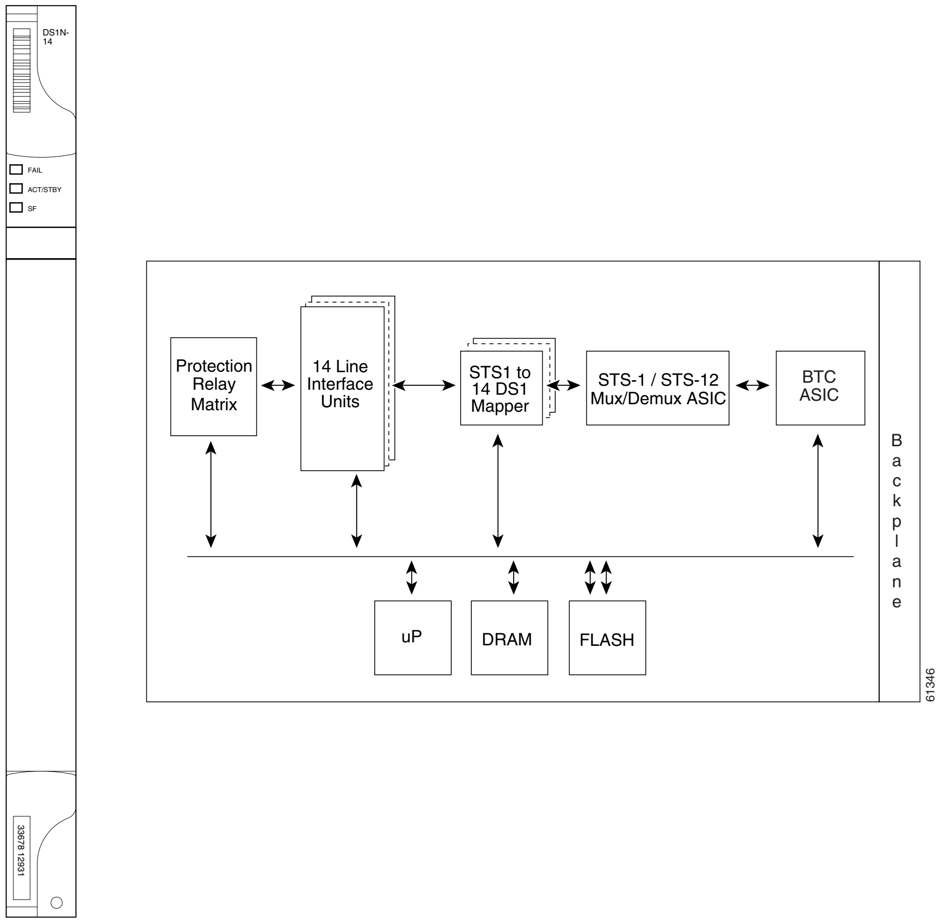


Figure 3-3 shows the DS1N-14 faceplate and a block diagram of the card.

Figure 3-3 DS1N-14 Faceplate and Block Diagram



3.4.4 DS1-14 and DS1N-14 Hosted by the Cross-Connect

All 14 VT1.5 payloads from DS1-14 and DSIN-14 cards are carried in a single STS-1 to the XCVT or XC10G card where the payload is further aggregated for efficient STS-1 transport. The XC10G and XCVT cards manage up to 336 bidirectional VT1.5 ports.

3.4.5 DS1-14 and DS1N-14 Card-Level Indicators

Table 3-3 describes the three card-level LEDs on the DS1-14 and DS1N-14 card faceplates.

Table 3-3 DS1-14 and DS1N-14 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	The green/amber ACT/STBY LED indicates whether the card is operational and ready to carry traffic (green) or in standby mode (amber).
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports.

3.4.6 DS1-14 and DS1N-14 Port-Level Indicators

You can obtain the status of the DS1-14 and DS1N-14 card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

3.4.7 DS1-14 and DS1N-14 Card Specifications

DS1-14 and DS1N-14 cards have the following specifications:

- Input:
  - Bit rate: 1.544 Mbps +/– 32 ppm
  - Frame format: Off, SF (D4), ESF
  - Line code: AMI, B8ZS
  - Termination: Wire-wrap, AMP Champ
  - Input impedance:100 ohms
  - Cable loss: Max 655 feet ABAM #22 AWG
  - AIS: TR-TSY-000191 compliant
- Output:
  - Bit rate: 1.544 Mbps +/– 32 ppm
  - Frame format: Off, SF (D4), ESF
  - Line code: AMI, B8ZS
  - Termination: Wire-wrap, AMP Champ
  - Input impedance:100 ohms
  - Cable loss: Max 655 feet ABAM #22 AWG
  - AIS: TR-TSY-000191compliant
  - Power level: 12.5 to 17.9 dBm centered at 772 KHz, –16.4 to –11.1 dBm centered at 1544 KHz
  - Pulse shape: Telcordia GR-499-CORE Figure 9-5
  - Pulse amplitude: 2.4 to 3.6 V peak-to-peak
  - Loopback modes: Terminal and facility

- Electrical interface: BNC or SMB connectors
- Surge protection: Telcordia GR-1089
- Operating temperature:
  - C-Temp (15454-DS1-14 and 15454-DS1N-14): 0 to +55 degrees Celsius (0 to 131 degrees Fahrenheit)
  - I-Temp (15454-DS1-14-T and 15454-DS1N-14-T): –40 to +65 degrees Celsius (–40 to 149 degrees Fahrenheit)

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

- Operating humidity: 5 to 95%, noncondensing
- Power consumption: 12.60 W, 0.26 A, 43.02 BTU/hr
- Dimensions:
  - Height: 321.3 mm (12.650 inches)
  - Width: 18.2 mm (0.716 inches)
  - Depth: 228.6 mm (9.000 inches)
  - Card weight: 0.8 kg (1.8 lb)
- Compliance:
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

3.5 DS3-12 and DS3N-12 Cards

The ONS 15454 DS3-12 card provides 12 Telcordiacompliant, GR-499 DS-3 ports per card. Each port operates at 44.736 Mbps over a single 75-ohm 728A or equivalent coaxial span. The DS3-12 card operates as a working or protect card in 1:1 protection schemes and as a working card in 1:N protection schemes.

The DS3-12 card supports 1:1 protection with the proper backplane EIA. EIAs are available with BNC, SMB, or SCSI connectors.

Caution When a protection switch moves traffic from the DS3-12 working/active card to the DS3-12 protect/standby card, ports on the now active/standby card cannot be taken out of service. Lost traffic can result if you take a port out of service even if the DS3-12 standby card no longer carries traffic.

Other than the protection capabilities, the DS3-12 and DS3N-12 cards are identical. The DS3N-12 can operate as the protect card in a 1:N (N <= 5) DS3 protection group. It has additional circuitry not present on the basic DS3-12 card that allows it to protect up to five working DS3-12 cards. The basic DS3-12 card can only function as the protect card for one other DS3-12 card.

3.5.1 DS3-12 and DS3N-12 Slots and Connectors

You can install the DS3-12 or DS3N-12 card in Slots 1 to 6 or 12 to 17 on the ONS 15454. Each DS3-12 or DS3N-12 card port features DSX-level outputs supporting distances up to 137 meters (450 feet) depending on facility conditions. With the proper backplane EIA, the card supports BNC or SMB connectors. See the "7.2 Electrical Card Protection and the Backplane" section on page 7-4 for more information about electrical card slot protection and restrictions.

3.5.2 DS3-12 and DS3N-12 Faceplate and Block Diagram

Figure 3-4 shows the DS3-12 faceplate and a block diagram of the card.

Figure 3-4 DS3-12 Faceplate and Block Diagram

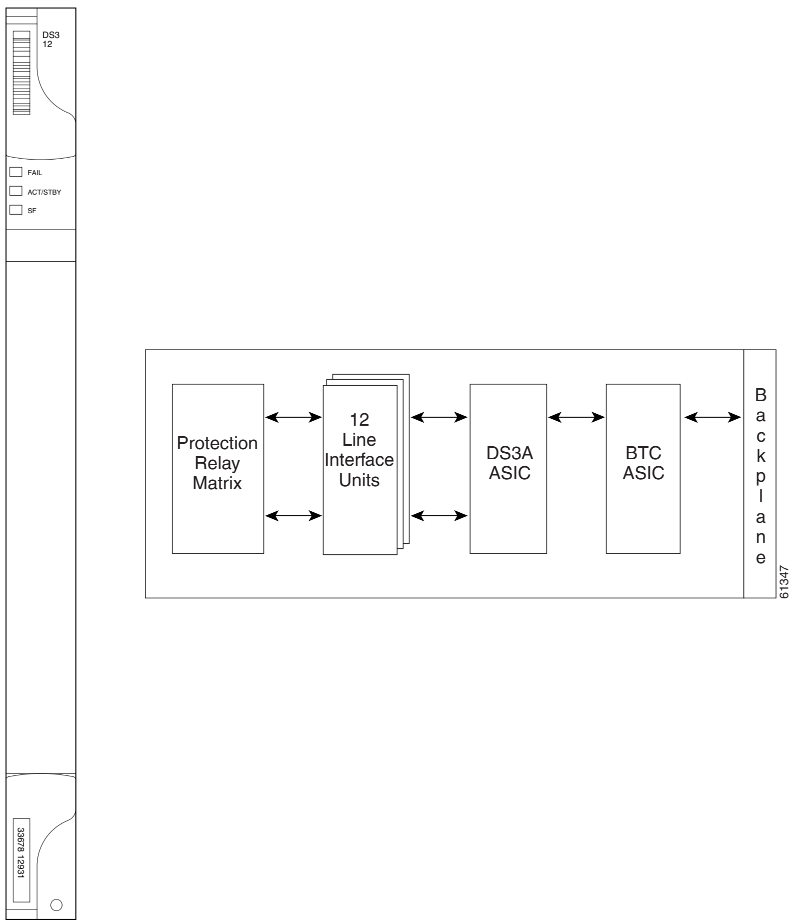
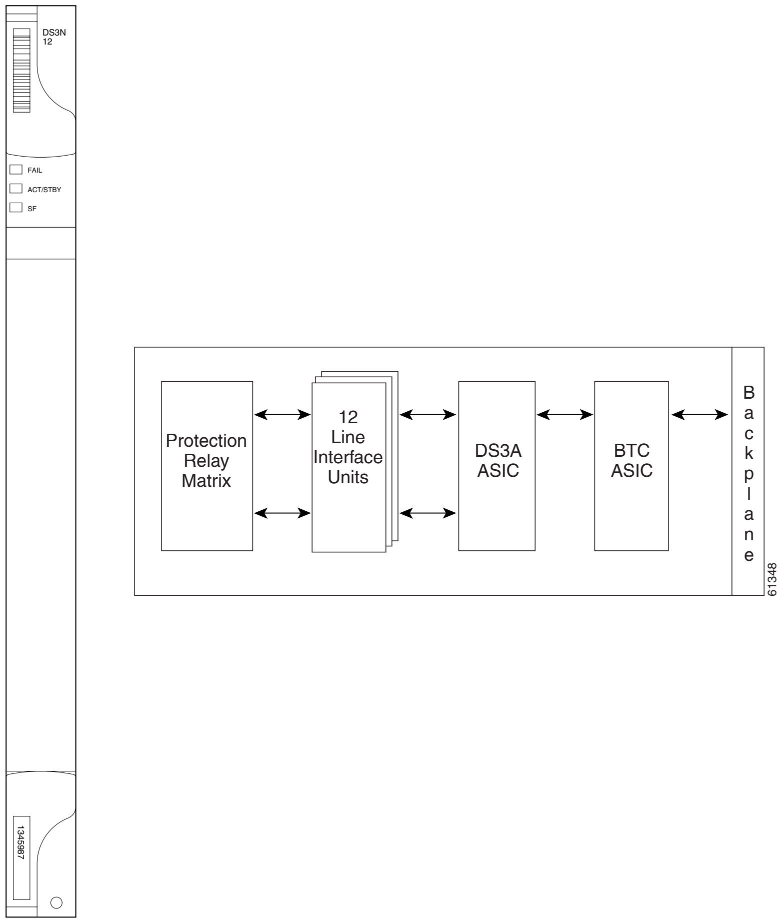


Figure 3-5 shows the DS3N-12 faceplate and a block diagram of the card.

Figure 3-5 DS3N-12 Faceplate and Block Diagram



3.5.3 DS3-12 and DS3N-12 Card-Level Indicators

Table 3-4 describes the three card-level LEDs on the DS3-12 and DS3N-12 card faceplates.

Table 3-4 DS3-12 and DS3N-12 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	When the ACT/STBY LED is green, the card is operational and ready to carry traffic. When the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as port LOS.

3.5.4 DS3-12 and DS3N-12 Port-Level Indicators

You can find the status of the 12 DS3-12 and 12 DS3N-12 card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

3.5.5 DS3-12 and DS3N-12 Card Specifications

DS3-12 and DS3N-12 cards have the following specifications:

- Input:
  - Bit rate: 44.736 Mbps +/– 20 ppm
  - Frame format: DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191 compliant
- Output:
  - Bit rate: 44.736 Mbps +/– 20 ppm
  - Frame format: DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
  - Power level: –1.8 to +5.7 dBm
  - Pulse shape: ANSI T1.102-1988 Figure 8
  - Pulse amplitude: 0.36 to 0.85 V peak-to-peak
  - Loopback modes: Terminal and facility
  - Line build out: 0 to 225 feet; 226 to 450 feet
- Electrical interface: BNC or SMB connectors
- Surge protection: Telcordia GR-1089
- Operating temperature:
  - C-Temp (15454-DS3-12 and 15454-DS3N-12): 0 to +55 degrees Celsius (0 to 131 degrees Fahrenheit)
  - I-Temp (15454-DS3-12-T and 15454-DS3N-12-T): –40 to +65 degrees Celsius (–40 to 149 degrees Fahrenheit)

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

- Operating humidity: 5 to 95%, noncondensing
- Power consumption: 38.20 W, 0.79 A, 130.43 BTU/hr
- Dimensions:
  - Height: 321.3 mm (12.650 inches)
  - Width: 18.2 mm (0.716 inches)
  - Depth: 228.6 mm (9.000 inches)
  - DS3-12 card weight: 0.7 kg (1.7 lb)
  - DS3N-12 card weight: 0.8 kg (1.8 lb)
- Compliance:
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

3.6 DS3i-N-12 Card

The 12-port ONS 15454 DS3i-N-12 card provides 12 ITU-T G.703, ITU-T G.704, and Telcordia GR-499-CORE compliant DS-3 ports per card. Each port operates at 44.736 Mbps over a 75-ohm coaxial cable. The DS3i-N-12 card supports 1:1 or 1:N protection with the proper backplane EIA. Each DS3-12 or DS3N-12 card port features DSX-level outputs supporting distances up to 137 meters (450 feet) depending on facility conditions. The DS3i-N-12 card works with the XCVT and XC10G cross-connect cards. Four sets of three adjacent DS-3 signals (Port 1 through Port 3, Port 4 through Port 6, Port 7 through Port 9, and Port 10 through Port 12) are mapped to VC3s into a VC4 and transported as an STC-3c.

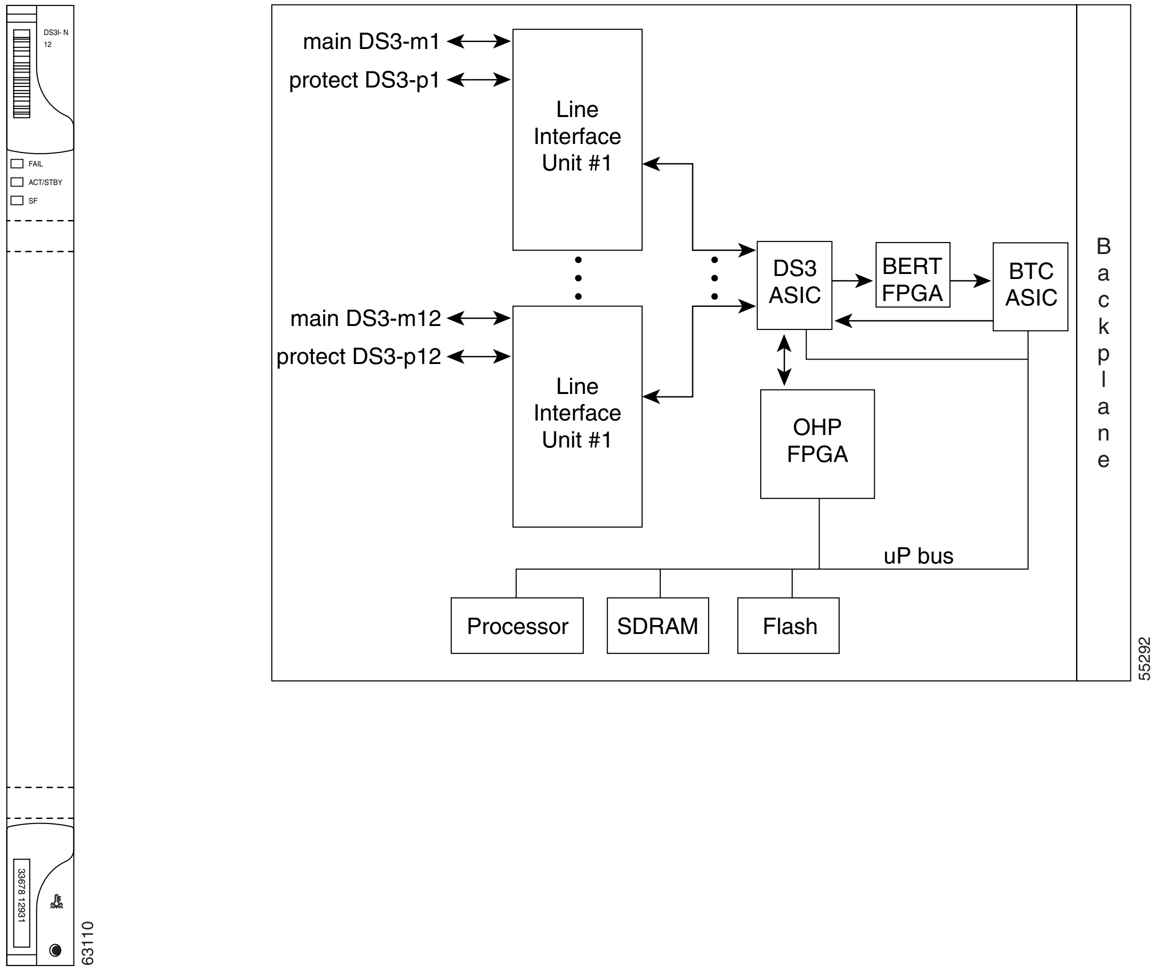
The DS3i-n-12 can also aggregate DS3 and E1 traffic and transport it between SONET and SDH networks through AU4/STS 3 trunks, with the ability to add and drop DS3s to an STS3 trunk at intermediate nodes.

3.6.1 DS3i-N-12 Slots and Connectors

You can install the DS3i-N-12 card in Slots 1 to 6 and 12 to 17. The DS3i-N-12 can operate as the protect card in a 1:N (N <= 5) DS-3 protection group on a half-shelf basis, with protection cards in Slots 3 and 15. It has circuitry that allows it to protect up to five working DS3i-N-12 cards. With the proper backplane EIA, the card supports BNC or SMB connectors. See "7.2 Electrical Card Protection and the Backplane" section on page 7-4 for more information about electrical card slot protection and restrictions.

Figure 3-6 shows the DS3i-N-12 faceplate and block diagram.

Figure 3-6 DS3i-N-12 Faceplate and Block Diagram



The following list summarizes the DS3i-N-12 card features:

- Provisionable framing format (M23, C-bit, or unframed)
- Autorecognition and provisioning of incoming framing
- VC-3 payload mapping as per ITU-T G.707, mapped into VC-4 and transported as STS-3c
- Idle signal (“1100”) monitoring as per Telcordia GR-499-CORE
- P-bit monitoring
- C-bit parity monitoring
- X-bit monitoring
- M-bit monitoring
- F-bit monitoring
- Far-end block error (FEBE) monitoring
- Far-end alarm and control (FEAC) status and loop code detection
- Path trace byte support with TIM-P alarm generation

3.6.2 DS3i-N-12 Card-Level Indicators

Table 3-5 describes the three LEDs on the DS3i-N-12 card faceplate.

Table 3-5 DS3i-N-12 Card-Level Indicators

Card-Level LEDs	Description
Red FAIL LED	Indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists in flashing.
ACT/STBY LED Green (Active) Amber (Standby)	When the ACT/STBY LED is green, the DS3i-N-12 card is operational and ready to carry traffic. When the ACT/STBY LED is amber, the DS3i-N-12 card is operational and in Standby (protect) mode.
Amber SF LED	Indicates a signal failure or condition such as LOS or LOF on one or more of the card's ports.

3.6.3 DS3i-N-12 Port-Level Indicators

You can find the status of the DS3i-N-12 card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

3.6.4 DS3i-N-12 Card Specifications

The DS3i-N-12 card has the following specifications:

- DS3i-N-12 input
  - Bit rate: 44.736 Mbps +/–20 ppm
  - Frame format: ITU-T G.704, ITU-T G.752/DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/– 5%
  - Cable loss:
    Maximum 137 m (450 ft): 734A, RG59, 728A
    Maximum 24 m (79 ft): RG179
  - AIS: ITU-T G.704 compliant
- DS3i-N-12 output
  - Bit rate: 44.736 Mbps +/– 20 ppm
  - Frame format: ITU-T G.704 , ITU-T G.752/DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Output impedance: 75 ohms +/–5%

- AIS: ITU-T G.704 compliant
- Power level: –1.8 to +5.7 dBm (The power level is for a signal of all ones and is measured at a center frequency of 22.368 MHz (3 +/–1 kHz) bandwidth.)
- Pulse shape: ITU-T G.703, Figure 14/ANSI T1.102-1988, Figure 8
- Pulse amplitude: 0.36 to 0.85 V peak-to-peak
- Loopback modes: terminal and facility
- Line build out: 0 to 69 m (0 to 225 ft); 69 to 137 m (226 to 450 ft)

- DS3i-N-12 electrical interface
  - Connectors: SMB, BNC
- Environmental
  - Overvoltage protection: As in ITU-T G.703 Annex B
  - Operating temperature: –5 to +45 degrees Celsius (+23 to +113 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 26.80 W, 0.56 A at –48 V, 91.5 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 inches)
  - Width: 18.2 mm (0.716 inches)
  - Depth: 228.6 mm (9.000 inches)
  - Depth with backplane connector: 235 mm (9.250 inches)
  - Weight not including clam shell: 0.8 kg (1.9 lb)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

3.7 DS3-12E and DS3N-12E Cards

The ONS 15454 DS3-12E card provides 12 Telcordiacompliant GR-499 DS-3 ports per card. Each port operates at 44.736 Mbps over a single 75 ohm 728A or equivalent coaxial span. The DS3-12E card provides enhanced performance monitoring functions. The DS3-12E can detect several different errored logic bits within a DS3 frame. This function allows the ONS 15454 to identify a degrading DS3 facility caused by upstream electronics (DS3 Framer). In addition, DS3 frame format autodetection and J1 path trace are supported. By monitoring additional overhead in the DS3 frame, subtle network degradations can be detected.

The following list summarizes DS3-12E card features:

- Provisionable framing format M23, C-bit or unframed
- Autorecognition and provisioning of incoming framing
- P-bit monitoring
- C-bit parity monitoring
- X-bit monitoring
- M-bit monitoring

- F-bit monitoring
- FEBE monitoring
- FEAC status and loop code detection
- Path trace byte support with TIM-P alarm generation

The DS3-12E supports a 1:1 protection scheme, meaning it can operate as the protect card for one other DS3-12E card.

The DS3N-12E can operate as the protect card in a 1:N (N <= 5) DS3 protection group. It has additional circuitry not present on the basic DS3-12E card that allows it to protect up to five working DS3-12E cards. The basic DS3-12E card can only function as the protect card for one other DS3-12E card.

3.7.1 DS3-12E and DS3N-12E Slots and Connectors

You can install the DS3-12E and DS3N-12E cards in Slots 1 to 6 or 12 to 17 on the ONS 15454. Each DS3-12E and DS3N-12E port features DSX-level outputs supporting distances up to 137 meters (450 feet). With the proper backplane EIA, the card supports BNC or SMB connectors. See "7.2 Electrical Card Protection and the Backplane" section on page 7-4 for more information about electrical card slot protection and restrictions.

3.7.2 DS3-12E Faceplate and Block Diagram

Figure 3-7 shows the DS3-12E faceplate and a block diagram of the card.

Figure 3-7 DS3-12E Faceplate and Block Diagram

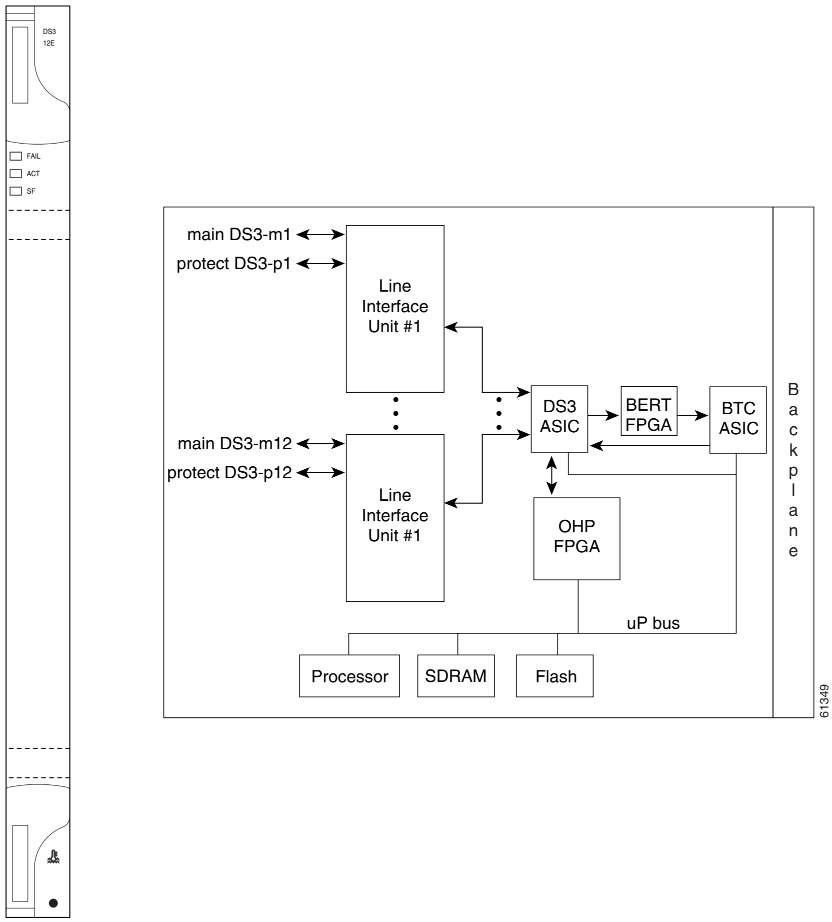
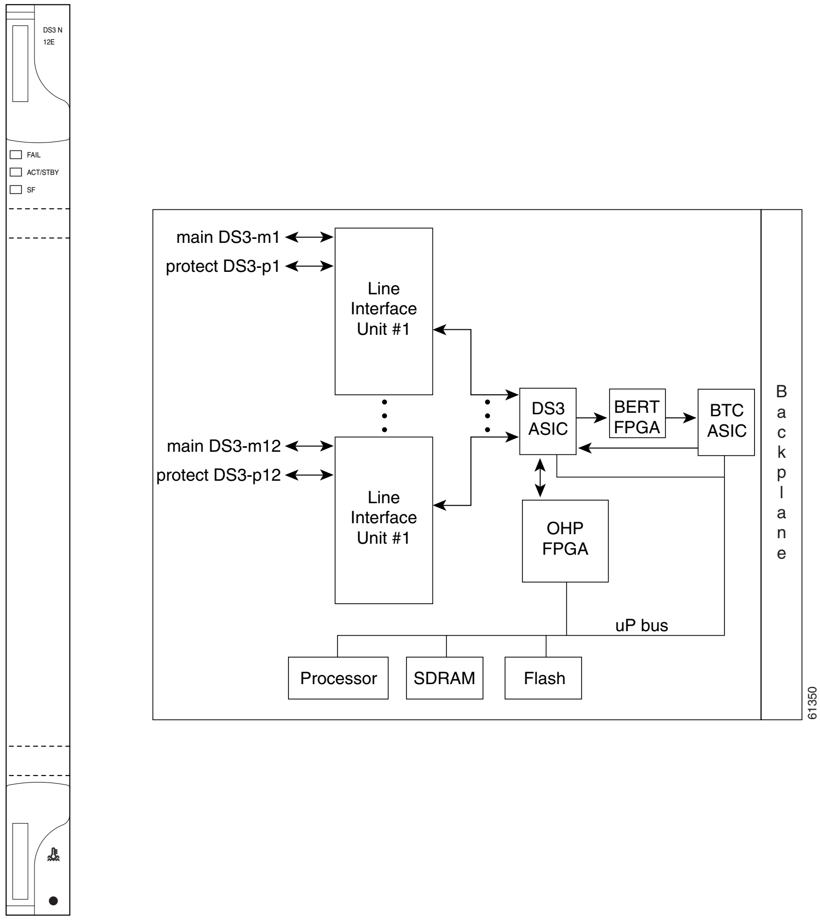


Figure 3-8 shows the DS3N-12E faceplate and a block diagram of the card.

Figure 3-8 DS3N-12E Faceplate and Block Diagram



3.7.3 DS3-12E and DS3N-12E Card-Level Indicators

Table 3-6 describes the three card-level LEDs on the DS3-12E and DS3N-12E card faceplates.

Table 3-6 DS3-12E and DS3N-12E Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	When the ACT/STBY LED is green, the card is operational and ready to carry traffic. When the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as port LOS or AIS.

3.7.4 DS3-12E and DS3N-12E Port-Level Indicators

You can find the status of the DS3-12E and DS3N-12E card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to quickly view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

3.7.5 DS3-12E and DS3N-12E Card Specifications

DS3-12E and DS3N-12E cards have the following specifications:

- Input:
  - Bit rate: 44.736 Mbps +/– 20 ppm
  - Frame format: DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
- Output:
  - Bit rate: 44.736 Mbps +/– 20 ppm
  - Frame format: DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
  - Power level: –1.8 to +5.7 dBm

Note The power level is for a signal of all ones and is measured at a center frequency of 22.368 MHz (+/– KHz) bandwidth.

  - Pulse shape: ANSI T1.102-1988 Figure 8
  - Pulse amplitude: 0.36 to 0.85 V peak-to-peak
  - Loopback modes: Terminal and facility
  - Line build out: 0 to 225 feet; 226 to 450 feet
- Electrical interface: Connectors: BNC or SMB
- Surge protection: Telcordia GR-1089
- Operating temperature: I-Temp (15454-DS3-12E-T and 15454-DS3N-12E-T): –40 to +65 degrees Celsius (–40 to 149 degrees Fahrenheit)

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

- Operating humidity: 5 to 95%, noncondensing
- Power consumption: 26.80 W, 0.56 A, 91.51 BTU/hr
- Dimensions:
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Depth with backplane connector: 235.0 mm (9.250 in.)
  - DS3-12E card weight: 0.8 kg (1.8 lb)
  - DS3N-12E card weight: 0.8 kg (1.8 lb)
- Compliance:
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

3.8 DS3XM-6 Card

The DS3XM-6 card, commonly referred to as a transmux card, provides six Telcordiacompliant, GR-499-CORE M13 multiplexing functions. The DS3XM-6 converts six framed DS-3 network connections to 28 x6 or 168 VT1.5s. You cannot create circuits from a DS3XM-6 card to a DS-3 card. DS3XM-6 cards operate at the VT1.5 level.

3.8.1 DS3XM-6 Slots and Connectors

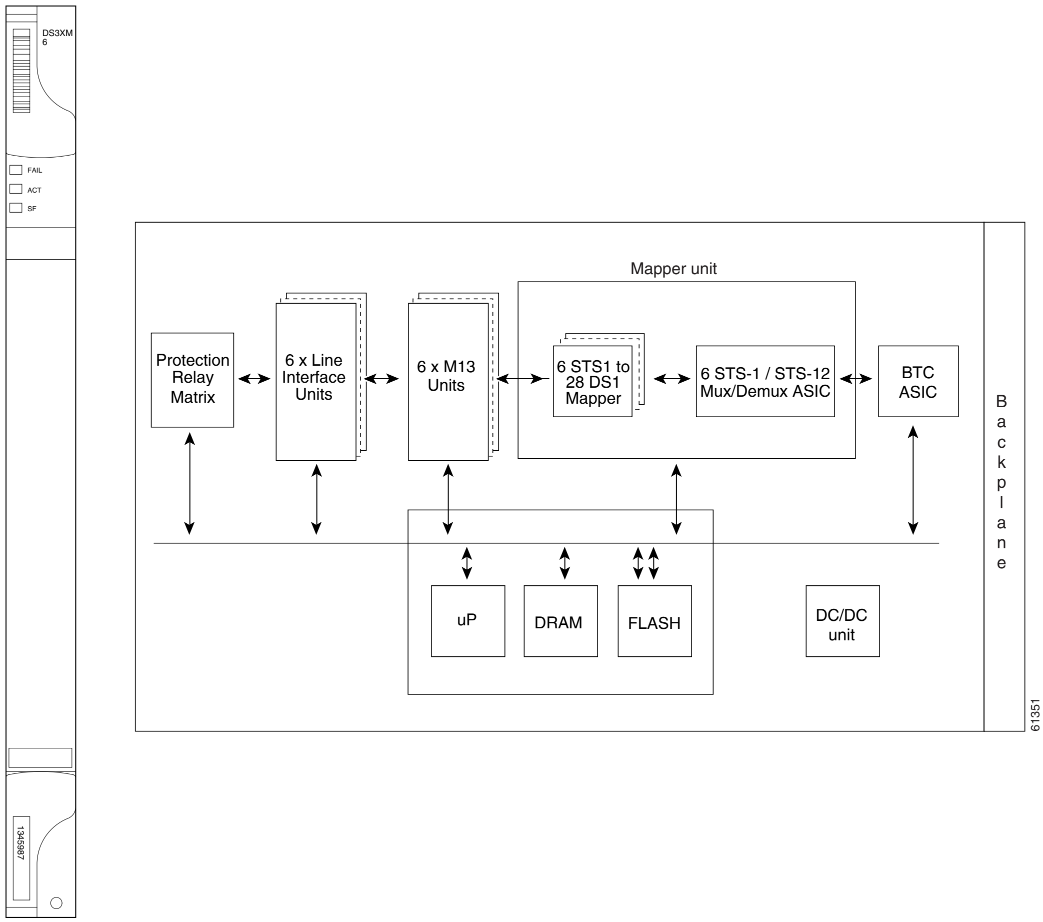
The DS3XM-6 card supports 1:1 protection with the proper backplane EIA. EIAs are available with BNC or SMB connectors.

You can install the DS3XM-6 in Slots 1 to 6 or 12 to 17. Each DS3XM-6 port features DSX-level outputs supporting distances up to 137 meters (450 feet) depending on facility conditions. See "7.2 Electrical Card Protection and the Backplane" section on page 7-4 for more information about electrical card slot protection and restrictions.

3.8.2 DS3XM-6 Faceplate and Block Diagram

Figure 3-9 shows the DS3XM-6 faceplate and a block diagram of the card.

Figure 3-9 DS3XM-6 Faceplate and Block Diagram



3.8.3 DS3XM-6 Hosted By XCVT

The DS3XM-6 card works in conjunction with the XCVT card. A single DS3XM-6 can demultiplex six DS-3 signals into 168 VT1.5s that the XCVT card then manages and cross connects. XCVT cards host a maximum of 336 bidirectional VT1.5s or two DS3XM-6 cards. In most network configurations, two DS3XM-6 cards are paired together as working and protect cards.

3.8.4 DS3XM-6 Card-Level Indicators

Table 3-7 describes the three card-level LEDs on the DS3XM-6 card faceplate.

Table 3-7 DS3XM-6 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	When the ACT/STBY LED is green, the DS3XM-6 card is operational and ready to carry traffic. When the ACT/STBY LED is amber, the DS3XM-6 card is operational and in standby in a 1:1 protection group.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BER on one or more of the card's ports.

3.8.5 DS3XM-6 Port-Level Indicators

You can find the status of the six DS3XM-6 card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to quickly view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

3.8.6 DS3XM-6 Card Specifications

DS3XM-6 cards have the following specifications:

- Input:
  - Bit rate: 44.736 Mbps +/–20 ppm
  - Frame format: DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
- Output:
  - Bit rate: 44.736 Mbps +/– 20 ppm
  - Frame format: DS-3 ANSI T1.107-1988
  - Line code: B3ZS
  - Termination: Unbalanced coaxial cable
  - Input impedance: 75 ohms +/–5%
  - Cable loss: Max 450 feet 734A, RG-59, 728A/Max 79 feet RG-179
  - AIS: TR-TSY-000191compliant
  - Power level: –1.8 to +5.7 dBm

  - Pulse shape: ANSI T1.102-1988 Figure 8
  - Pulse amplitude: 0.36 to 0.85 V peak-to-peak
  - Loopback modes: Terminal and facility
  - Line build out: 0 to 225 feet; 226 to 450 feet
- Interface: BNC or SMB connectors
- Surge protection: Telcordia GR-1089
- Operating temperature:
  - C-Temp (15454-DS3XM-6): 0 to +55 degrees Celsius (0 to 131 degrees Fahrenheit)
  - I-Temp (15454-DS3XM-6-T): –40 to +65 degrees Celsius (–40 to 149 degrees Fahrenheit)

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

- Operating humidity: 5 to 95%, noncondensing
- Power consumption: 20 W, 0.42 A, 68 BTU/hr
- Dimensions:
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 0.8 kg (1.8 lb)
- Compliance:
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

Optical Cards

This chapter describes the Cisco ONS 15454 optical card features and functions. It includes descriptions, hardware specifications, and block diagrams for each optical card. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

4.1 OC-N Cards

This section gives an overview and detailed descriptions of the Cisco ONS 14454 OC-N cards

4.1.1 OC-N Card Overview

Warning **Class 1 (21 CFR 1040.10 and 1040.11) and Class 1M (IEC 60825-1 2001-01) laser products. Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments, or performance of procedures other than those specified may result in hazardous radiation exposure.Invisible laser radiation present.**

Warning **Use of controls, adjustments, or performing procedures other than those specified may result in hazardous radiation exposure.**

For software and cross-connect card compatibility information, see the "2.1.2 Card Compatibility" section on page 2-2.

Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. See the "1.13 Cards and Slots" section on page 1-42 for a list of slots and symbols.

Table 4-1 lists the Cisco ONS 15454 OC-N cards.

Table 4-1 OC-N Cards for the ONS 15454

Card	Port Description	For Additional Information...
OC3 IR 4 SH 1310	The OC3 IR 4 SH 1310 card provides four intermediate- or short-range OC-3 ports and operates at 1310 nm. **Note** The OC3 IR 4 SH 1310 and OC3 IR 4/STM1 SH 1310 cards are functionally the same.	See the "4.1.2 OC3 IR 4/STM1 SH 1310 Card" section on page 4-4.
OC3 IR 4/ STM1 SH 1310	The OC3 IR 4/STM1 SH 1310 card provides four intermediate- or short-range OC-3 ports and operates at 1310 nm.	See the "4.1.2 OC3 IR 4/STM1 SH 1310 Card" section on page 4-4.
OC3 IR/ STM1 SH 1310-8	The OC3 IR/STM1 SH 1310-8 card provides eight intermediate- or short-range OC-3 ports and operates at 1310 nm.	See the "4.1.3 OC3 IR/STM1 SH 1310-8 Card" section on page 4-7.
OC12 IR 1310	The OC12 IR 1310 card provides one intermediate- or short-range OC-12 port and operates at 1310 nm. **Note** The OC12 IR 1310 and OC12/STM4 SH 1310 cards are functionally the same.	See the "4.1.4 OC12 IR/STM4 SH 1310 Card" section on page 4-11.
OC12 IR/STM4 SH 1310	The OC12 IR/STM4 SH 1310 card provides one intermediate- or short-range OC-12 port and operates at 1310 nm.	See the "4.1.4 OC12 IR/STM4 SH 1310 Card" section on page 4-11.
OC12 LR 1310	The OC12 LR 1310 card provides one long-range OC-12 port and operates at 1310 nm. **Note** The OC12 LR 1310 and OC12 LR/STM4 LH 1310 cards are functionally the same.	See the "4.1.5 OC12 LR/STM4 LH 1310 Card" section on page 4-14.
OC12 LR/STM4 LH 1310	The OC12 LR/STM4 LH 1310 card provides one long-range OC-12 port and operates at 1310 nm.	See the "4.1.5 OC12 LR/STM4 LH 1310 Card" section on page 4-14.
OC12 LR 1550	The OC12 LR 1550 card provides one long-range OC-12 port and operates at 1550 nm. **Note** The OC12 LR 1550 and OC12 LR/STM4 LH 1550 cards are functionally the same.	See the "4.1.6 OC12 LR/STM4 LH 1550 Card" section on page 4-17.
OC12 LR/STM4 LH 1550	The OC12 LR/STM4 LH 1550 card provides one long-range OC-12 port and operates at 1550 nm.	See the "4.1.6 OC12 LR/STM4 LH 1550 Card" section on page 4-17.
OC12 IR/STM4 SH 1310-4	The OC12 IR/STM4 SH 1310-4 card provides four intermediate- or short-range OC-12 ports and operates at 1310 nm.	See the "4.1.7 OC12 IR/STM4 SH 1310-4 Card" section on page 4-20.

Table 4-1 OC-N Cards for the ONS 15454 (continued)

Card	Port Description	For Additional Information...
OC48 IR 1310	The OC48 IR 1310 card provides one intermediate-range OC-48 port and operates at 1310 nm.	See the "4.1.8 OC48 IR 1310 Card" section on page 4-24.
OC48 LR 1550	The OC48 LR 1550 card provides one long-range OC-48 port and operates at 1550 nm.	See the "4.1.9 OC48 LR 1550 Card" section on page 4-26.
OC48 IR/STM16 SH AS 1310	The OC48 IR/STM16 SH AS 1310 card provides one intermediate- or short-range OC-48 port at 1310 nm.	See the "4.1.10 OC48 IR/STM16 SH AS 1310 Card" section on page 4-29.
OC48 LR/STM16 LH AS 1550	The OC48 LR/STM16 LH AS 1550 card provides one long-range OC-48 port at 1550 nm.	See the "4.1.11 OC48 LR/STM16 LH AS 1550 Card" section on page 4-32.
OC48 ELR/STM16 EH 100 GHz	The OC48 ELR/STM16 EH 100 GHz card provides one long-range (enhanced) OC-48 port and operates in Slots 5, 6, 12, or 13. This card is available in 18 different wavelengths (9 in the blue band and 9 in the red band) in the 1550-nm range, every second wavelength in the ITU grid for 100-GHz spacing dense wavelength division multiplexing (DWDM).	See the "4.1.12 OC48 ELR/STM16 EH 100 GHz Cards" section on page 4-35.
OC48 ELR 200 GHz	The OC48 ELR 200 GHz card provides one long-range (enhanced) OC-48 port and operates in Slots 5, 6, 12, or 13. This card is available in 18 different wavelengths (9 in the blue band and 9 in the red band) in the 1550-nm range, every fourth wavelength in the ITU grid for 200-GHz spacing DWDM.	See the "4.1.13 OC48 ELR 200 GHz Cards" section on page 4-38.
OC192 SR/STM64 IO 1310	The OC192 SR/STM64 IO 1310 card provides one intra-office-haul OC-192 port at 1310 nm.	See the "4.1.14 OC192 SR/STM64 IO 1310 Card" section on page 4-41.
OC192 IR/STM64 SH 1550	The OC192 IR/STM64 SH 1550 card provides one intermediate-range OC-192 port at 1550 nm.	See the "4.1.15 OC192 IR/STM64 SH 1550 Card" section on page 4-45.
OC192 LR/STM64 LH 1550	The OC192 LR/STM64 LH 1550 card provides one long-range OC-192 port at 1550 nm.	See the "4.1.16 OC192 LR/STM64 LH 1550 Card" section on page 4-49.
OC192 LR/ STM64 LH ITU 15xx.xx	The OC192 LR/STM64 LH ITU 15xx.xx card provides one extended long-range OC-192 port. This card is available in multiple wavelengths in the 1550-nm range of the ITU grid for 100-GHz-spaced DWDM.	See the "4.1.17 OC192 LR/STM64 LH ITU 15xx.xx Card" section on page 4-54.

Note The Cisco OC3 IR/STM1 SH, OC12 IR/STM4 SH, and OC48 IR/STM16 SH interface optics, all working at 1310 nm, are optimized for the most widely used SMF-28 fiber, available from many suppliers.

Corning MetroCor fiber is optimized for optical interfaces that transmit at 1550 nm or in the C and L

DWDM windows, and targets interfaces with higher dispersion tolerances than those found in OC3 IR/STM1 SH, OC12 IR/STM4 SH, and OC48 IR/STM16 SH interface optics. If you are using Corning MetroCor fiber, OC3 IR/STM1 SH, OC12 IR/STM4 SH, and OC48 IR/STM16 SH interface optics become dispersion limited before they become attenuation limited. In this case, consider using OC12 LR/STM4 LH and OC48 LR/STM16 LH cards instead of OC12 IR/STM4 SH and OC48 IR/STM16 SH cards.

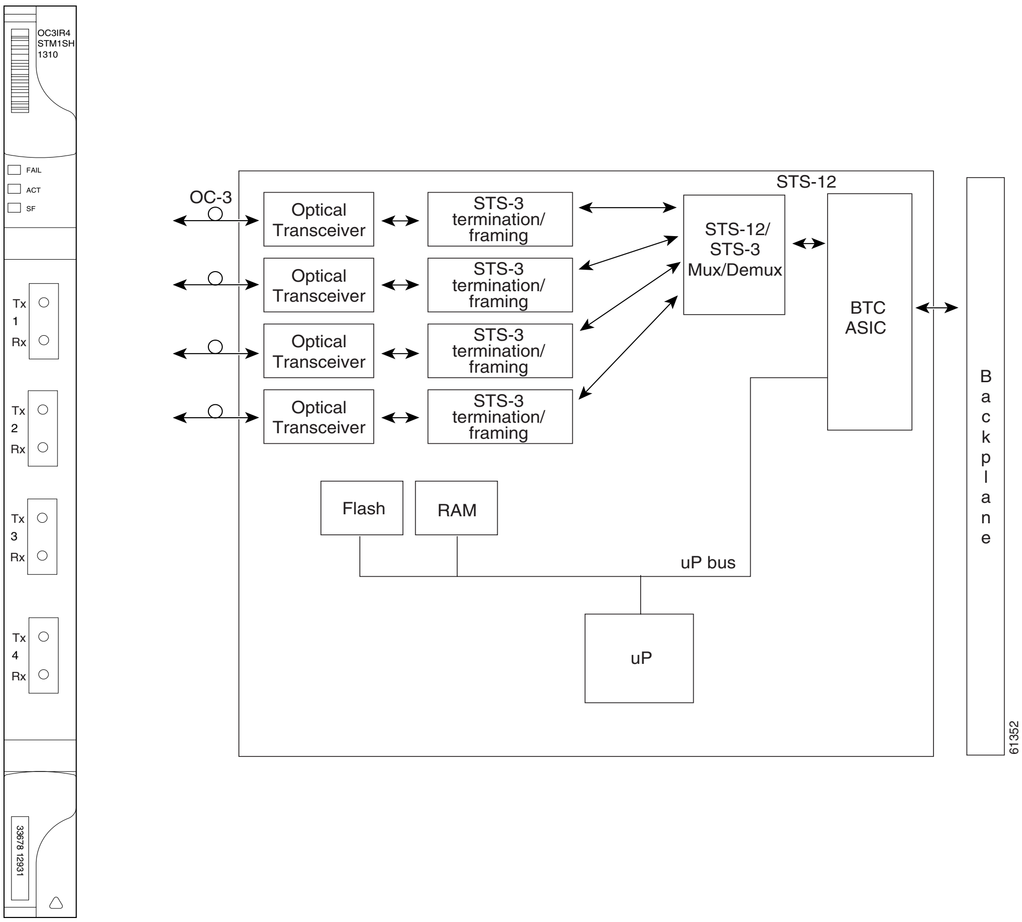
With all fiber types, network planners/engineers should review the relative fiber type and optics specifications to determine attenuation, dispersion, and other characteristics to ensure appropriate deployment.

4.1.2 OC3 IR 4/STM1 SH 1310 Card

The OC3 IR 4/STM1 SH 1310 card provides four intermediate or short range SONET/SDH OC-3 ports compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. Each port operates at 155.52 Mbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at the STS-1 or STS-3c signal levels. Figure 4-1 shows the OC3 IR 4/STM1 SH 1310 faceplate and a block diagram of the card.

Note The OC3 IR 4 SH 1310 and OC3 IR 4/STM1 SH 1310 cards are functionally the same.

Figure 4-1 OC3 IR 4/STM1 SH 1310 Faceplate and Block Diagram



You can install the OC3 IR 4/STM1 SH 1310 card in Slots 1 to 6 and 12 to 17. The card can be provisioned as part of a path protectionor in a linear add/drop multiplexer (ADM) configuration. Each interface features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses SC connectors.

The OC3 IR 4/STM1 SH 1310 card supports 1+1 unidirectional or bidirectional protection switching. You can provision protection on a per port basis.

The OC3 IR 4/STM1 SH 1310 card detects loss of signal (LOS), loss of frame (LOF), loss of pointer (LOP), line-layer alarm indication signal (AIS-L), and line-layer remote defect indication (RDI-L) conditions. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line bit interleaved parity (BIP) errors.

To enable automatic protection switching (APS), the OC3 IR 4/STM1 SH 1310 card extracts the K1 and K2 bytes from the SONET overhead to perform appropriate protection switches. The data communication channel/general communication channel (DCC/GCC) bytes are forwarded to the TCC2 card, which terminates the DCC/GCC.

4.1.2.1 OC3 IR 4/STM1 SH 1310 Card-Level Indicators

The OC3 IR 4/STM1 SH 1310 card has three card-level LED indicators, described in Table 4-2.

Table 4-2 OC3 IR 4/STM1 SH 1310 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as loss of signal (LOS), loss of frame (LOF), line alarm indicator signal (AIS-L), or high BER on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the links are working, the light turns off.

4.1.2.2 OC3 IR 4/STM1 SH 1310 Port-Level Indicators

Eight bicolor LEDs show the status per port. The LEDs shows green if the port is available to carry traffic, is provisioned as in-service, and is part of a protection group, in the active mode. You can find the status of the four card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

4.1.2.3 OC3 IR 4/STM1 SH 1310 Card Specifications

The OC3 IR 4/STM1 SH 1310 card has the following specifications:

- Line
  - Bit rate: 155.52 Mbps
  - Code: Scrambled non-return to zero (NRZ)
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility
  - Connector: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: –8 dBm
  - Minimum transmitter output power: –15 dBm
  - Center wavelength: 1274 to 1356 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Fabry Perot laser
  - Extinction Ratio: 8.2 dB

- Dispersion Ratio: 96 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –28 dBm at BER 1 * 10 exp – 12
  - Receiver: InGaAs/InP photodetector
  - Link loss budget: 13 dB
  - Receiver input wavelength range: 1274 to 1356 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp (15454-OC34IR1310): –5 to +45 degrees Celsius (+23 to +113 degrees Fahrenheit)

    I-Temp (15454-OC34I13-T): –40 to +65 degrees Celsius (–40 to +149 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 19.20 W, 0.40 A at –48 V, 65.56 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 1.0 lb (0.4 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.3 OC3 IR/STM1 SH 1310-8 Card

The OC3 IR/STM1 SH 1310-8 card provides eight intermediate or short range SONET/SDH OC-3 ports compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. Each port operates at 155.52 Mbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at the STS-1 or STS-3c signal levels. Figure 4-2 shows the card faceplate.

Figure 4-2 OC3IR/STM1 SH 1310-8 Faceplate

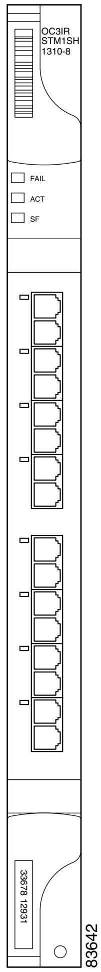
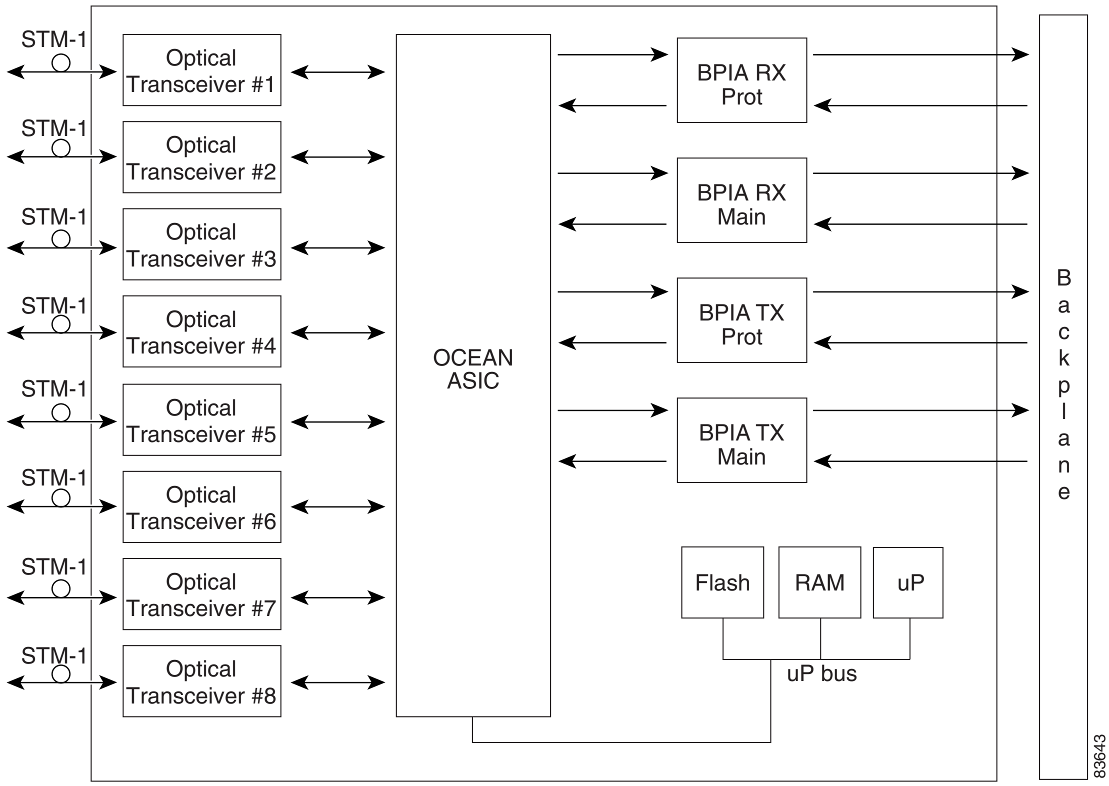


Figure 4-3 shows a block diagram of the OC3 IR/STM1 SH 1310-8 card.

Figure 4-3 OC3IR/STM1 SH 1310-8 Block Diagram



You can install the OC3 IR/STM1 SH 1310-8 card in Slots 1 to 4 and 14 to 17. The card can be provisioned as part of a path protection or in an add/drop multiplexer/terminal monitor (ADM/TM) configuration. Each interface features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses LC connectors on the faceplate, angled downward 12.5 degrees.

The OC3 IR/STM1 SH 1310-8 card supports 1+1 unidirectional and bidirectional protection switching. You can provision protection on a per port basis.

The OC3 IR/STM1 SH 1310-8 card detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors.

To enable APS, the OC3 IR/STM1 SH 1310-8 card extracts the K1 and K2 bytes from the SONET overhead to perform appropriate protection switches. The OC3 IR/STM1 SH 1310-8 card supports full DCC/GCC connectivity for remote network management.

4.1.3.1 OC3 IR/STM1 SH 1310-8 Card-Level Indicators

Table 4-3 describes the three card-level LEDs on the eight-port OC3 IR/STM1 SH 1310-8 card.

Table 4-3 OC3IR/STM1 SH 1310-8 Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BER on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the links are working, the light turns off.

4.1.3.2 OC3 IR/STM1 SH 1310-8 Port-Level Indicators

Eight bicolor LEDs show the status per port. The LEDs shows green if the port is available to carry traffic, is provisioned as in-service, and is part of a protection group, in the active mode. You can also find the status of the eight card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

4.1.3.3 OC3 IR/STM1SH 1310-8 Card Specifications

The OC3IR/STM1 SH 1310-8 card has the following specifications:

- Line
  - Bit rate: 155.52 Mbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility
  - Connector: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: –8 dBm
  - Minimum transmitter output power: –15 dBm
  - Center wavelength: 1261 to 1360 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Fabry Perot laser

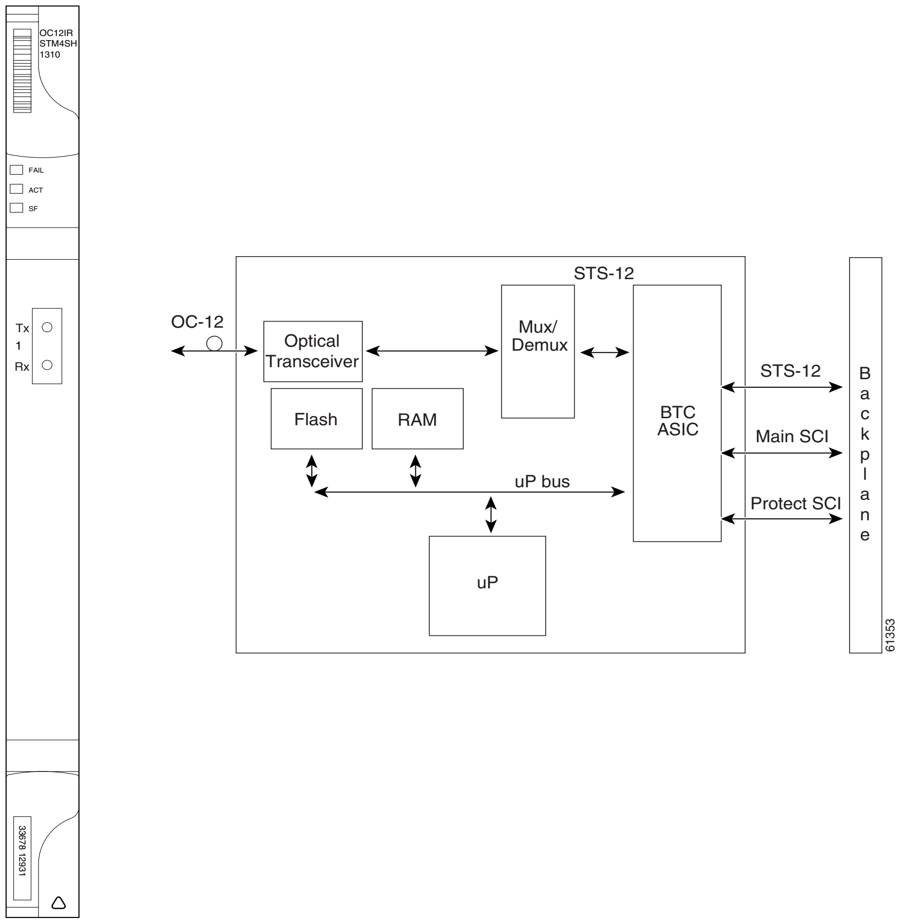
  - Extinction ratio: 8.2 dB
  - Dispersion tolerance: 96 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –28 dBm at BER 1 * 10 exp – 12
  - Receiver: InGaAs/InP photodetector
  - Link loss budget: 13 dB
  - Receiver input wavelength range: 1261 to 1360 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature: –5 to +45 degrees Celsius (+23 to +113 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 23.00 W, 0.48 A at –48 V, 78.5 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 1.0 lb (0.4 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.4 OC12 IR/STM4 SH 1310 Card

The OC12 IR/STM4 SH 1310 card provides one intermediate or short range SONET OC-12 port compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. The port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, or STS-12c signal levels. Figure 4-4 shows the OC12 IR/STM4 SH 1310 faceplate and a block diagram of the card.

Note The OC12 IR 1310 and OC12/STM4 SH 1310 cards are functionally the same.

Figure 4-4 OC12 IR/STM4 SH 1310 Faceplate and Block Diagram



You can install the OC12 IR/STM4 SH 1310 card in Slots 1 to 6 and 12 to 17, and provision the card as a drop card or span card in a two-fiber BLSR, path protection, or ADM (linear) configuration.

The OC12 IR/STM4 SH 1310 card interface features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The OC12 IR/STM4 SH 1310 card uses SC optical connections and supports 1+1 unidirectional and bidirectional protection.

The OC12 IR/STM4 SH 1310 detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIT errors.

To enable APS, the OC12 IR/STM4 SH 1310 card extracts the K1 and K2 bytes from the SONET overhead to perform appropriate protection switches. The DCC/GCC bytes are forwarded to the TCC2 card, which terminates the DCC/GCC.

4.1.4.1 OC12 IR/STM4 SH 1310 Card-Level Indicators

Table 4-4 describes the three card-level LEDs on the OC12 IR/STM4 SH 1310 card.

Table 4-4 OC12 IR/STM4 SH 1310 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is operational and is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.1.4.2 OC12 IR/STM4 SH 1310 Port-Level Indicators

You can find the status of the OC-12 IR/STM4 SH 1310 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

4.1.4.3 OC12 IR/STM4 SH 1310 Card Specifications

The OC12 IR/STM4 SH 1310 card has the following specifications:

- Line
  - Bit rate: 622.08 Mbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: –8 dBm
  - Minimum transmitter output power: –15 dBm
  - Center wavelength: 1274 to 1356 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Fabry Perot laser
  - Extinction ratio: 8.2 dB
  - Dispersion tolerance: 96 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –28 dBm at BER 1 * 10 exp – 12
  - Receiver: InGa As/InP photodetector

  - Link loss budget: 13 dB
  - Receiver input wavelength range: 1274 to 1356 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp (15454-OC121IR1310): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)

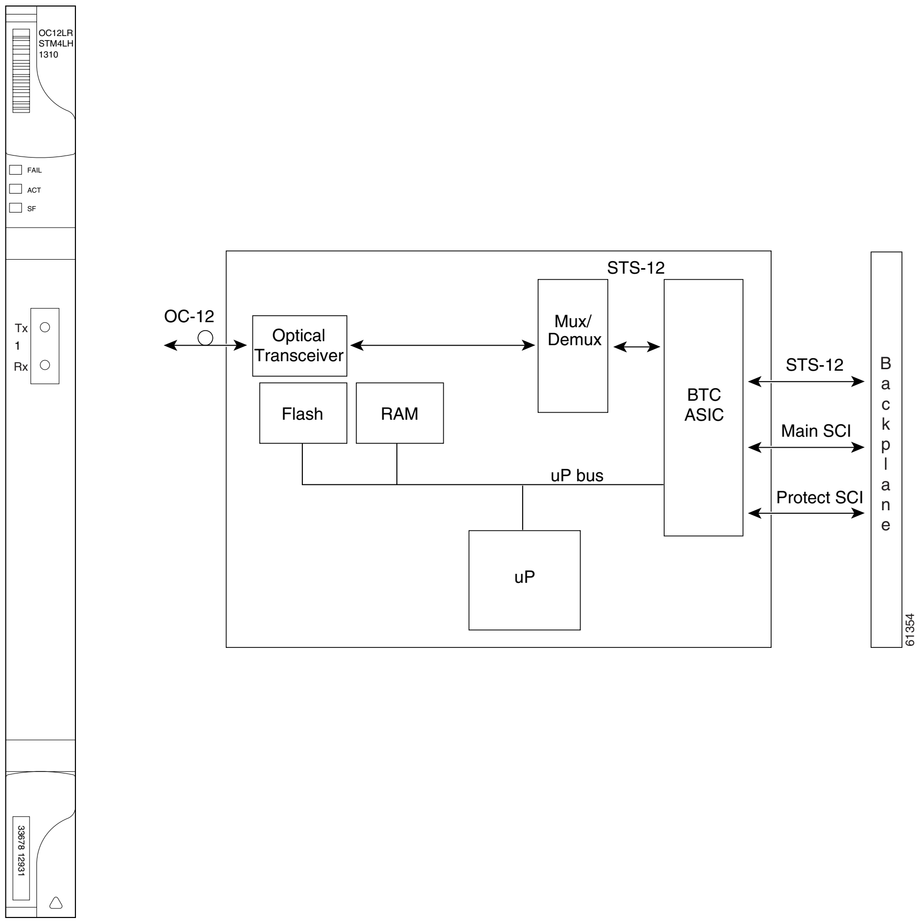
    I-Temp (15454-OC121I13-T): –40 to +65 degrees Celsius (–40 to +149 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 10.90 W, 0.23 A at –48 V, 37.22 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 1.4 lb (0.6 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.5 OC12 LR/STM4 LH 1310 Card

The OC12 LR/STM4 LH 1310 card provides one long-range SONET OC-12 port per card compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. The port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, or STS-12c signal levels. Figure 4-5 shows the OC12 LR/STM4 LH 1310 faceplate and a block diagram of the card.

Note The OC12 LR 1310 and OC12 LR/STM4 LH 1310 cards are functionally the same.

Figure 4-5 OC12 LR/STM4 LH 1310 Faceplate and Block Diagram



You can install the OC12 LR/STM4 LH 1310 card in Slots 1 to 6 and 12 to 17, and provision the card as a drop card or span card in a two-fiber BLSR, path protection, or ADM (linear) configuration.

The OC12 LR/STM4 LH 1310 card interface features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses SC optical connections and supports 1+1 unidirectional and bidirectional protection.

The OC12 LR/STM4 LH 1310 card detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIT errors.

To enable APS, the OC12 LR/STM4 LH 1310 card extracts the K1 and K2 bytes from the SONET overhead to perform appropriate protection switches. The DCC/GCC bytes are forwarded to the TCC2 card, which terminates the DCC/GCC.

4.1.5.1 OC12 LR/STM4 LH 1310 Card-Level Indicators

Table 4-5 describes the three card-level LEDs on the OC12 LR/STM4 LH 1310 card.

Table 4-5 OC12 LR/STM4 LH 1310 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is operational and is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.5.2 OC12 LR/STM4 LH 1310 Port-Level Indicators

You can find the status of the OC12 LR/STM4 LH 1310 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to quickly view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.5.3 OC12 LR/STM4 LH 1310 Card Specifications

The OC12 LR/STM4 LH 1310 card has the following specifications:

- Line
  - Bit rate: 622.08 Mbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia SONET, GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: +2 dBm
  - Minimum transmitter output power: –3 dBm
  - Center wavelength: 1280 to 1335 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Distributed feedback (DFB) laser

  - Extinction ratio: 10 dB
  - Dispersion tolerance: 190 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –28 dBm at BER 1 * 10 exp – 12
  - Receiver: InGaAs/InP photodetector
  - Link loss budget: 25 dB
  - Receiver input wavelength range: 1280 to 1335 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp (15454-OC121LR1310): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)

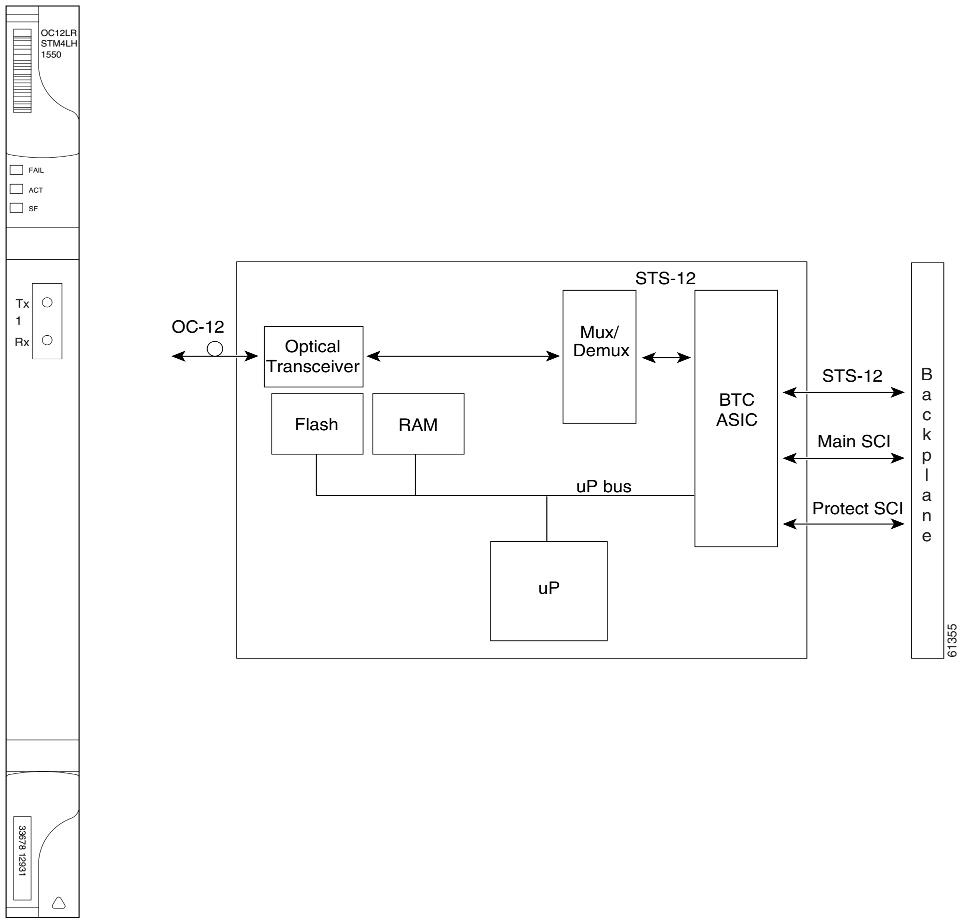
    I-Temp (15454-OC121L13-T): –40 to +65 degrees Celsius (–40 to +149 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 9.28 W, 0.25 A, 41 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 1.4 lb (0.6 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.6 OC12 LR/STM4 LH 1550 Card

The OC12 LR/STM4 LH 1550 card provides one long-range SONET/SDH OC-12 port compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. The port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, or STS-12c signal levels. Figure 4-6 shows the OC12 LR/STM4 LH 1550 faceplate and a block diagram of the card.

Note The OC12 LR 1550 and OC12 LR/STM4 LH 1550 cards are functionally the same.

Figure 4-6 OC12 LR/STM4 LH 1550 Faceplate and Block Diagram



You can install the OC12 LR/STM4 LH 1550 card in Slots 1 to 4 and 14 to 17. The OC12 LR/STM4 LH 1550 can be provisioned as part of a two-fiber BLSR, path protection, or linear ADM.

The OC12 LR/STM4 LH 1550 uses long-reach optics centered at 1550 nm and contains a transmit and receive connector (labeled) on the card faceplate. The OC12 LR/STM4 LH 1550 uses SC optical connections and supports 1+1 bidirectional or unidirectional protection switching.

The OC12 LR/STM4 LH 1550 detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. The card also counts section and line BIT errors.

4.1.6.1 OC12 LR/STM4 LH 1550 Card-Level Indicators

Table 4-6 describes the three card-level LEDs on the OC12 LR/STM4 LH 1550 card.

Table 4-6 OC12 LR/STM4 LH 1550 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is operational and ready to carry traffic.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.6.2 OC12 LR/STM4 LH 1550 Port-Level Indicators

You can find the status of the OC12 LR/STM4 LH 1550 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.6.3 OC12 LR/STM4 LH 1550 Card Specifications

The OC12 LR/STM4 LH 1550 card has the following specifications:

- Line
  - Bit rate: 622.08 Mbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia SONET, GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: +2 dBm
  - Minimum transmitter output power: –3 dBm
  - Center wavelength: 1480 to 1580 nm
  - Nominal wavelength: 1550 nm
  - Transmitter: DFB laser
  - Dispersion tolerance: 1440 ps/nm

- Receiver
  - Maximum receiver level: –8 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –28 dBm at BER 1 * 10 exp – 12
  - Receiver: InGaAs/InP photodetector
  - Link loss budget: 25 dB
  - Receiver input wavelength range: 1480 to 1580 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp (15454-OC121LR1550): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)

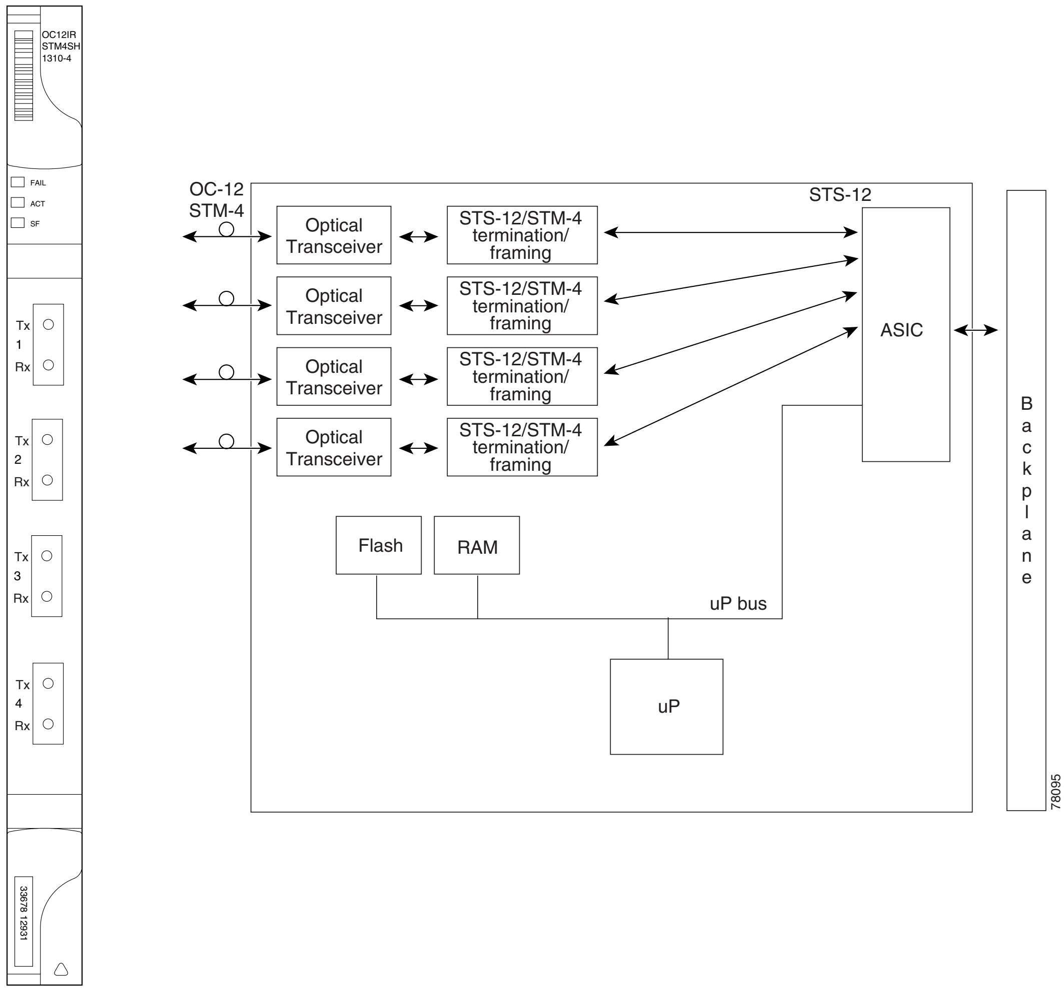
    I-Temp (15454-OC121L15-T): –40 to +65 degrees Celsius (–40 to +149 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 9.28 W, 0.19 A, 31.68 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 1.4 lb (0.6 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.7 OC12 IR/STM4 SH 1310-4 Card

The OC12 IR/STM4 SH 1310-4 card provides four intermediate or short range SONET/SDH OC-12/STM-4 ports compliant with the ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. Each port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at the STS-1, STS-3c, STS-6c, or STS-12c signal levels.

Figure 4-7 shows the OC12 IR/STM4 SH 1310-4 faceplate and a block diagram of the card.

Figure 4-7 OC12 IR/STM4 SH 1310-4 Faceplate and Block Diagram



Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.**

You can install the OC12 IR/STM4 SH 1310-4 card in Slots 1 to 4 and 14 to 17. The card can be provisioned as part of an SNCP, part of an multiplex section-shared protection ring (MS-SPRing), or in an ADM/TM configuration. Each interface features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses SC connectors.

The OC12 IR/STM4 SH 1310-4 card supports 1+1 unidirectional and bidirectional protection switching. You can provision protection on a per port basis.

The OC12 IR/STM4 SH 1310-4 card detects LOS, LOF, LOP, MS-AIS, and MS-FERF conditions. Refer to the *Cisco ONS 15454 SDH Reference Manual* for a description of these conditions. The card also counts section and line BIP errors.

Each port is configurable to support all ONS 15454 SDH configurations and can be provisioned as part of an MS-SPRing, SNCP, or MSP configuration.

To enable MSP, the OC12 IR/STM4 SH 1310-4 card extracts the K1 and K2 bytes from the SDH overhead and processes them to switch accordingly. The DCC/GCC bytes are forwarded to the TCC2 card, which terminates the DCC/GCC.

Note If you ever expect to upgrade an OC-12/STM-4 ring to a higher bit rate, you should not put an OC12 IR/STM4 SH 1310-4 card in that ring. The four-port card is not upgradable to a single-port card. The reason is that four different spans, possibly going to four different nodes, cannot be merged to a single span.

4.1.7.1 OC12 IR/STM4 SH 1310-4 Card-Level Indicators

Table 4-7 describes the three card-level LEDs on the OC12 IR/STM4 SH 1310-4 card.

Table 4-7 OC12 IR/STM4 SH 1310-4 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card’s processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BER on one or more of the card’s ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.7.2 OC12 IR/STM4 SH 1310-4 Port-Level Indicators

You can find the status of the four card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.7.3 OC12 IR/STM4 SH 1310-4 Specifications

The OC12 IR/STM4 SH 1310-4 card has the following specifications:

- Line
  - Bit rate: 622.08 Mbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility

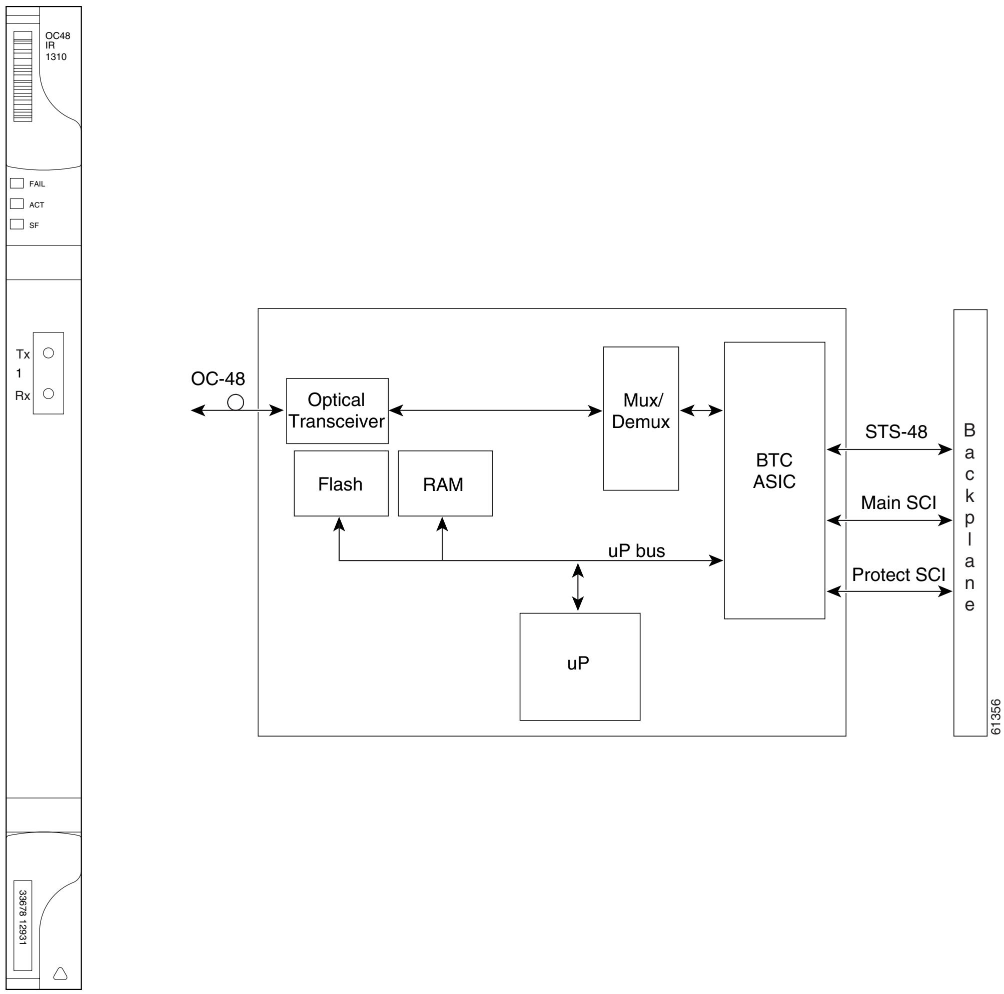
  - Connector: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: –8 dBm
  - Minimum transmitter output power: –15 dBm
  - Center wavelength: 1274 to 1356 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Fabry Perot laser
  - Extinction ratio: 10 dB
  - Dispersion tolerance: 190 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm
  - Minimum receiver level: –30 dBm
  - Receiver: InGaAs/InP photodetector
  - Link loss budget: 15 dB
  - Receiver input wavelength range: 1274 to 1356 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Operating temperature
  - C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
- Operating humidity
  - 5 to 95%, noncondensing
- Power consumption
  - 28 W, 0.58 A, 100 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 1.0 lb (0.4 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

Note Minimum transmit power, Minimum receive power, and link loss budget might exceed standard specifications.

4.1.8 OC48 IR 1310 Card

The OC48 IR 1310 card provides one intermediate-range, SONET OC-48 port per card, compliant with Telcordia GR-253-CORE. Each port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels. Figure 4-8 shows the OC48 IR 1310 faceplate and a block diagram of the card.

Figure 4-8 OC48 IR 1310 Faceplate and Block Diagram



You can install the OC48 IR 1310 card in Slots 5, 6, 12, and 13, and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or in an ADM (linear) configuration.

The OC-48 port features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The OC48 IR 1310 uses SC connectors. The card supports 1+1 unidirectional and bidirectional protection switching.

The OC48 IR 1310 detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. The card also counts section and line BIP errors.

4.1.8.1 OC48 IR 1310 Card-Level Indicators

Table 4-8 describes the three card-level LEDs on the OC48 IR 1310 card.

Table 4-8 OC48 IR 1310 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.8.2 OC48 IR 1310 Port-Level Indicators

You can find the status of the OC48 IR 1310 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.8.3 OC48 IR 1310 Card Specifications

The OC48 IR 1310 card has the following specifications:

- Line
  - Bit rate: 2.49 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE
- Transmitter
  - Maximum transmitter output power: 0 dBm
  - Minimum transmitter output power: –5 dBm
  - Center wavelength: 1280 to 1350 nm

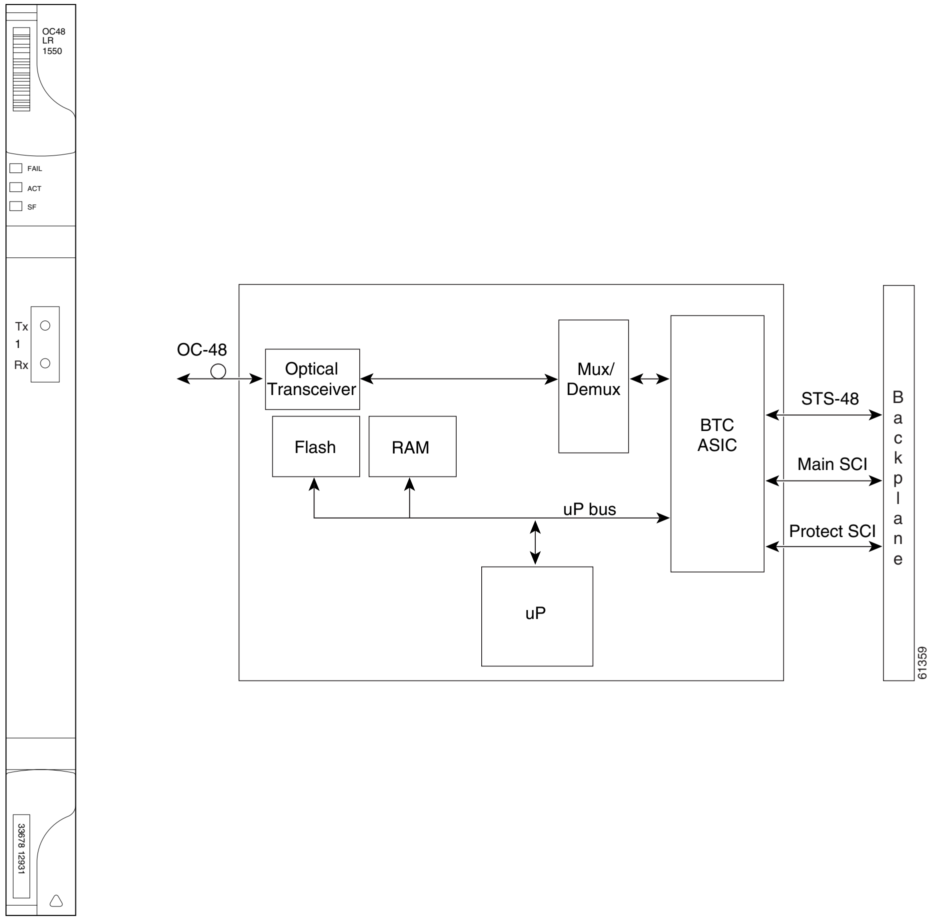
  - Nominal wavelength: 1310 nm
  - Transmitter: Uncooled direct modulated DFB
- Receiver
  - Maximum receiver level: 0 dBm
  - Minimum receiver level: –18 dBm
  - Receiver: InGaAs InP photodetector
  - Link loss budget: 13 dB minimum
  - Receiver input wavelength range: 1280 to 1350 nm
- Environmental
  - Operating temperature:

    C-Temp (15454-OC481IR1310): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 32.20 W, 0.67 A, 109.94 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 1.8 lb (0.8 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.9 OC48 LR 1550 Card

The OC48 LR 1550 card provides one long-range, SONET OC-48 port per card, compliant with Telcordia GR-253-CORE. Each port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT, nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels. Figure 4-9 shows the OC48 LR 1550 faceplate and a block diagram of the card.

Figure 4-9 OC48 LR 1550 Faceplate and Block Diagram



You can install OC48 LR 1550 cards in Slots 5, 6, 12, and 13 and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or ADM (linear) configuration.

The OC48 LR 1550 port features a 1550-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses SC connectors, and it supports 1+1 unidirectional and bidirectional protection switching.

The OC48 LR 1550 detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. The card also counts section and line BIP errors.

4.1.9.1 OC48 LR 1550 Card-Level Indicators

Table 4-9 describes the three card-level LEDs on the OC48 LR 1550 card.

Table 4-9 OC48 LR 1550 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.

Table 4-9 OC48 LR 1550 Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.9.2 OC48 LR 1550 Port-Level Indicators

You can find the status of the OC48 LR 1550 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.9.3 OC48 LR 1550 Card Specifications

The OC48 LR 1550 card has the following specifications:

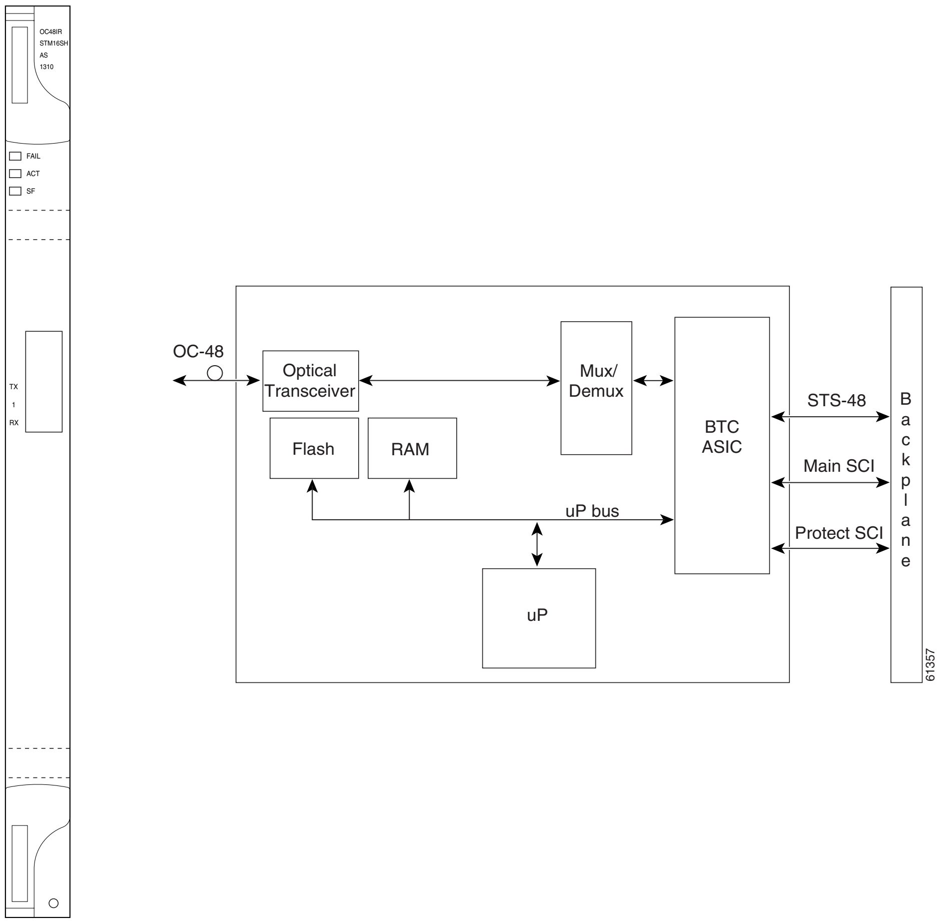
- Line
  - Bit rate: 2.49 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE
- Transmitter
  - Maximum transmitter output power: +3 dBm
  - Minimum transmitter output power: –2 dBm
  - Center wavelength: 1520 to 1580 nm
  - Nominal wavelength: 1550 nm
  - Transmitter: DFB laser
- Receiver
  - Maximum receiver level: –8 dBm
  - Minimum receiver level: –28 dBm
  - Receiver: InGaAs avalanche photo diode (APD) photodetector
  - Link loss budget: 26 dB minimum, with 1 dB dispersion penalty

   - Receiver input wavelength range: 1520 to 1580 nm
- Environmental
   - Operating temperature:
     C-Temp (15454-OC481LR1550): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
   - Operating humidity: 5 to 95%, noncondensing
   - Power consumption: 26.80 W, 0.56 A, 91.50 BTU/hr
- Dimensions
   - Height:12.650 in. (321.3 mm)
   - Width: 0.716 in. (18.2 mm)
   - Depth: 9.000 in. (228.6 mm)
   - Weight not including clam shell: 1.8 lb (0.8 kg)
- Compliance
   - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.10 OC48 IR/STM16 SH AS 1310 Card

The OC48 IR/STM16 SH AS 1310 card provides one intermediate-range SONET/SDH OC-48 port compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. The port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels. Figure 4-10 shows the OC48 IR/STM16 SH AS 1310 faceplate and a block diagram of the card.

Figure 4-10 OC48 IR/STM16 SH AS 1310 Faceplate and Block Diagram



You can install the OC48 IR/STM16 SH AS 1310 card in Slots 1 to 6 and 12 to 17 and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or ADM (linear) configuration.

The OC-48 port features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The OC48 IR/STM16 SH AS 1310 uses SC connectors. The card supports 1+1 unidirectional and bidirectional protection switching.

The OC48 IR/STM16 SH AS 1310 detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. The card also counts section and line BIP errors.

4.1.10.1 OC48 IR/STM16 SH AS 1310 Card-Level Indicators

Table 4-10 lists the three card-level LEDs on the OC48 IR/STM16 SH AS 1310 card.

Table 4-10 OC48 IR/STM16 SH AS 1310 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.

Table 4-10 OC48 IR/STM16 SH AS 1310 Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.10.2 OC48 IR/STM16 SH AS 1310 Port-Level Indicators

You can find the status of the OC48 IR/STM16 SH AS 1310 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.10.3 OC48 IR/STM16 SH AS 1310 Compatibility

Refer to the "Optical Card Software Release Compatibility" table (Table 2-6 on page 2-4) and the "Optical Card Cross-Connect Compatibility" table (Table 2-7 on page 2-5) for information on optical card compatibility.

4.1.10.4 OC48 IR/STM16 SH AS 1310 Card Specifications

The OC48 IR/STM16 SH AS 1310 card has the following specifications:

- Line
  - Bit rate: 2.49 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: 0 dBm
  - Minimum transmitter output power: –5 dBm
  - Center wavelength: 1280 to 1350 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser

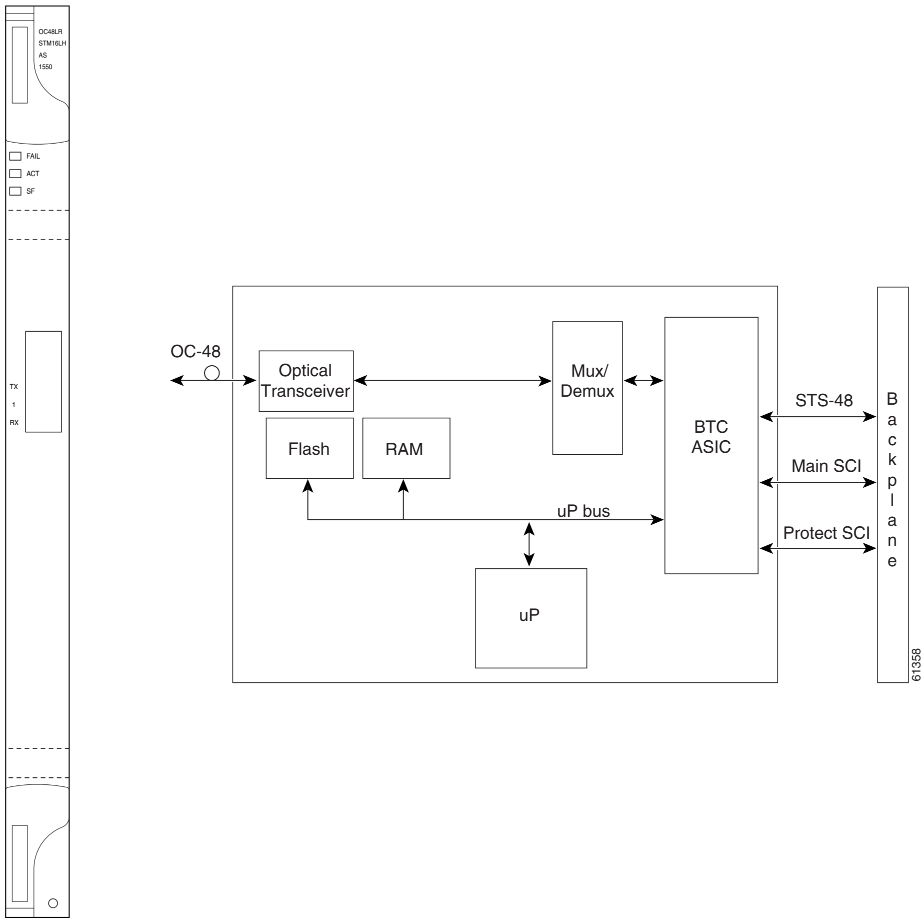
   - Dispersion tolerance: 96 ps/nm
- Receiver
   - Maximum receiver level: 0 dBm
   - Minimum receiver level: –18 dBm
   - Receiver: InGaAs InP photodetector
   - Link loss budget: 13 dB minimum
   - Receiver input wavelength range: 1280 to 1350 nm
   - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
   - Operating temperature:

     C-Temp (15454-OC481IR1310A): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
   - Operating humidity: 5 to 95%, noncondensing
   - Power consumption: 37.20 W, 0.77 A, 127.01 BTU/hr
- Dimensions
   - Height: 12.650 in. (321.3 mm)
   - Width: 0.716 in. (18.2 mm)
   - Depth: 9.000 in. (228.6 mm)
   - Weight not including clam shell: 2.2 lb (0.9 kg)
- Compliance
   - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.11 OC48 LR/STM16 LH AS 1550 Card

The OC48 LR/STM16 LH AS 1550 card provides one long-range SONET/SDH OC-48 port compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE. Each port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and nonconcatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels. Figure 4-11 shows a block diagram and the faceplate of the OC48 LR/STM16 LH AS 1550 card.

Figure 4-11 OC48 LR/STM16 LH AS 1550 Faceplate and Block Diagram



You can install OC48 LR/STM16 LH AS 1550 cards in Slots 1 to 6 and 12 to 17 and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or ADM (linear) configuration.

The OC48 LR/STM16 LH AS 1550 port features a 1550-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses SC connectors, and it supports 1+1 unidirectional and bidirectional protection switching.

The OC48 LR/STM16 LH AS 1550 detects LOS, LOF, LOP, AIS-L, and RDI-L conditions. The card also counts section and line BIP errors.

4.1.11.1 OC48 LR/STM16 LH AS 1550 Card-Level Indicators

Table 4-11 describes the three card-level LEDs on the OC48 LR/STM16 LH AS 1550 card.

Table 4-11 OC48 LR/STM16 LH AS 1550 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.

Table 4-11 OC48 LR/STM16 LH AS 1550 Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.11.2 OC48 LR/STM16 LH AS 1550 Port-Level Indicators

You can find the status of the OC48 LR/STM16 LH AS 1550 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.11.3 OC48 LR/STM16 LH AS 1550 Compatibility

Refer to the "Optical Card Software Release Compatibility" table (Table 2-6 on page 2-4) and the "Optical Card Cross-Connect Compatibility" table (Table 2-7 on page 2-5) for information on optical card compatibility.

4.1.11.4 OC48 LR/STM16 LH AS 1550 Card Specifications

The OC48 LR/STM16 LH AS 1550 card has the following specifications:

- Line
  - Bit rate: 2.49 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: +3 dBm
  - Minimum transmitter output power: –2 dBm
  - Center wavelength: 1520 to 1580 nm
  - Nominal wavelength: 1550 nm
  - Transmitter: DFB laser

  - Dispersion ratio: 3600 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm
  - Minimum receiver level: –28 dBm
  - Receiver: InGaAs APD photodetector
  - Link loss budget: 26 dB minimum, with 1 dB dispersion penalty
  - Receiver input wavelength range: 1520 to 1580 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature:

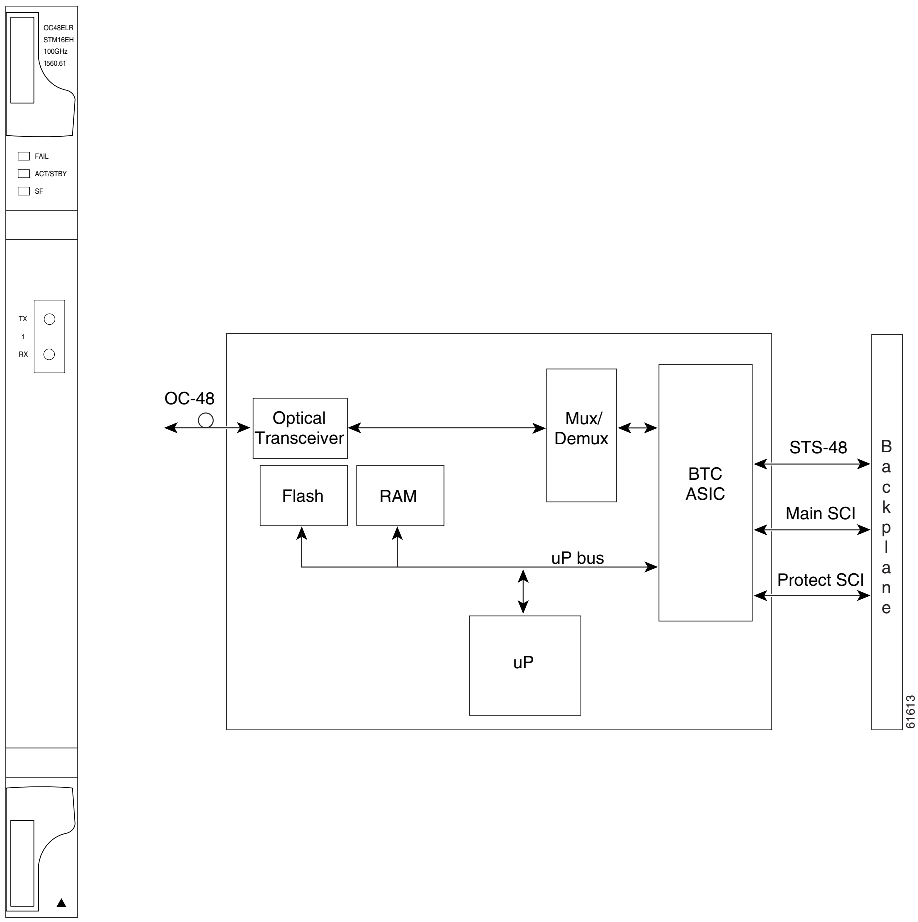
    C-Temp (15454-OC481LR1550A): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 37.20 W, 0.77 A, 127.01 BTU/hr
- Dimensions
  - Height:12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 2.2 lb (0.9 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.12 OC48 ELR/STM16 EH 100 GHz Cards

Thirty-seven distinct OC48 ELR/STM16 EH 100 GHz cards provide the ONS 15454 DWDM channel plan. Each OC48 ELR/STM16 EH 100 GHz card has one SONET OC-48/SDH STM-16 port that complies with Telcordia GR-253-CORE, ITU-T G.692, and ITU-T G.958.

The port operates at 2.49 Gbps over a single-mode fiber span. The card carries VT, concatenated, and nonconcatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels. Figure 4-12 shows the OC48 ELR/STM16 EH 100 GHz faceplate and a block diagram of the card.

Figure 4-12 OC48 ELR/STM16 EH 100 GHz Faceplate and Block Diagram



Nineteen of the cards operate in the blue band with spacing of 100 GHz on the ITU grid (1528.77 nm, 1530.33 nm, 1531.12 nm, 1531.90 nm, 1532.68 nm, 1533.47 nm, 1534.25 nm, 1535.04 nm, 1535.82 nm, 1536.61 nm, 1538.19 nm, 1538.98 nm, 1539.77 nm, 1540.56 nm, 1541.35 nm, 1542.14 nm, 1542.94 nm, 1543.73 nm, and 1544.53 nm). ITU spacing conforms to ITU-T G.692 and Telcordia GR-2918-CORE, Issue 2.

The other 18 cards operate in the red band with spacing of 100 GHz on the ITU grid (1546.12 nm, 1546.92 nm, 1547.72 nm, 1548.51 nm,1549.32 nm, 1550.12 nm, 1550.92 nm, 1551.72 nm, 1552.52 nm, 1554.13 nm, 1554.94 nm, 1555.75 nm, 1556.55 nm, 1557.36 nm, 1558.17 nm, 1558.98 nm, 1559.79 nm, and 1560.61 nm). These cards are also designed to interoperate with the Cisco ONS 15216 DWDM solution.

You can install the OC48 ELR/STM16 EH 100 GHz cards in Slots 5, 6, 12, and 13, and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or ADM (linear) configuration. Each OC48 ELR/STM16 EH 100 GHz card uses extended long-reach optics operating individually within the ITU-T 100-GHz grid. The OC-48 DWDM cards are intended to be used in applications with long unregenerated spans of up to 300 km (186 miles) (with mid-span amplification). These transmission distances are achieved through the use of inexpensive optical amplifiers (flat gain amplifiers) such as Cisco ONS 15216 erbium-doped fiber amplifiers (EDFAs).

Maximum system reach in filterless applications is 26 dB without the use of optical amplifiers or regenerators. However, system reach also depends on the condition of the facilities, number of splices and connectors, and other performance-affecting factors. When used in combination with ONS 15216

100-GHz filters, the link budget is reduced by the insertion loss of the filters plus an additional 2-dB power penalty. The wavelength stability of the OC48 ELR/STM16 EH 100 GHz cards is +/– 0.12 nm for the life of the product and over the full range of operating temperatures. Each interface contains a transmitter and receiver.

The OC48 ELR/STM16 EH 100 GHz cards detect LOS, LOF, LOP, and AIS-L conditions. The cards also count section and line BIP errors.

4.1.12.1 OC48 ELR 100 GHz Card-Level Indicators

Table 4-12 lists the three card-level LEDs on the OC48 ELR/STM16 EH 100 GHz cards.

Table 4-12 OC48 ELR/STM16 EH 100 GHz Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.12.2 OC48 ELR 100 GHz Port-Level Indicators

You can find the status of the OC48 ELR/STM16 EH 100 GHz card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to quickly view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.12.3 OC48 ELR 100 GHz Card Specifications

The OC48 ELR 100 GHz card has the following specifications:

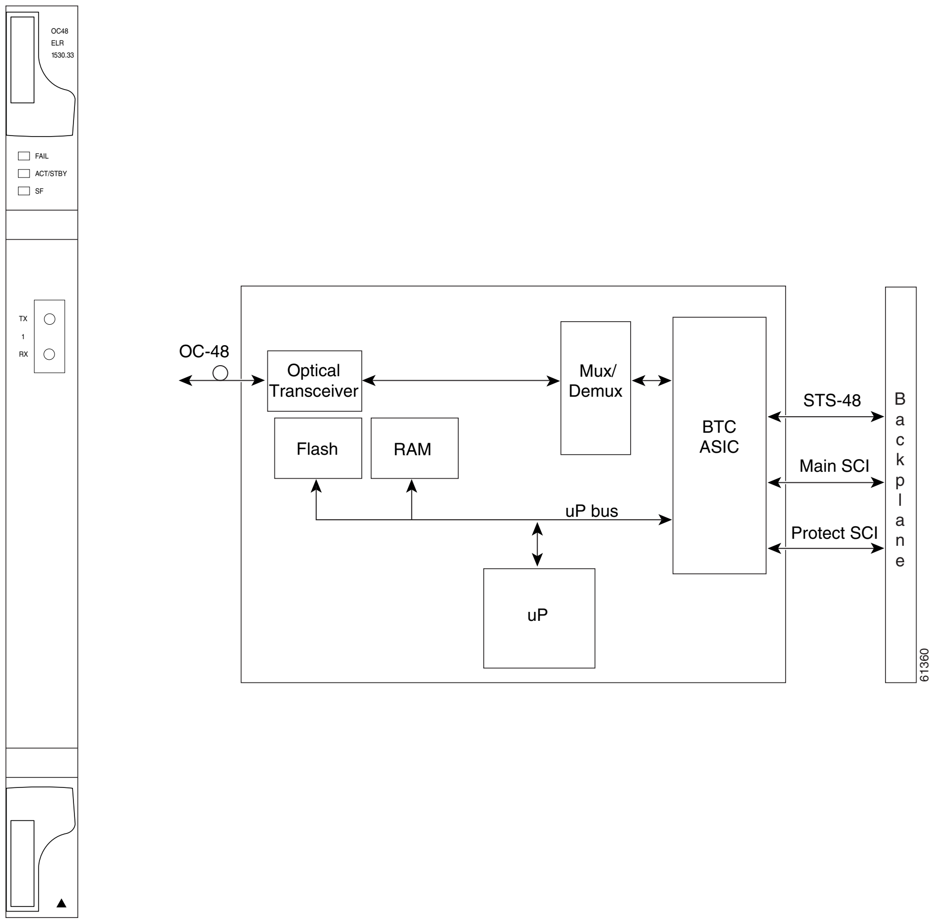
- Line
  - Bit rate: 2.49 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.692, ITU-T G.958

- Transmitter
  - Maximum transmitter output power: 0 dBm
  - Minimum transmitter output power: –2 dBm
  - Center wavelength: ±.12 nm
  - Transmitter: Electro-absorption laser
  - Dispersion tolerance: 5400 ps/nm
- Receiver
  - Maximum receiver level: –9 dBm
  - Minimum receiver level: –27 dBm at 1E–12 BER
  - Receiver: InGaAs APD photodetector
  - Link loss budget: 25 dB minimum at 1E–12 BER (not including the power dispersion penalty)
  - Dispersion Penalty: 2 dB for a dispersion of up to 5400 ps/nm
  - Receiver input wavelength range: 1520 to 1580 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature: C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 31.20 W, 0.65 A, 106.53 BTU/hr
- Dimensions
  - Height:12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 2.4 lb (1.1 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.13 OC48 ELR 200 GHz Cards

Eighteen distinct OC48 ELR 200 GHz cards provide the ONS 15454 DWDM channel plan. Each OC48 ELR 200 GHz card provides one SONET OC-48 port that is compliant with Telcordia GR-253-CORE. The port operates at 2.49 Gbps over a single-mode fiber span. The card carries VT, concatenated, and nonconcatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels. Figure 4-13 shows the OC48 ELR 200 GHz faceplate and a block diagram of the card.

Figure 4-13 OC48 ELR 200 GHz Faceplate and Block Diagram



Nine of the cards operate in the blue band with spacing of 200 GHz on the ITU grid (1530.33 nm, 1531.90 nm, 1533.47 nm, 1535.04 nm, 1536.61 nm, 1538.19 nm, 1539.77 nm, 1541.35 nm, and 1542.94 nm).

The other nine cards operate in the red band with spacing of 200 GHz on the ITU grid (1547.72 nm, 1549.32 nm, 1550.92 nm, 1552.52 nm, 1554.13 nm, 1555.75 nm, 1557.36 nm, 1558.98 nm, and 1560.61 nm). These cards are also designed to interoperate with the Cisco ONS 15216 DWDM solution.

You can install the OC48 ELR 200 GHz cards in Slots 5, 6, 12, and 13, and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or ADM (linear) configuration. Each OC48 ELR 200 GHz card uses extended long-reach optics operating individually within the ITU-T 200-GHz grid. The OC48 ELR 200 GHz cards are intended to be used in applications with long unregenerated spans of up to 200 km (124 miles) (with mid-span amplification). These transmission distances are achieved through the use of inexpensive optical amplifiers (flat gain amplifiers) such as EDFAs. Using collocated amplification, distances up to 200 km (124 miles) can be achieved for a single channel, 160 km (99 miles) for 8 channels.

Maximum system reach in filterless applications is 24 dB or approximately 80 km (50 miles) without the use of optical amplifiers or regenerators. However, system reach also depends on the condition of the facilities, number of splices and connectors or other performance-affecting factors. The OC48 ELR DWDM cards feature wavelength stability of +/–0.25 nm. Each interface contains a transmitter and receiver.

The OC48 ELR 200 GHz cards are the first in a family of cards meant to support extended long-reach applications in conjunction with optical amplification. Using electro-absorption technology, the OC48 DWDM cards provide a solution at the lower extended long-reach distances.

The OC48 ELR 200 GHz interface features a 1550-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses SC connectors and supports 1+1 unidirectional and bidirectional protection switching.

The OC48 ELR 200 GHz cards detect LOS, LOF, LOP, AIS-L, and RDI-L conditions. The cards also count section and line BIP errors. To enable APS, the OC48 ELR 200 GHz cards extract the K1 and K2 bytes from the SONET overhead. The DCC bytes are forwarded to the TCC2 card; the TCC2 terminates the DCC/GCC.

4.1.13.1 OC48 ELR 200 GHz Card-Level Indicators

Table 4-13 describes the three card-level LEDs on the OC48 ELR 200 GHz cards.

Table 4-13 OC48 ELR 200 GHz Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.13.2 OC48 ELR 200 GHz Port-Level Indicators

You can find the status of the OC48 ELR 200 GHz card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to quickly view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.13.3 OC48 ELR 200 GHz Card Specifications

The OC48 ELR 200 GHz card has the following specifications:

- Line
  - Bit rate: 2.49 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode

- Loopback modes: Terminal and facility
- Connectors: SC
- Compliance: Telcordia GR-253-CORE, ITU-T G692, ITU-T G958

- Transmitter
  - Maximum transmitter output power: 0 dBm
  - Minimum transmitter output power: –2 dBm
  - Center wavelength: ±.25 nm
  - Transmitter: Electro-absorption laser
  - Dispersion tolerance: 3600 ps/nm
- Receiver
  - Maximum receiver level: –8 dBm
  - Minimum receiver level: –28 dBm
  - Receiver: InGaAs APD photodetector
  - Link loss budget: 26 dB minimum, with 1 dB dispersion penalty
  - Receiver input wavelength range: 1520 to 1580 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 31.20 W, 0.65 A, 106.53 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 2.9 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.14 OC192 SR/STM64 IO 1310 Card

The OC192 SR/STM64 IO 1310 card provides one intra-office haul SONET/SDH OC-192 port in the 1310-nm wavelength range, compliant with ITU-T G.707, ITU-T G.691, ITU-T G.957, and Telcordia GR-253-CORE. The port operates at 9.95328 Gbps over unamplified distances up to 2 km (1.24 miles). The card supports VT and nonconcatenated or concatenated payloads. Figure 4-14 shows the OC192 SR/STM64 IO 1310 faceplate.

Figure 4-14 OC192 SR/STM64 IO 1310 Faceplate

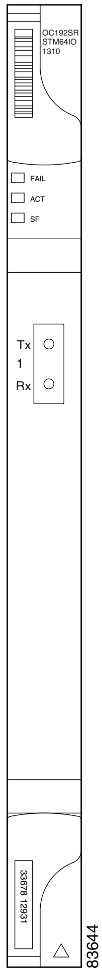
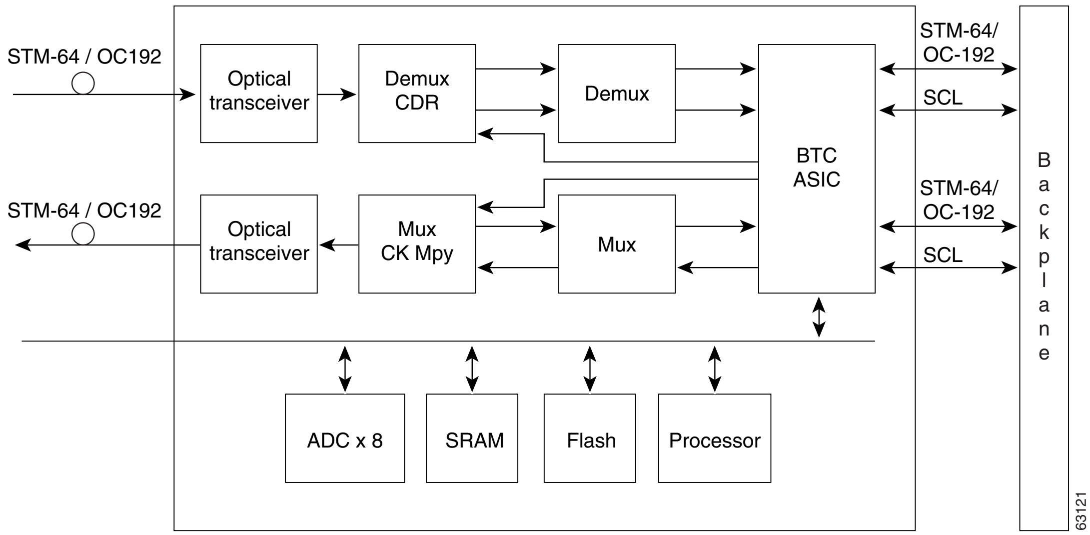


Figure 4-15 shows a block diagram of the OC192 SR/STM64 IO 1310 card.

Figure 4-15 OC192 SR/STM64 IO 1310 Block Diagram



You can install OC192 SR/STM64 IO 1310 cards in Slot 5, 6, 12, or 13. You can provision this card as part of an BLSR, a path protection, a linear configuration, or as a regenerator for longer span reaches.

The OC192 SR/STM64 IO 1310 port features a 1310-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses a dual SC connector for optical cable termination. The card supports 1+1 unidirectional and bidirectional facility protection. It also supports 1:1 protection in four-fiber bidirectional line switched ring applications where both span switching and ring switching might occur.

The OC192 SR/STM64 IO 1310 card detects SF, LOS, or LOF conditions on the optical facility. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors from B1 and B2 byte registers in the section and line overhead.

4.1.14.1 OC192 SR/STM64 IO 1310 Card-Level Indicators

Table 4-14 describes the three card-level LEDs on the OC192 SR/STM64 IO 1310 card.

Table 4-14 OC192 SR/STM64 IO 1310 Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	If the ACT/STBY LED is green, the card is operational and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.1.14.2 OC192 SR/STM64 IO 1310 Port-Level Indicators

You can find the status of the OC192 SR/STM64 IO 1310 card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

4.1.14.3 OC192 SR/STM64 IO 1310 Card Specifications

The OC 192 SR/STM64 IO 1310 card has the following specifications:

- Line
  - Bit rate: 9.95328 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, ITU-T G.691
- Transmitter
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Directly modulated laser
- Receiver
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –11 dBm at BER 1 * 10 exp – 12
  - Receiver: PIN diode
  - Link loss budget: 5 dB minimum, plus 1 dB dispersion penalty at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1290 to 1330 nm
  - Dispersion tolerance: 6.6 ps/nm
- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 47.00 W, 0.98 A at –48 V, 160.5 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)

- Depth with backplane connector: 9.250 in. (235 mm)
- Weight not including clam shell: 3.1 lb (1.3 kg)

- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.15 OC192 IR/STM64 SH 1550 Card

Warning **High-performance devices on this card can get hot during operation. To remove the card, hold it by the faceplate and bottom edge. Allow the card to cool before touching any other part of it or before placing it in an antistatic bag.**

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

The OC192 IR/STM64 SH 1550 card provides one intermediate reach SONET/SDH OC-192 port in the 1550-nm wavelength range, compliant with ITU-T G.707,ITU-T G.691, ITU-T G.957, and Telcordia GR-253-CORE. The port operates at 9.95328 Gbps over unamplified distances up to 40 km (25 miles) with SMF-28 fiber limited by loss and/or dispersion. The card supports VT and nonconcatenated or concatenated payloads. Figure 4-16 shows the OC192 IR/STM64 SH 1550 faceplate.

Figure 4-16 OC192 IR/STM64 SH 1550 Faceplate

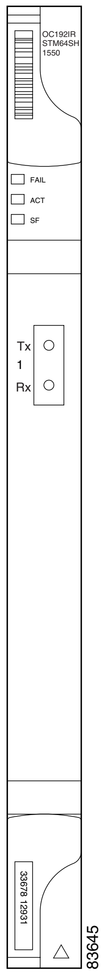
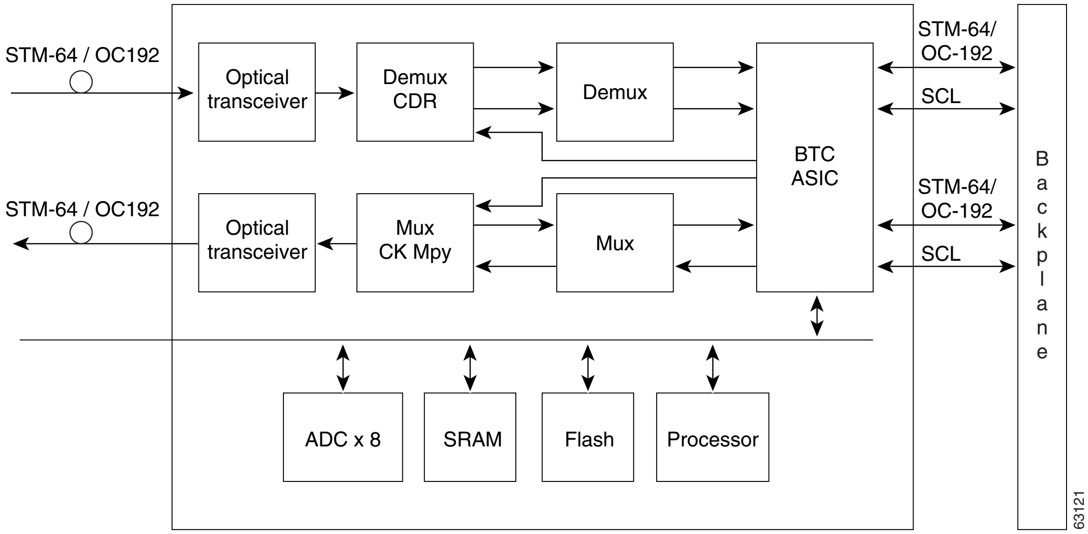


Figure 4-17 shows a block diagram of the OC192 IR/STM64 SH 1550 card.

Figure 4-17 OC192 IR/STM64 SH 1550 Block Diagram



Note You must use a 3 to 15 dB fiber attenuator (5 dB recommended) when working with the OC192 IR/STM64 SH 1550 card in a loopback. Do not use fiber loopbacks with the OC192 IR/STM64 SH 1550 card. Using fiber loopbacks can cause irreparable damage to the card.

You can install OC192 IR/STM64 SH 1550 cards in Slot 5, 6, 12, or 13. You can provision this card as part of an BLSR, path protection, or linear configuration, or also as a regenerator for longer span reaches.

The OC192 IR/STM64 SH 1550 port features a 1550-nm laser and contains a transmit and receive connector (labeled) on the card faceplate. The card uses a dual SC connector for optical cable termination. The card supports 1+1 unidirectional and bidirectional facility protection. It also supports 1:1 protection in four-fiber bidirectional line switched ring applications where both span switching and ring switching might occur.

The OC192 IR/STM64 SH 1550 card detects SF, LOS, or LOF conditions on the optical facility. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors from B1 and B2 byte registers in the section and line overhead.

4.1.15.1 OC192 IR/STM64 SH 1550 Card-Level Indicators

Table 4-15 describes the three card-level LEDs on the OC192 IR/STM64 SH 1550 card.

Table 4-15 OC192 IR/STM64 SH 1550 Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.

Table 4-15 OC192 IR/STM64 SH 1550 Card-Level Indicators (continued)

Card-Level LED	Description
ACT/STBY LED Green (Active) Amber (Standby)	If the ACTV/STBY LED is green, the card is operational and ready to carry traffic. If the ACTV/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.1.15.2 OC192 IR/STM64 SH 1550 Port-Level Indicators

You can find the status of the OC192 IR/STM64 SH 1550 card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

4.1.15.3 OC192 IR/STM64 SH 1550 Card Specifications

The OC192 IR/STM64 SH 1550 card has the following specifications:

- Line
  - Bit rate: 9.95328 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 800 ps/nm
  - Loopback modes: Terminal and facility

Note You must use a 3 to 15 dB fiber attenuator (5 dB recommended) when working with the OC192 IR/STM64 SH 1550 card in a loopback. Do not use fiber loopbacks with the OC192 IR/STM64 SH 1550 card. Using fiber loopbacks can cause irreparable damage to the OC192 IR/STM64 SH 1550 card.

  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, ITU-T G.691
- Transmitter
  - Maximum transmitter output power: +2 dBm
  - Minimum transmitter output power: –1 dBm
  - Center wavelength: 1530 to 1565 nm
  - Nominal wavelength: 1550 nm
  - Transmitter: Cooled EA modulated laser
- Receiver
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12

- Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
- Receiver: PIN diode
- Link loss budget: 13 dB minimum, plus 2 dB dispersion penalty at BER = 1 * 10 exp – 12 including dispersion
- Receiver input wavelength range: 1530 to 1565 nm
- Dispersion Tolerance: 800 ps/nm

- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 50.00 W, 1.04 A at –48 V, 170.7 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.16 OC192 LR/STM64 LH 1550 Card

The OC192 LR/STM64 LH 1550 card provides one long-range SONET/SDH OC-192 port compliant with ITU-T G.707, ITU-T G.691, ITU-T G.957, and Telcordia GR-253-CORE (except minimum and maximum transmit power, and minimum receive power). The card port operates at 9.96 Gbps over unamplified distances up to 80 km (50 miles) with different types of fiber such as C-SMF or dispersion compensated fiber limited by loss and/or dispersion. The card supports VT and nonconcatenated or concatenated payloads.

Figure 4-18 shows the OC192 LR/STM64 LH 1550 faceplate and a block diagram of the card.

Figure 4-18 OC192 LR/STM64 LH 1550 Faceplate and Block Diagram

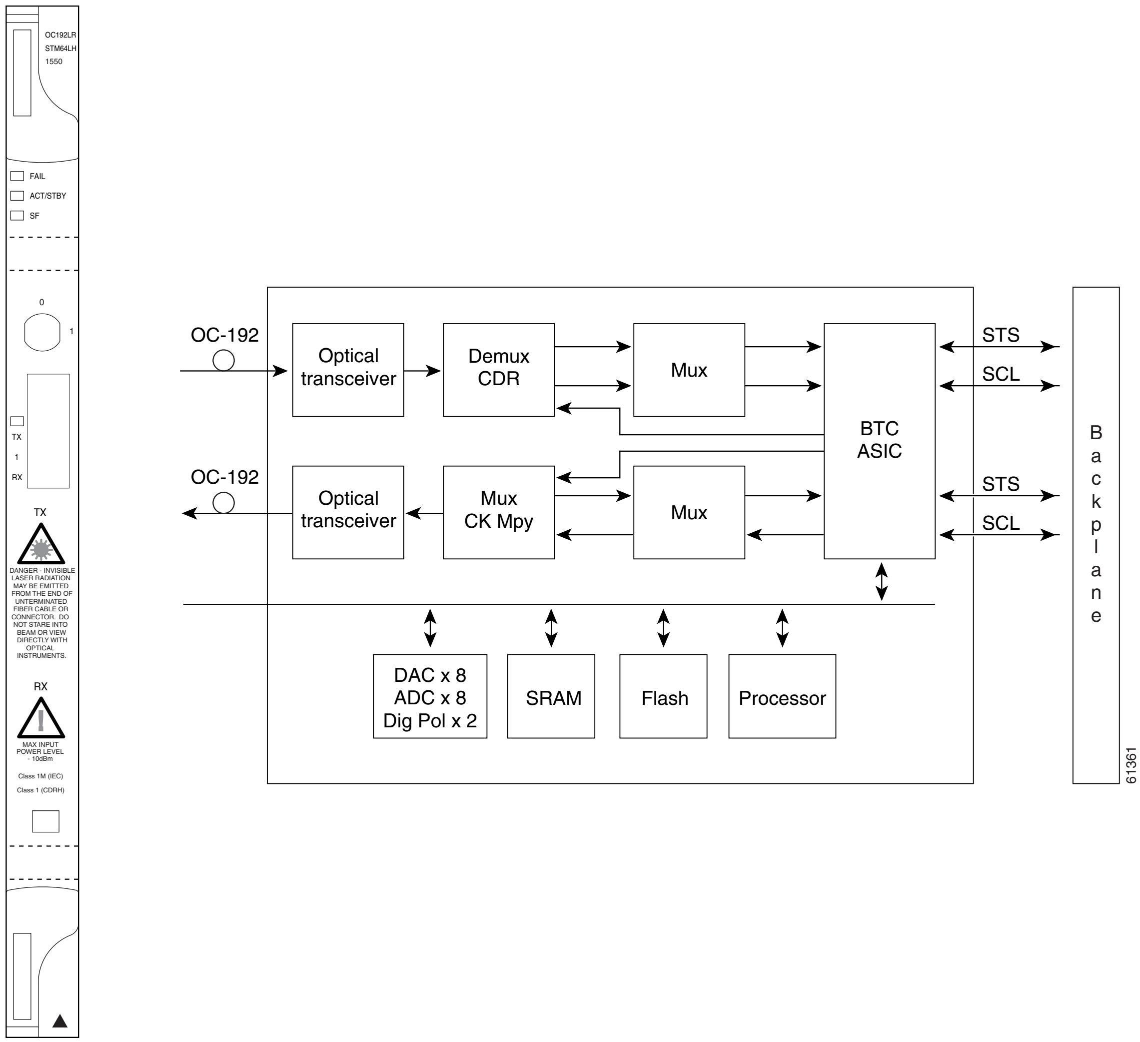
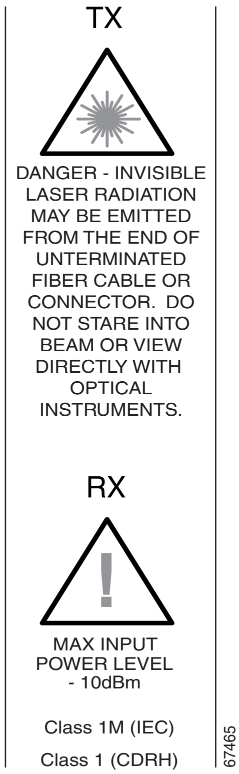


Figure 4-19 shows an enlarged view of the faceplate warning.

Figure 4-19 Enlarged Section of the OC192 LR/STM64 LH 1550 Faceplate



Caution You must use a 19 to 24 dB (20 dB recommended) fiber attenuator when connecting a fiber loopback to an OC192 LR/STM64 LH 1550 card. Never connect a direct fiber loopback. Using fiber loopbacks causes irreparable damage to the card. A transmit-to-receive (Tx-to-Rx) connection that is not attenuated damages the receiver.

You can install OC192 LR/STM64 LH 1550 cards in Slots 5, 6, 12, and 13 and provision the card as a drop or span card in a two-fiber or four-fiber BLSR, path protection, or ADM (linear) configuration.

The OC-192 card port features a 1550-nm laser and contains a transmit and receive connector (labeled) on the card faceplate.

Warning **On the OC192 LR/STM64 LH 1550 card, the laser is on if the card is booted and the safety key is in the on position (labeled 1). The port does not have to be in service for the laser to be on. The laser is off when the safety key is off (labeled 0).**

The card uses a dual SC connector for optical cable termination. The card supports 1+1 unidirectional and bidirectional facility protection. It also supports 1:1 protection in four-fiber bidirectional line switched ring applications where both span switching and ring switching might occur.

The OC192 LR/STM64 LH 1550 card detects SF, LOS, or LOF conditions on the optical facility. The card also counts section and line BIT errors from B1 and B2 byte registers in the section and line overhead.

4.1.16.1 OC192 LR/STM64 LH 1550 Card-Level Indicators

Table 4-16 describes the three card-level LEDs on the OC192 LR/STM64 LH 1550 card.

Table 4-16 OC192 LR/STM64 LH 1550 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	If the ACT/STBY LED is green, the card is operational and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on the card's port. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected, the light turns off.

4.1.16.2 OC192 LR/STM64 LH 1550 Port-Level Indicators

You can find the status of the OC192 LR/STM64 LH 1550 card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of the port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.**

4.1.16.3 OC192 LR/STM64 LH 1550 Compatibility

Refer to the "Optical Card Software Release Compatibility" table (Table 2-6 on page 2-4) and the "Optical Card Cross-Connect Compatibility" table (Table 2-7 on page 2-5) for information on optical card compatibility.

4.1.16.4 OC192 LR/STM64 LH 1550 Card Specifications

The OC192 LR/STM64 LH 1550 card has the following specifications:

- Line
  - Bit rate: 9.96 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Note You must use a 19 to 24 dB (20 dB recommended) fiber attenuator when connecting a fiber loopback to an OC192 LR/STM64 LH 1550 card. Never connect a direct fiber loopback.

  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: +10 dBm
  - Minimum transmitter output power: +7 dBm
  - Center wavelength: 1530 to 1565 nm
  - Nominal wavelength: 1550 nm
  - Transmitter: LN (Lithium Niobate) external modulator transmitter
- Receiver
  - Maximum receiver level: –10 dBm
  - Minimum receiver level: –19 dBm
  - Receiver: APD/TIA
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 – exp (–12) including dispersion
  - Receiver input wavelength range: 1530 to 1565 nm
  - Jitter tolerance: Telcordia GR-253/ITU-T G.823 compliant
  - Dispersion tolerance: 1360 ps/nm
- Environmental
  - Operating temperature:

    C-Temp (15454-OC192LR1550): –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 72.20 W, 1.50 A, 246.52 BTU/hr
- Dimensions
  - Height:12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.1.17 OC192 LR/STM64 LH ITU 15xx.xx Card

Sixteen distinct OC-192/STM-64 ITU 100 GHz DWDM cards comprise the ONS 15454 DWDM channel plan. Each OC192 LR/STM64 LH ITU 15xx.xx card provides one long-reach STM-64/OC-192 port per card, compliant with ITU-T G.707, ITU-T G.957, and and Telcordia GR-253-CORE (except minimum and maximum transmit power, and minimum receive power). The port operates at 9.95328 Gbps over unamplified distances up to 60 km (37 miles) with different types of fiber such as C-SMF or dispersion compensated fiber limited by loss and/or dispersion.

Note Longer distances are possible in an amplified system using dispersion compensation.

The card supports VT and nonconcatenated or concatenated payloads. Figure 4-20 shows the OC192 LR/STM64 LH ITU 15xx.xx faceplate.

Figure 4-20 OC192 LR/STM64 LH ITU 15xx.xx Faceplate

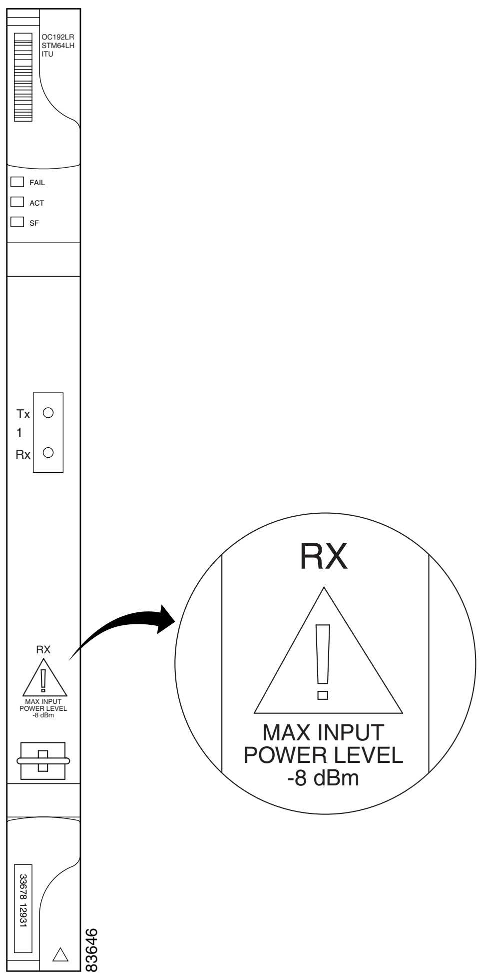
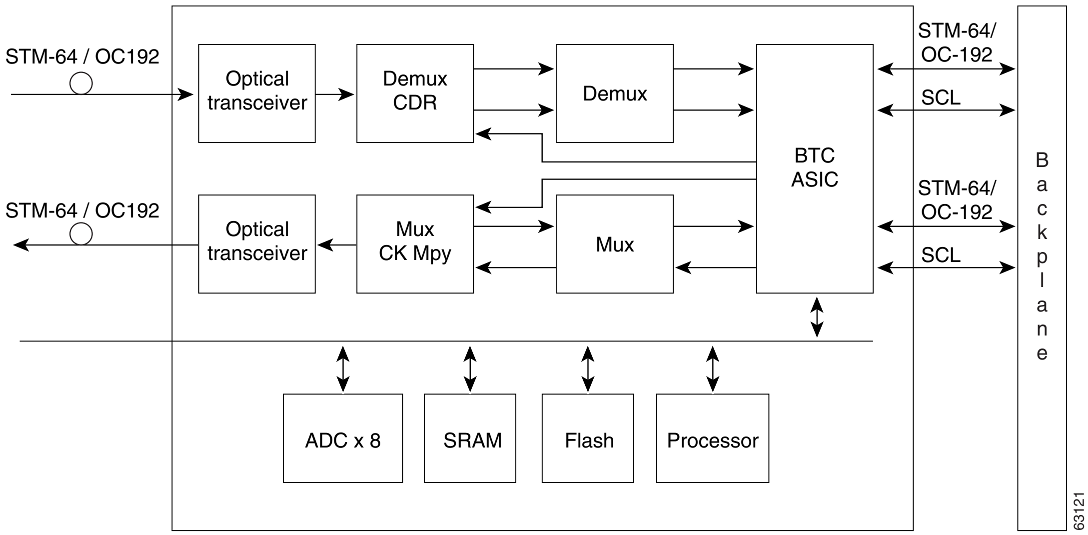


Figure 4-21 shows a block diagram of the OC192 LR/STM64 LH ITU 15xx.xx card.

Figure 4-21 OC192 LR/STM64 LH ITU 15xx.xx Block Diagram



Note You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the OC192 LR/STM64 LH 15xx.xx card in a loopback. Do not use fiber loopbacks with the OC192 LR/STM64 LH 15xx.xx card. Using fiber loopbacks causes irreparable damage to this card.

Eight of the cards operate in the blue band with a spacing of 100 GHz in the ITU grid (1534.25 nm, 1535.04 nm, 1535.82 nm, 1536.61 nm, 1538.19 nm, 1538.98 nm, 1539.77 nm, and 1540.56 nm). The other eight cards operate in the red band with a spacing of 100 GHz in the ITU grid (1550.12 nm, 1550.92 nm, 1551.72 nm, 1552.52 nm, 1554.13 nm, 1554.94 nm, 1555.75 nm, and 1556.55 nm).

You can install OC192 LR/STM64 LH ITU 15xx.xx cards in Slot 5, 6, 12, or 13. You can provision this card as part of an BLSR, path protection, or linear configuration or also as a regenerator for longer span reaches.

The OC192 LR/STM64 LH ITU 15xx.xx port features a laser on a specific wavelength in the 1550-nm range and contains a transmit and receive connector (labeled) on the card faceplate. The card uses a dual SC connector for optical cable termination. The card supports 1+1 unidirectional and bidirectional facility protection. It also supports 1:1 protection in four-fiber BLSR applications where both span switching and ring switching might occur.

The OC192 LR/STM64 LH ITU 15xx.xx card detects SF, LOS, or LOF conditions on the optical facility. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors from B1 and B2 byte registers in the section and line overhead.

4.1.17.1 OC192 LR/STM64 LH ITU 15xx.xx Card-Level Indicators

Table 4-17 describes the three card-level LEDs on the OC192 LR/STM64 LH ITU 15xx.xx card.

Table 4-17 OC192 LR/STM64 LH ITU 15xx.xx Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.1.17.2 OC192 LR/STM64 LH ITU 15xx.xx Port-Level Indicators

You can find the status of the OC192 LR/STM64 LH ITU 15xx.xx card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

4.1.17.3 OC192 LR/STM64 LH ITU 15xx.xx Card Specifications

The OC192 LR/STM64 LH ITU 15xx.xx card has the following specifications:

- Line
  - Bit rate: 9.95328 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance:
    in deployments with a dispersion compensation unit (DCU): +/– 1000 ps/nm, with optical signal-to-noise ration (OSNR) of 19 dB (0.5 nm RBW)
    in deployments without a DCU: +/– 1200 ps/nm, with OSNR of 23 dB (0.5 nm RBW)
  - Loopback modes: Terminal and facility

    Note You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the OC192 LR/STM64 LH 15xx.xx card in a loopback. Do not use fiber loopbacks with the OC192 LR/STM64 LH 15xx.xx card. Using fiber loopbacks causes irreparable damage to this card.

  - Connectors: SC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.691, ITU-T G.957
- Transmitter
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm

- Center wavelength: See wavelength plan
- Center wavelength accuracy: +/– 0.040 nm
- Transmitter: LN external modulator transmitter

- Receiver
  - Maximum receiver level: –8 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –22 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 25 dB minimum, plus 2 dB dispersion penalty at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1565 nm
- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 52.00 W, 1.08 A at –48 V, 177.6 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.
- Currently available wavelengths and versions of OC192 LR/STM64 LH ITU 15xx.xx card:

  ITU grid blue band:
  - 1534.25 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1534.25
  - 1535.04 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1535.04
  - 1535.82 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1535.82
  - 1536.61 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1536.61
  - 1538.19 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1538.19
  - 1538.98 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1538.98
  - 1539.77 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1539.77
  - 1540.56 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1540.56

  ITU grid red band:
  - 1550.12 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1550.12
  - 1550.92 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1550.92
  - 1551.72 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1551.72
  - 1552.52 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1552.52

- 1554.13 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1554.13
- 1554.94 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1554.94
- 1555.75 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1555.75
- 1556.55 +/– 0.040 nm, OC192 LR/STM64 LH ITU 1556.55

4.2 Transponder and Muxponder Cards

This section gives an overview and detailed descriptions of the Cisco ONS 14454 transponder and muxponder cards

4.2.1 Transponder and Muxponder Card Overview

Warning **Class 1 (21 CFR 1040.10 and 1040.11) and Class 1M (IEC 60825-1 2001-01) laser products. Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not stare into the beam or view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. Use of controls or adjustments, or performance of procedures other than those specified may result in hazardous radiation exposure.Invisible laser radiation present.**

Warning **Use of controls, adjustments, or performing procedures other than those specified may result in hazardous radiation exposure.**

For software and cross-connect card compatibility information, see the "2.1.2 Card Compatibility" section on page 2-2.

Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. See the "1.13 Cards and Slots" section on page 1-42 for a list of slots and symbols.

Table 4-18 lists the Cisco ONS 15454 transponder and muxponder cards

Table 4-18 Transponder and Muxponder Cards for the ONS 15454

Card	Port Description	For Additional Information...
TXP_MR_10G	The TXP_MR_10G (10-Gbps Transponder–100-GHz–Tunable xx.xx-xx.xx) card provides one extended long-range OC-192 port (trunk side) and one short-range OC-192 port (client side). It can process one standard OC-192 interface for use in a 100-GHz DWDM system. On the trunk side, it can provide forward error correction (FEC). The card is tunable over two neighboring wavelengths in the 1550-nm, ITU 100-GHz range. It is available in four different versions, covering eight different wavelengths in the 1550-nm range. For the individual card, "xx.xx" is replaced with the wavelength intended to be used. The card operates in Slots 1 to 6 and 12 to 17. **Note** The trunk side is also known as the span side.	See the "4.2.2 TXP_MR_10G Card" section on page 4-61.
MXP_2.5G_10G	The MXP_2.5G_10G (2.5-Gbps–10-Gbps Muxponder–100 GHz–Tunable xx.xx-xx.xx) card provides one extended long-range OC-192 port (trunk side) and four short-range OC-48 ports (client side). It can multiplex four standard OC-48 interfaces into one OC-192 interface for use in a 100-GHz DWDM system. On the trunk side, it can provide FEC. The card is tunable over two neighboring wavelengths in the 1550-nm, ITU 100-GHz range. It is available in four different versions, covering eight different wavelengths in the 1550-nm range. For the individual card, "xx.xx" is replaced with the wavelength intended to be used. The card operates in Slots 1 to 6 and 12 to 17.	See the "4.2.3 MXP_2.5G_10G Card" section on page 4-65.

Table 4-18 Transponder and Muxponder Cards for the ONS 15454 (continued)

Card	Port Description	For Additional Information...
TXP_MR_2.5G	The TXP_MR_2.5G (2.5-Gbps Multirate Transponder–100-GHz–Tunable xx.xx-xx.xx) card provides one long-range OC-48 port (trunk side) and one client side interface ranging from 8 Mbps to 2.488 Gbps. It can process one standard OC-48 interface for use in a 100-GHz DWDM system. On the trunk side, it can provide forward error correction (FEC). The card operates in Slots 1 to 6 and 12 to 17. The card is tunable over four wavelengths in the 1550 nm, ITU 100-GHz range. It is available in eight different versions, covering 32 different wavelengths in the 1550-nm range. For the individual card, "xx.xx" is replaced with the wavelengths intended to be used.	See the "4.2.4 TXP_MR_2.5G and TXPP_MR_2.5G Cards" section on page 4-71
TXPP_MR_2.5G	The TXPP_MR_2.5G (2.5-Gbps Multirate Transponder-Protected–100-GHz–Tunable xx.xx-xx.xx) card provides two long-range OC-48 ports (trunk side) and one client side interface ranging from 8 Mbps to 2.488 Gbps. It can process one standard OC-48 interface for use in a 100-GHz DWDM system. On the trunk side, it can provide FEC. The card operates in Slots 1 to 6 and 12 to 17. The card is tunable over four wavelengths in the 1550 nm, ITU 100-GHz range. It is available in eight different versions, covering 32 different wavelengths in the 1550-nm range. For the individual card, "xx.xx" is replaced with the wavelengths intended to be used.	See the "4.2.4 TXP_MR_2.5G and TXPP_MR_2.5G Cards" section on page 4-71

Note The Cisco OC3 IR/STM1 SH, OC12 IR/STM4 SH, and OC48 IR/STM16 SH interface optics, all working at 1310 nm, are optimized for the most widely used SMF-28 fiber, available from many suppliers.

Corning MetroCor fiber is optimized for optical interfaces that transmit at 1550 nm or in the C and L DWDM windows, and targets interfaces with higher dispersion tolerances than those found in OC3 IR/STM1 SH, OC12 IR/STM4 SH, and OC48 IR/STM16 SH interface optics. If you are using Corning MetroCor fiber, OC3 IR/STM1 SH, OC12 IR/STM4 SH, and OC48 IR/STM16 SH interface optics become dispersion limited before they become attenuation limited. In this case, consider using OC12 LR/STM4 LH and OC48 LR/STM16 LH cards instead of OC12 IR/STM4 SH and OC48 IR/STM16 SH cards.

With all fiber types, network planners/engineers should review the relative fiber type and optics specifications to determine attenuation, dispersion, and other characteristics to ensure appropriate deployment.

4.2.2 TXP_MR_10G Card

Warning **High-performance devices on this card can get hot during operation. To remove the card, hold it by the faceplate and bottom edge. Allow the card to cool before touching any other part of it or before placing it in an antistatic bag.**

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

The TXP_MR_10G card (10-Gbps Transponder–100-GHz–Tunable xx.xx-xx.xx) processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). It provides one 10Gbps port per card that can be provisioned to STM64/OC-192 Short Reach (1310nm), compliant with ITU-T G.707, G.709, ITU-T G.691, Telcordia GR-253-CORE, or to 10GE BASE-LR compliant to IEEE 802.3.

The TXP_MR_10G card is tunable over two neighboring wavelengths in the 1550-nm, ITU 100-GHz range. It is available in 16 different versions, covering 32 different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of FEC that uses a “wrapper” approach. The digital wrapper lets you transparently take in a signal on the client side, wrap a frame around it and restore it to its original form. FEC enables longer fiber links because errors caused by the optical signal degrading with distance are corrected.

The trunk port operates at 9.95328 Gbps (or 10.70923 Gbps with ITU-T G.709 Digital Wrapper/FEC) and at 10.3125 Gbps (or 11.095 Gbps with ITU-T G.709 Digital Wrapper/FEC) over unamplified distances up to 80km(50 miles) with different types of fiber such as C-SMF or dispersion-compensated fiber, limited by loss and/or dispersion.

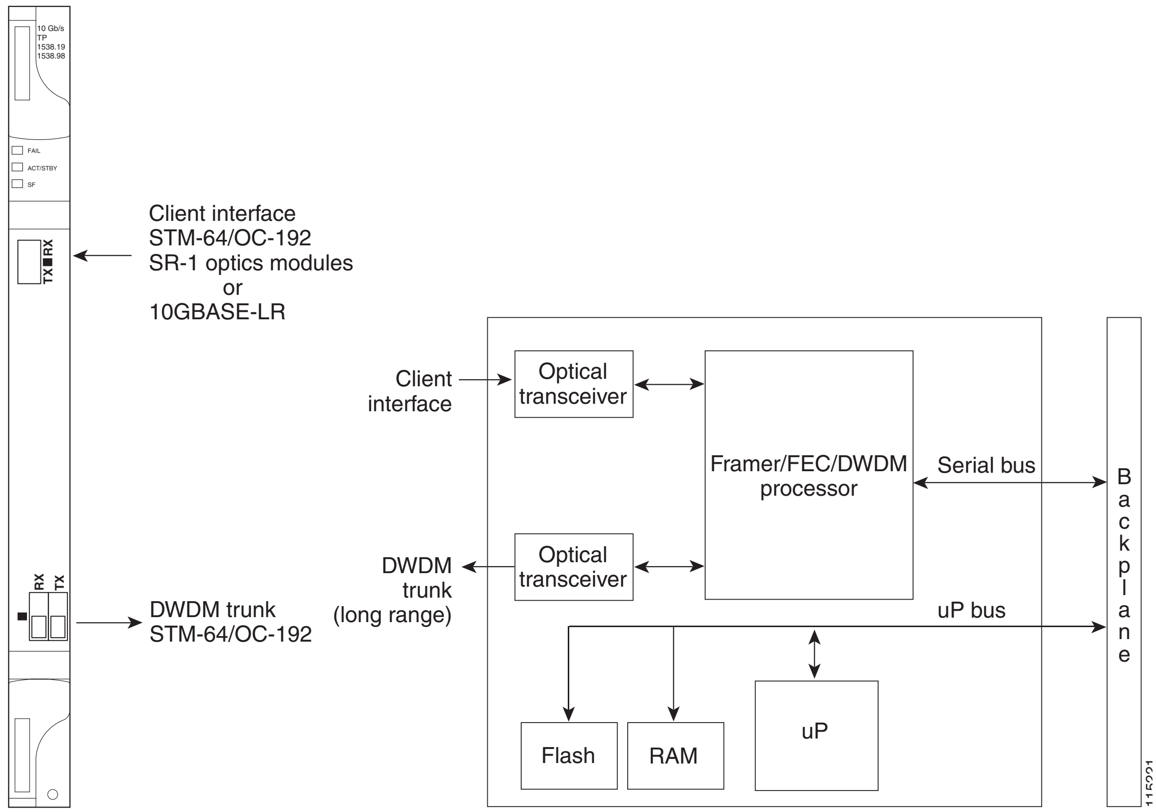
Caution Because the transponder has no capability to look into the payload and detect circuits, a TXP_MR_10G card does not display circuits under card view.

For the TXP_MR_10G card, protection is done using Y-cable protection. Two TXP_MR_10G cards can be joined in a Y-cable protection group. In Y-cable protection, the client ports of the two cards are joined by Y-cables. A single incoming Rx client signal is injected into the Rx Y-cable port and is split between the two TXP_MR_10G cards (connected to the Rx client ports) in the protection group. The transmit (Tx) client signals from the two protection group TXP_MR_10G cards are connected to the correspondent ports of the Tx Y-cable. Only the Tx client port of the Active TXP_MR_10G card is turned on and transmits the signal towards the receiving client equipment.

Note If you create a GCC on either card of the protection group, the trunk (span) port stays permanently active, regardless of the switch state. When you provision a GCC, you are provisioning unprotected overhead bytes. The GCC is not protected by the protect group.

Figure 4-22 shows the TXP_MR_10G faceplate and block diagram.

Figure 4-22 TXP_MR_10G Faceplate and Block Diagram



Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10G card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10G card.

You can install TXP_MR_10G cards in Slots 1 to 6 and 12 to 17. You can provision this card in a linear configuration. TXP_MR_10G cards cannot be provisioned as a BLSR, a path protection, or a regenerator. They can be used in the middle of BLSR or 1+1 spans. They can only be used in the middle of BLSR and 1+1 spans when the card is configured for transparent termination mode.

The TXP_MR_10G port features a 1550-nm laser for the trunk port and a 1310-nm laser for the client port and contains two transmit and receive connector pairs (labeled) on the card faceplate. The card uses dual LC connectors for optical cable termination.

The TXP_MR_10G card detects SF, LOS, or LOF conditions on the optical facility. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors from B1 and B2 byte registers in the section and line overhead.

4.2.2.1 TXP_MR_10G Card-Level Indicators

Table 4-19 lists the three card-level LEDs on the TXP_MR_10G card.

Table 4-19 TXP_MR_10G Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.2.2.2 TXP_MR_10G Port-Level Indicators

Table 4-20 lists the four port-level LEDs in the TXP_MR_10G card.

Table 4-20 TXP_MR_10G Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED	The green dense wavelength division multiplexing (DWDM) LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green Wavelength 1 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the board is configured for wavelength 1.
Green Wavelength 2 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the board is configured for wavelength 2.

4.2.2.3 TXP_MR_10G Card Specifications

The TXP_MR_10G card has the following specifications:

- Line (trunk side)
  - Bit rate: 9.95328 Gbps for OC-192/STM-64 or 10.70923 Gbps with ITU-T G.709 Digital Wrapper/FEC
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 1000 ps/nm
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10G card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10G card.

  - Connectors: LC
  - Compliance Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter (trunk side)
  - Transmitter output power: +3 dBm (with an accuracy of +/–0.5 dB)
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/- 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/- 25 pm.

- Currently available wavelengths and versions of TXP_MR_10G:

  ITU grid blue band:
  - 1538.19 to 1538.98 nm, 10T-L1-38.1
  - 1539.77 to 1540.56 nm, 10T-L1-39.7

  ITU grid red band:
  - 1554.13 to 1554.94 nm, 10T-L1-54.1
  - 1555.75 to 1556.55 nm, 10T-L1-55.7
- Receiver (trunk side)
  - -8 to -21 dBm (no FEC, unamplified, 23 dB OSNR, BER 1 * 10 exp - 12)
  - -8 to -19 dBm (no FEC, unamplified, 23 dB OSNR, @ +/- 1000 ps/nm BER 1 * 10 exp - 12)
  - -8 to -20 dBm (no FEC, amplified, 19 dB OSNR, BER 1 * 10 exp - 12)
  - -8 to -18 dBm (no FEC, amplified, 19 dB OSNR, @ +/- 1000 ps/nm BER 1 * 10 exp - 12)
  - -8 to -24 dBm (FEC, unamplified, 23 dB OSNR, BER 8 * 10 exp - 5)
  - -8 to -22 dBm (FEC, unamplified, 23 dB OSNR, @ +/- 1000 ps/nm, BER 8 * 10 exp - 5)
  - -8 to -18 dBm (FEC, amplified, 9 dB OSNR, BER 8 * 10 exp - 5)
  - -8 to -18 dBm (FEC, unamplified, 11 dB OSNR, @ +/- 800 ps/nm, BER 8 * 10 exp - 5)
  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1290 to 1605 nm
- Line (client side)
  - Bit rate: 9.95328 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 1600 ps/nm

  - Loopback modes: Terminal and facility
  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Receiver level:

    For OC-192, compliant with SR-1 Telcordia GR253 (-1 to -11 dBm)

    For 10GE LAN PHY, compliant with IEEE 802.3ae (-1 to -14.4 dBm)
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +113 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 35.00 W, 0.73 A at –48 V, 119.5 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.2.3 MXP_2.5G_10G Card

Warning **High-performance devices on this card can get hot during operation. To remove the card, hold it by the faceplate and bottom edge. Allow the card to cool before touching any other part of it or before placing it in an antistatic bag.**

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

The MXP_2.5G_10G card (2.5-Gbps–10-Gbps Muxponder–100 GHz–Tunable xx.xx-xx.xx) multiplexes/demultiplexes four 2.5-Gbps signals (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). It provides one extended long-range STM-64/OC-192 port per card on the trunk side (compliant with ITU-T G.707, G.709, ITU-T G.957, and Telcordia GR-253-CORE) and four intermediate- or short-range OC-48/STM-16 ports per card on the client side. The port operates at 9.95328 Gbps over unamplified distances up to 80 km (50 miles) with different types of fiber such as C-SMF or dispersion compensated fiber limited by loss and/or dispersion.

Client ports on the MXP_2.5G_10G card are also interoperable with OC-1 (STS-1) fiber optic signals defined in Telcordia GR.252-CORE. An OC-1 signal is the equivalent of one DS-3 channel transmitted across optical fiber. OC-1 is primarily used for trunk interfaces to phone switches in the United States.There is no SDH equivalent for OC-1.

The MXP_2.5G_10G card is tunable over two neighboring wavelengths in the 1550-nm, ITU 100-GHz range. It is available in four different versions, covering eight different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of FEC that uses a "wrapper" approach. The digital wrapper lets you transparently take in a signal on the client side, wrap a frame around it and restore it to its original form. FEC enables longer fiber links because errors caused by the optical signal degrading with distance are corrected.

The port can also operate at 10.70923 Gbps in ITU-T G.709 Digital Wrapper/FEC mode.

Caution Because the transponder has no capability to look into the payload and detect circuits, an MXP_2.5G_10G card does not display circuits under card view.

For the MXP_2.5G_10G card, protection is done using Y-cable protection. Two MXP_2.5G_10G cards can be joined in a Y-cable protection group. In Y-cable protection, the client ports of the two cards are joined by Y-cables. A single receive (Rx) client signal is injected into the Rx Y-cable and is split between the two MXP_2.5G_10G cards in the protection group. The transmit (TX) client signals from the two protection group MXP_2.5G_10G cards are connected via the TX Y-cable with only the active card signal passing through as the single TX client signal.

Note If you create a GCC on either card of the protect group, the trunk port stays permanently active, regardless of the switch state. When you provision a GCC, you are provisioning unprotected overhead bytes. The GCC is not protected by the protect group.

Figure 4-23 shows the MXP_2.5G_10G faceplate.

Figure 4-23 MXP_2.5G_10G Faceplate

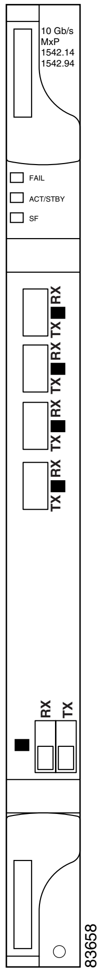
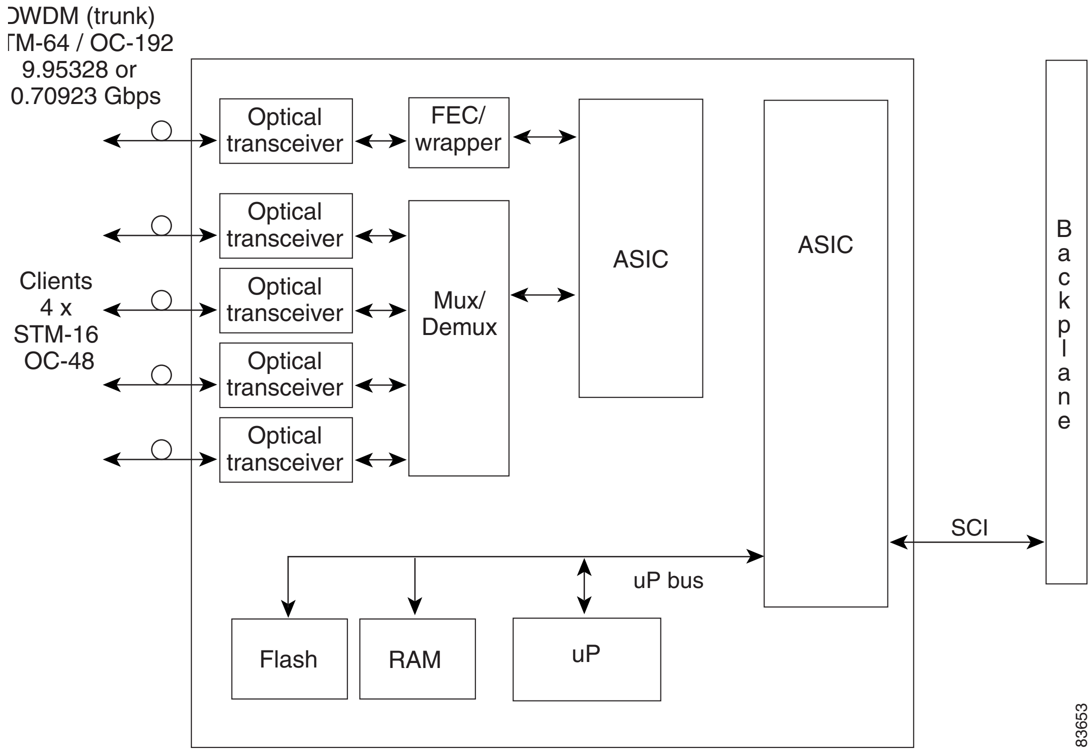


Figure 4-24 shows a block diagram of the MXP_2.5G_10G card.

Figure 4-24 MXP_2.5G_10G Block Diagram



Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10G card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10G card.

You can install MXP_2.5G_10G cards in Slots 1 to 6 and 12 to 17. You can provision this card in a linear configuration. MXP_2.5G_10G cards cannot be provisioned as a BLSR, a path protection, or a regenerator. They can be used in the middle of BLSR or 1+1 spans. They can only be used in the middle of BLSR and 1+1 spans when the card is configured for transparent termination mode.

The MXP_2.5G_10G port features a 1550-nm laser on the trunk port and four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The card uses a dual LC connector on the trunk side and small form factor pluggable (SFP) connectors on the client side for optical cable termination.

The MXP_2.5G_10G card detects SF, LOS, or LOF conditions on the optical facility. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors from B1 and B2 byte registers in the section and line overhead.

4.2.3.1 Timing Synchronization

The MXP_2.5G_10G card is synchronized to the TCC clock during normal conditions and transmits the ITU-T G.709 frame using this clock. The TCC can operate from an external BITS clock, an internal Stratum 3 clock, or from clock recovered from one of the four valid client clocks. If clocks from both TCC cards are not available, the MXP_2.5G_10G card switches automatically (with errors, not hitless) to an internal 19.44 MHz clock that does not meet SONET clock requirements. This will result in a clock alarm.

4.2.3.2 MXP_2.5G_10G Card-Level Indicators

Table 4-21 describes the three card-level LEDs on the MXP_2.5G_10G card.

Table 4-21 MXP_2.5G_10G Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.2.3.3 MXP_2.5G_10G Port-Level Indicators

Table 4-22 describes the seven port-level LEDs on the MXP_2.5G_10G card.

Table 4-22 MXP_2.5G_10G Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal. The card has four client ports, and so has four Client LEDs.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green Wavelength 1 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the board is configured for wavelength 1.
Green Wavelength 2 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the board is configured for wavelength 2.

4.2.3.4 MXP_2.5G_10G Card Specifications

The MXP_2.5G_10G card has the following specifications:

- Line (trunk side)
  - Bit rate: 9.95328 Gbps for OC-192/STM-64 or 10.70923 Gbps with ITU-T G.709 Digital Wrapper/FEC
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 1000 ps/nm

- Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10G card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10G card.

  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter (trunk side)
  - Transmitter output power: +3 dBm (with an accuracy of +/- 0.5dB)
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/- 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/- 25 pm.

- Currently available wavelengths and versions of MXP_2.5G_10G:

  ITU grid blue band:
  - 1542.14 to 1542.94 nm, 10M-L1-42.1
  - 1543.73 to 1544.53 nm, 10M-L1-43.7

  ITU grid red band:
  - 1558.17 to 1558.98 nm, 10M-L1-58.1
  - 1559.79 to 1560.61 nm, 10M-L1-59.7
- Receiver (trunk side)
  - -8 to -21 dBm (no FEC, unamplified, 23 dB OSNR, BER 1 * 10 exp - 12)
  - -8 to -19 dBm (no FEC, unamplified, 23 dB OSNR, @ +/- 1000 ps/nm BER 1 * 10 exp - 12)
  - -8 to -20 dBm (no FEC, amplified, 19 dB OSNR, BER 1 * 10 exp - 12)
  - -8 to -18 dBm (no FEC, amplified, 19 dB OSNR, @ +/- 1000 ps/nm BER 1 * 10 exp - 12)
  - -8 to -24 dBm (FEC, unamplified, 23 dB OSNR, BER 8 * 10 exp - 5)
  - -8 to -22 dBm (FEC, unamplified, 23 dB OSNR, @ +/- 1000 ps/nm, BER 8 * 10 exp - 5)
  - -8 to -18 dBm (FEC, amplified, 9 dB OSNR, BER 8 * 10 exp - 5)
  - -8 to -18 dBm (FEC, unamplified, 11 dB OSNR, @ +/- 800 ps/nm, BER 8 * 10 exp - 5)
  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1290 to 1605 nm
- Line (client side)
  - Bit rate: 2.48832 Gbps
  - Code: Scrambled NRZ

- Fiber: 1550-nm single-mode
- Maximum chromatic dispersion allowance: 1600 ps/nm
- Loopback modes: Terminal and facility
- Connectors: SFF
- Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957

- Transmitter (client side)
  - Depends on SFP that is used. There are two SFPs available: 15454-SFP-OC48-IR (1310 nm for OC48/DV6000, intermediate reach) and ONS-SE-2G-S1 (1310 nm for OC48/STM-16, short reach). See the "4.2.7 SFP Modules" section on page 4-81 and the document titled "Installing GBIC, SFP and XFP Optics Modules in Cisco ONS 15454, 15327, 15600, and 15310 Platforms" for more details.
- Receiver (client side)
  - Depends on SFP that is used. There are two SFPs available: 15454-SFP-OC48-IR (1310 nm for OC48/DV6000, intermediate reach) and ONS-SE-2G-S1 (1310 nm for OC48/STM-16, short reach). See the "4.2.7 SFP Modules" section on page 4-81 and the document titled "Installing GBIC, SFP and XFP Optics Modules in Cisco ONS 15454, 15327, 15600, and 15310 Platforms" for more details.
- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +113 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 50.00 W, 1.04 A at –48 V, 170.7 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.2.4 TXP_MR_2.5G and TXPP_MR_2.5G Cards

Warning **High-performance devices on this card can get hot during operation. To remove the card, hold it by the faceplate and bottom edge. Allow the card to cool before touching any other part of it or before placing it in an antistatic bag.**

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

The TXP_MR_2.5G card (2.5-Gbps Multirate Transponder–100-GHz–Tunable xx.xx-xx.xx) processes one 8-Mbps to 2.488-Gbps signal (client side) into one 8-Mbps to 2.5-Gbps, 100-GHz DWDM signal (trunk side). It provides one long-reach STM-16/OC-48 port per card, compliant with ITU-T G.707, ITU-T G.709, ITU-T G.957, and Telcordia GR-253-CORE.

The TXPP_MR_2.5G card (2.5-Gbps Multirate Transponder-Protected–100-GHz–Tunable xx.xx-xx.xx) processes one 8-Mbps to 2.488-Gbps signal (client side) into two 8-Mbps to 2.5-Gbps, 100-GHz DWDM signals (trunk side). It provides two long-reach STM-16/OC-48 ports per card, compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE.

The TXP_MR_2.5G and TXPP_MR_2.5G cards are tunable over four wavelengths in the 1550-nm, ITU 100-GHz range. They are available in eight versions, covering 32 different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of FEC that uses a “wrapper” approach. The digital wrapper lets you transparently take in a signal on the client side, wrap a frame around it, and restore it to its original form. FEC enables longer fiber links because errors caused by the optical signal degrading with distance are corrected.

The trunk/line port operates at up to 2.488 Gbps (or up to 2.66 Gbps with ITU-T G.709 Digital Wrapper/FEC) over unamplified distances up to 360 km (223.7 miles) with different types of fiber such as C-SMF or higher if dispersion compensation is used.

Caution Because the transponder has no capability to look into the payload and detect circuits, a TXP_MR_2.5G or TXPP_MR_2.5G card does not display circuits under card view.

For the TXP_MR_2.5G card, protection is done using Y-cable protection. Two TXP_MR_2.5G cards can be joined in a Y-cable protection group. In Y-cable protection, the client ports of the two cards are joined by Y-cables. A single incoming Rx client signal is injected into the Rx Y-cable port and is split between the two TXP_MR_2.5G cards (connected to the Rx client ports) in the protection group. The transmit (Tx) client signals from the two protection group TXP_MR_2.5G cards are connected to the correspondent ports of the Tx Y-cable. Only the Tx client port of the Active TXP_MR_2.5G card is turned on and transmits the signal towards the receiving client equipment.

Note If you create a GCC on either card of the protect group, the trunk (span) port stays permanently active, regardless of the switch state. When you provision a GCC, you are provisioning unprotected overhead bytes. The GCC is not protected by the protect group.

For the TXPP_MR_2.5G card, protection is done using splitter protection. In splitter protection, the single client signal is injected into the client receive (Rx) port. It is then split into two separate signals on the two trunk transmit (Tx) ports. The two signals are transmitted over diverse paths. The far-end TXPP_MR_2.5G card chooses one of the two trunk receive (Rx) port signals and injects it into the transmit (Tx) client port. The TXPP_MR_2.5G card switches the selected trunk receive (Rx) port signal in case of failure.

The TXP_MR_2.5G and TXPP_MR_2.5G cards support 2R and 3R+ modes of operation where the client signal is mapped into a ITU-T G.709 frame. The mapping function is simply done by placing a digital wrapper around the client signal. Only OC-48/STM-16 client signals are fully ITU-T G.709 compliant, and the output bit rate depends on the input client signal. Table 4-23 shows the possible combinations of client interfaces, input bit rates, 2R and 3R modes, and ITU-T G.709 monitoring.

Table 4-23 2R and 3R Mode and ITU-T G.709 Compliance by Client Interface

Client Interface	Input Bit Rate	3R vs. 2R	ITU-T G.709
OC-48/STM-16	2.488 Gbps	3R	On or Off
DV-6000	2.38 Gbps	2R	—
2 Gigabit Fiber Channel (2G-FC)/FICON	2.125 Gbps	3R[1]	On or Off
High definition television (HDTV)	1.48 Gbps	2R	—
Gigabit Ethernet (GE)	1.25 Gbps	3R	On or Off
1 Gigabit Fiber Channel (1G-FC)/FICON	1.06 Gbps	3R	On or Off
OC-12/STM-4	622 Mbps	3R	On or Off
OC-3/STM-1	155 Mbps	3R	On or Off
ESCON	200 Mbps	2R	—
SDI/D1 Video	270 Mbps	2R	—

1. No monitoring

The output bit rate is calculated for the trunk bit rate by using the 255/238 ratio as specified in ITU-T G.709 for OTU1. Table 4-24 lists the calculated trunk bit rates for the client interfaces with ITU-T G.709 enabled.

Table 4-24 Trunk Bit Rates With ITU-T G.709 Enabled

Client Interface	ITU-T G.709 Disabled	ITU-T G.709 Enabled
OC-48/STM-16	2.488 Gbps	2.66 Gbps
2G-FC	2.125 Gbps	2.27 Gbps
GE	1.25 Gbps	1.34 Gbps
1G-FC	1.06 Gbps	1.14 Gbps
OC-12/STM-3	622 Mbps	666.43 Mbps
OC-3/STM-1	155 Mbps	166.07 Mbps

For 2R operation mode, the TXP_MR_2.5G and TXPP_MR_2.5G cards have the ability to pass data through transparently from client side interfaces to a trunk side interface, which resides on an ITU grid. The data might vary at any bit rate from 200-Mbps up to 2.38-Gbps, including ESCON and video signals. In this pass-through mode, no performance monitoring (PM) or digital wrapping of the incoming signal is provided, except for the usual PM outputs from the SFPs. Similarly, this card has the ability to pass data through transparently from the trunk side interfaces to the client side interfaces with bit rates varying from 200-Mbps up to 2.38-Gbps. Again, no performance monitoring or digital wrapping of received signals is available in this pass-through mode.

For 3R+ operation mode, the TXP_MR_2.5G and TXPP_MR_2.5G cards apply a digital wrapper to the incoming client interface signals (OC-N, 1G-FC, 2G-FC, GE). Performance monitoring is available on all of these signals except for 2G-FC, and varies depending upon the type of signal. For client inputs other than OC-48/STM-16, a digital wrapper might be applied but the resulting signal is not ITU-T G.709 compliant. The card applies a digital wrapper that is scaled to the frequency of the input signal.

The TXP_MR_2.5G and TXPP_MR_2.5G card has the ability to take digitally wrapped signals in from the trunk interface, remove the digital wrapper, and send the unwrapped data through to the client interface. Performance monitoring of the ITU-T G.709 OH and SONET/SDH OH is implemented. Figure 4-25 shows the TXP_MR_2.5G and TXPP_MR_2.5G faceplate.

Figure 4-25 TXP_MR_2.5G and TXPP_MR_2.5G Faceplates

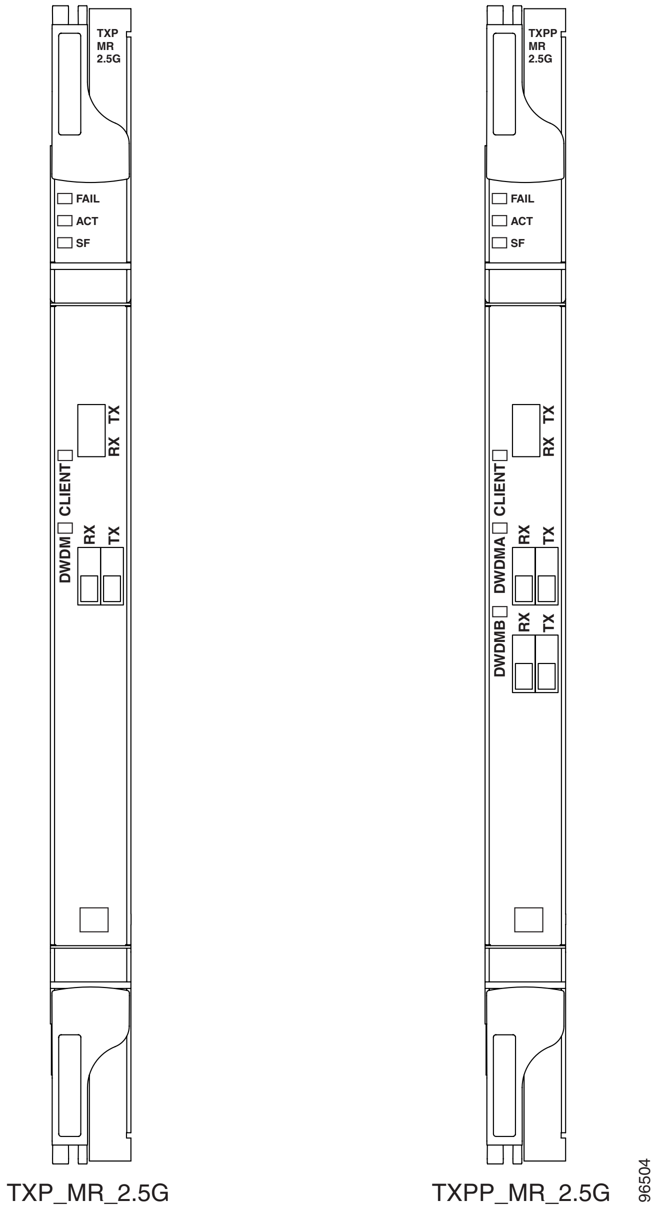
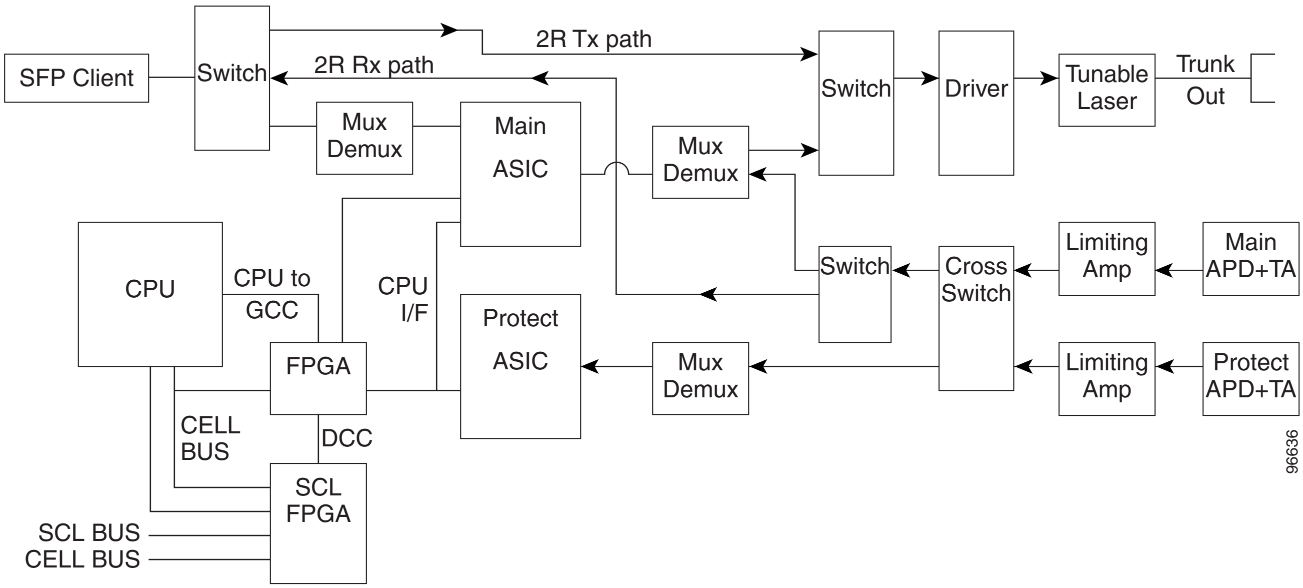


Figure 4-26 shows a block diagram of the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Figure 4-26 TXP_MR_2.5G and TXPP_MR_2.5G Block Diagram



Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the TXP_MR_2.5G and TXPP_MR_2.5G cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_2.5G and TXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_2.5G and TXPP_MR_2.5G cards.

You can install TXP_MR_2.5G and TXPP_MR_2.5G cards in Slots 1 to 6 and 12 to 17. You can provision this card in a linear configuration. TXP_MR_10G and TXPP_MR_2.5G cards cannot be provisioned as a BLSR, a path protection, or a regenerator. They can be used in the middle of BLSR or 1+1 spans. They can only be used in the middle of BLSR and 1+1 spans when the card is configured for transparent termination mode.

The TXP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm laser for the client port and contains two transmit and receive connector pairs (labeled) on the card faceplate. The card uses dual LC connectors for optical cable termination.

The TXPP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client port and contains three transmit and receive connector pairs (labeled) on the card faceplate. The card uses dual LC connectors for optical cable termination.

The TXP_MR_2.5G and TXPP_MR_2.5G cards detect SF, LOS, or LOF conditions on the optical facility. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a description of these conditions. The card also counts section and line BIP errors from B1 and B2 byte registers in the section and line overhead.

4.2.4.1 TXP_MR_2.5G and TXPP_MR_2.5G Safety Labels

The TXP_MR_2.5G and TXPP_MR_2.5G cards have several safety labels that provide laser radiation and electrical shock warnings.

Figure 4-27 shows the laser radiation warning hazard level label. The faceplate of these cards are clearly labeled with warnings about the equipment radiation level. Personnel must understand all warning labels before working with these cards. The hazard level label warns the personnel against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

Figure 4-27 Laser Radiation Warning—Hazard Level Label

Figure 4-28 shows the laser source connector label. This label indicates a laser source at the optical connectors where it has been placed.

Figure 4-28 Laser Radiation Warning—Laser Source Connector Label

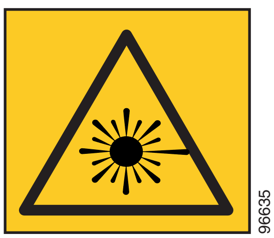


Figure 4-29 shows the FDA compliance label. This label shows the statement of compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 4-29 FDA Compliance Statement Label

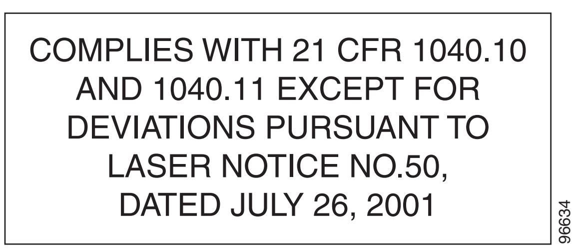


Figure 4-30 shows the electrical energy hazard label. This label alerts personnel to electrical hazards within the card. The potential of shock hazard exists when adjacent cards are removed during maintenance and touching exposed electrical circuitry on the card itself.

Figure 4-30 Electrical Energy Hazard Label

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4.2.4.2 TXP_MR_2.5G and TXPP_MR_2.5G Card-Level Indicators

Table 4-25 lists the three card-level LEDs on the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Table 4-25 TXP_MR_10G and TXPP_MR_2.5G Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED **Green (Active)** **Amber (Standby)**	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

4.2.4.3 TXP_MR_2.5G and TXPP_MR_2.5G Port-Level Indicators

Table 4-26 lists the four port-level LEDs on the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Table 4-26 TXP_MR_10G Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green TX LED	The green TX LED indicates that indicated the DWDM port is in service and that it is currently transmitting a recognized signal.
Green RX LED	The green RX LED indicates that the indicated DWDM port is in service and that it is currently receiving a recognized signal.

4.2.4.4 TXP_MR_2.5G and TXPP_MR_2.5G Card Specifications

The TXP_MR_2.5G and TXPP_MR_2.5G cards have the following specifications:

- Line (trunk side)
  - Bit rate: 2.488 Gbps for OC-48/STM-16 or
    2.66 Gbps with ITU-T G.709 Digital Wrapper/FEC
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 6000 ps/nm
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the TXP_MR_2.5G and TXPP_MR_2.5G cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_2.5G and TXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_2.5G and TXPP_MR_2.5G cards.

  - Connectors: LC
  - Compliance Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter (trunk side)
  - Maximum transmitter output power: +1 dBm
  - Minimum transmitter output power: –4.5 dBm
  - Transmitter: Direct modulated laser
  - Wavelength stability (drift): +/- 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/- 25 pm.

- Currently available wavelengths of TXP_MR_2.5G and TXPP_MR_2.5G:

  ITU grid blue band:
  - 1530.334 to 1544.526 nm

  ITU grid red band:
  - 1546.119 to 1560.606 nm
- Receiver (trunk side)
  - Receiver input power (no FEC, unamplified, BER 1 * 10 exp – 12): –9 to –30 dBm
  - Receiver input power (FEC, unamplified, BER 1 * 10 exp – 6): –9 to –31 dBm
  - Receiver input power (no FEC, amplified, BER 1 * 10 exp – 12): –9 to –23 dBm
  - Receiver input power (FEC, amplified, BER 1 * 10 exp – 6): –9 to –25 dBm
  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at
    BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1290 to 1605 nm

- Line (client side)
  - Bit rate: 8 Mbps to 2.488 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 1600 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957
- Transmitter (client side)
  - Depends on SFP that is used. There are 13 SFPs available: 15454-SFP3-1-IR, 15454E-SFP-L.1.1, 15454-SFP12-4-IR, 15454E-SFP-L.4.1, 15454-SFP-OC48-IR, 15454E-SFP-L.16.1, ONS-SE-2G-S1, 15454-SFP-200, 15454E-SFP-200, 15454-SFP-GEFC-SX, 15454E-SFP-GEFC-S, 15454-SFP-GE+-LX, and 15454E-SFP-GE+-LX. See the "4.2.7 SFP Modules" section on page 4-81 and the document titled "Installing GBIC, SFP and XFP Optics Modules in Cisco ONS 15454, 15327, 15600, and 15310 Platforms" for more details and specifications.
- Receiver (client side)
  - Depends on SFP that is used. There are 13 SFPs available: 15454-SFP3-1-IR, 15454E-SFP-L.1.1, 15454-SFP12-4-IR, 15454E-SFP-L.4.1, 15454-SFP-OC48-IR, 15454E-SFP-L.16.1, ONS-SE-2G-S1, 15454-SFP-200, 15454E-SFP-200, 15454-SFP-GEFC-SX, 15454E-SFP-GEFC-S, 15454-SFP-GE+-LX, and 15454E-SFP-GE+-LX. See See the "4.2.7 SFP Modules" section on page 4-81 the document titled "Installing GBIC, SFP and XFP Optics Modules in Cisco ONS 15454, 15327, 15600, and 15310 Platforms" for more details and specifications.
- Environmental
  - Operating temperature: –5 to +45 degrees Celsius (+23 to +113 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 35.00 W, 0.73 A at –48 V, 119.5 BTU/hr
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.716 in. (18.2 mm)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

4.2.5 Transponder and Muxponder Jitter Considerations

Jitter introduced by the SFPs used in the transponders and muxponders must be considered when cascading several cards. In the case of the TXP_MR_2.5G and TXPP_MR_2.5G cards, several transponders may be cascaded before the cumulative jitter violates the jitter specification. The recommended limit is 20 cards.

In the case of the TXP_MR_10G cards, you may also cascade several cards, although the recommended limit is 12 cards.

In the case of the MXP_2.5G_10G cards, any number of cards may be cascaded as long as the maximum reach between any two is not exceeded. This is because any time the signal is demultiplexed, the jitter is eliminated as a limiting factor.

4.2.6 Transponder and Muxponder Termination Modes

DWDM transponder and muxponder cards have various SONET termination modes that can be configured using CTC. The termination modes are summarized in Table 4-27.

Table 4-27 DWDM Transponder and Muxponder Termination Modes

Card	Termination Modes	Description
TXP_MR_2.5G, TXPP_MR_2.5G, and TXP_MR_10G	Transparent Termination	All the bytes of the payload pass transparently through the cards.
	Section Termination	The SONET Transport Overhead (TOH) section bytes are terminated. None of these section overhead bytes are passed through. They are all regenerated, including the SONET TOH section data communication channel (DCC) bytes. In the section termination mode, the SONET TOH line overhead bytes are passed transparently.
	Line Termination	In the line termination mode, the section and line overhead bytes for SONET are terminated. None of the overhead bytes are passed through. They are all regenerated, including the SONET SDCC and line data communication channel (LDCC) bytes.
MXP_2.5G_10G[1]	Transparent Termination	All of the client bytes pass transparently through except the following: B1 is rebuilt, S1 is rewritten, A1–A2 are regenerated, and H1–H3 are regenerated.
	Section Termination	The SONET TOH section bytes are terminated. None of these section overhead bytes are passed through. They are all regenerated, including the SONET TOH section DCC bytes. In the section termination mode, the SONET TOH line overhead bytes are passed transparently.
	Line Termination	In the line termination mode, the section and line overhead bytes for SONET are terminated. None of the overhead bytes are passed through. They are all regenerated, including the SONET SDCC and LDCC bytes.

1. The clients operating at rates of OC48/STM16 are multiplexed into an OC192/STM64 frame before going to OTN or DWDM.

4.2.7 SFP Modules

This section describes the small-form factor pluggables (SFPs) that can be used with certain transponder and muxponder cards.

4.2.7.1 Compatibility by Card

Table 4-28 lists the transponder and muxponder cards and their compatible SFPs.

Caution Only use SFP certified for use in Cisco Optical Networking Systems. The qualified Cisco SFP pluggable module's top assembly numbers (TANs) are provided in Table 4-28.

Table 4-28 SFP Card Compatibility

Card	Compatible SFP (Cisco Product ID)	Cisco Top Assembly Number (TAN)
MXP_2.5G_10G (ONS 15454 SONET)	15454-SFP-OC48-IR= ONS-SE-2G-S1=	10-1975-01 10-2017-01
TXP_MR_2.5G (ONS 15454 SONET) TXPP_MR_2.5G (ONS 15454 SONET)	15454-SFP3-1-IR= 15454E-SFP-L.1.1= 15454-SFP12-4-IR= 15454E-SFP-L.4.1= 15454-SFP-OC48-IR= 15454E-SFP-L.16.1= ONS-SE-2G-S1= 15454-SFP-200= 15454E-SFP-200= 15454-SFP-GEFC-SX= 15454E-SFP-GEFC-S= 15454-SFP-GE+-LX= 15454E-SFP-GE+-LX=	10-1828-01 10-1828-01 10-1976-01 10-1976-01 10-1975-01 10-1975-01 10-2017-01 10-1750-01 10-1750-01 10-1833-01 10-1833-02 10-1832-01 10-1832-02

4.2.7.2 SFP Description

SFPs are integrated fiber optic transceivers that provide high-speed serial links from a port or slot to the network. Various latching mechanisms can be utilized on the SFP modules. There is no correlation between the type of latch to the model type (such as SX or LX/LH) or technology type (such as Gigabit Ethernet). See the label on the SFP for technology type and model. One type of latch available is a mylar tab as shown in Figure 4-31, a second type of latch available is an actuator/button (Figure 4-32), and a third type of latch is a bail clasp (Figure 4-33).

SFP dimensions are:

- Height 0.03 in. (8.5 mm)
- Width 0.53 in. (13.4 mm)
- Depth 2.22 in. (56.5 mm)

SFP temperature ranges for are:

- COM—commercial operating temperature range -5•C to 70•C

- EXT—extended operating temperature range -5•C to 85•C
- IND—industrial operating temperature range -40•C to 85•C

Figure 4-31 Mylar Tab SFP

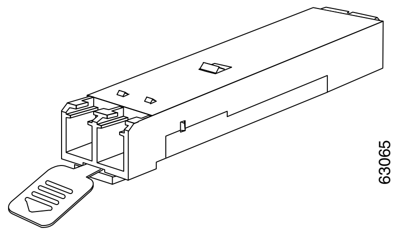


Figure 4-32 Actuator/Button SFP

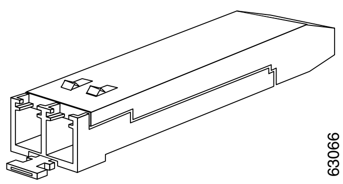
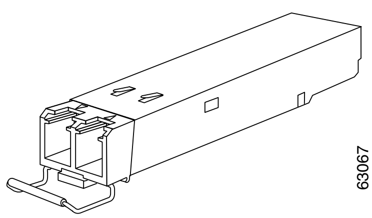


Figure 4-33 Bail Clasp SFP



4.2.7.3 Client Cabling Distances

Client cabling distances are defined in the "Installing GBIC, SFP and XFP Optics Modules in Cisco ONS 15454, 15327, 15600, and 15310 Platforms" document. If Y-cable protection is used, the maximum reach between one transponder and the other must be halved.

CHAPTER 5

Ethernet Cards

The Cisco ONS 15454 integrates Ethernet into a SONET platform through the use of Ethernet cards. This chapter describes the E-Series, G-Series, and ML-Series Ethernet cards. For G-Series and E-Series Ethernet application information, see Chapter 16, "Ethernet Operation." For installation and card turn-up procedures, refer to the *Cisco ONS 15454 Procedure Guide*. For ML-Series configuration information, see the *Cisco ONS 15454 SONET/SDH ML-Series Multilayer Ethernet Card Software Feature and Configuration Guide.*

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

5.1 Ethernet Card Overview

The card overview section summarizes card functions, power consumption, and temperature ranges.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. Refer to the *Cisco ONS 15454 Procedure Guide* for a list of slots and symbols.

5.1.1 Ethernet Cards

Table 5-1 lists the Cisco ONS 15454 Ethernet cards.

Table 5-1 Ethernet Cards for the ONS 15454

Card	Port Description	For Additional Information...
E100T-12	The E100T-12 card provides 12 switched, autosensing, 10/100BaseT Ethernet ports.	See the "5.2 E100T-12 Card" section on page 5-5.
E100T-G	The E100T-G card provides 12 switched, autosensing, 10/100BaseT Ethernet ports and is compatible with the XC10G card.	See the "5.3 E100T-G Card" section on page 5-7.
E1000-2	The E1000-2 card provides two IEEE-compliant, 1000-Mbps ports. Gigabit Interface Converters (GBICs) are separate.	See the "5.4 E1000-2 Card" section on page 5-10.
E1000-2-G	The E1000-2-G card provides two IEEE-compliant, 1000-Mbps ports. GBICs are separate. The E1000-2-G card is compatible with the XC10G card.	See the "5.5 E1000-2-G Card" section on page 5-13.
G1000-4	The G1000-4 card provides four IEEE-compliant, 1000-Mbps ports. GBICs are separate. The G1000-4 requires the XC10G card.	See the "5.6 G1000-4 Card" section on page 5-16.
G1K-4	The G1K-4 card provides four IEEE-compliant, 1000-Mbps ports. GBICs are separate. The G1K-4 card is functionally identical to the G1000-4 card, but can operate with XC, XCVT, or XC10G cross-connect cards.	See the "5.7 G1K-4 Card" section on page 5-19.
ML100T-12	The ML100T-12 card provides 12 switched, autosensing, 10/100Base-T Ethernet ports.	See the "5.8 ML100T-12 Card" section on page 5-22.
ML1000-2	The ML1000-2 card provides two IEEE-compliant, 1000-Mbps ports. Small form-factor pluggable (SFP) connectors are separate.	See the "5.9 ML1000-2 Card" section on page 5-25.

5.1.2 Card Power Requirements

Table 5-2 lists power requirements for Ethernet cards.

Table 5-2 Ethernet Card Power Requirements

Card Name	Watts	Amps	BTU/hr
E100T-12	65.00	1.35	221.93
E100T-G	65.00	1.35	221.93
E1000-2	53.50	1.11	182.67
E1000-2-G	53.50	1.11	182.67
G1000-4	63.00 incl. GBICs	1.31	215.11

Table 5-2 Ethernet Card Power Requirements (continued)

Card Name	Watts	Amps	BTU/hr
G1K-4	63.00 incl. GBICs	1.31	215.11
ML100T-12	53.00	1.10	181.0
ML1000-2	49.00 incl. SFPs	1.02	167.3

5.1.3 Card Temperature Ranges

Table 5-3 shows C-Temp and I-Temp compliant cards and their product names.

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

Table 5-3 Ethernet Card Temperature Ranges and Product Names for the ONS 15454

Card	C-Temp Product Name (0 to +55 degrees Celsius)	I-Temp Product Name (–40 to +65 degrees Celsius)
E100T-12	15454-E100T	—
E1000-2	15454-E1000-2	—
E100T-G	15454-E100T-G	—
E1000-2-G	15454-E1000-2-G	—
G1000-4	15454-G1000-4	—
G1K-4	15454-G1K-4	—
ML100T-12	15454-ML100T-12	—
ML1000-2	15454-ML1000-2	—

5.1.4 Ethernet Clocking Versus SONET/SDH Clocking

Ethernet clocking is asynchronous. IEEE 802.3 clock tolerance allows some links in a network to be as much as 200 ppm (parts or bits per million) slower than other links (0.02%). A traffic stream sourced at line rate on one link may traverse other links which are 0.02% slower. A fast source clock, or slow intermediate clocks, may limit the end-to-end thoughput to only 99.98% of the source link rate.

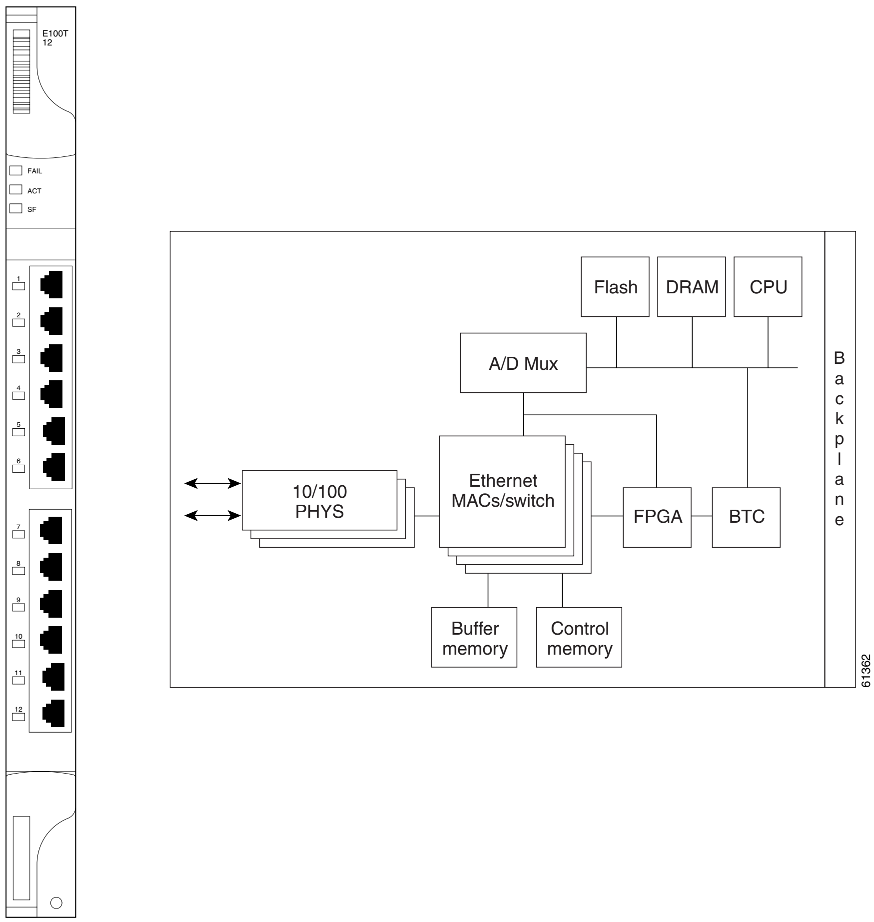
Traditionally, Ethernet is a shared media that is under utilized except for brief bursts which may combine from multiple devices to exceed line-rate at an aggregation point. Due to this utilization model, the asynchronous clocking of Ethernet has been acceptable. Some Service Providers accustomed to loss-less TDM transport may find the 99.98% throughput guarantee of Ethernet surprising.

Clocking enhancements of ML-Series and G-Series cards ensure Ethernet transmit rates that are at worst 50 ppm slower than the fastest compliant source clock, ensuring a worst-case clocking loss of 50 ppm - a 99.995% throughput guarantee. In many cases, the ML-Series or G-Series clock will be faster than the source traffic clock, and line-rate traffic transport will have zero loss. Actual results will depend on clock variation of the traffic source transmitter.

5.2 E100T-12 Card

The ONS 15454 uses E100T-12 cards for Ethernet (10 Mbps) and Fast Ethernet (100 Mbps). Each card provides 12 switched, IEEE 802.3-compliant, 10/100BaseT Ethernet ports that can independently detect the speed of an attached device (autosense) and automatically connect at the appropriate speed. The ports autoconfigure to operate at either half or full duplex and determine whether to enable or disable flow control. You can also configure Ethernet ports manually. Figure 5-1 shows the faceplate and a block diagram of the card.

Figure 5-1 E100T-12 Faceplate and Block Diagram



The E100T-12 Ethernet card provides high-throughput, low-latency packet switching of Ethernet traffic across a SONET network while providing a greater degree of reliability through SONET self-healing protection services. This Ethernet capability enables network operators to provide multiple 10/100-Mbps access drops for high-capacity customer LAN interconnects, Internet traffic, and cable modem traffic aggregation. It enables the efficient transport and co-existence of traditional time-division multiplexing (TDM) traffic with packet-switched data traffic.

Each E100T-12 card supports standards-based, wire-speed, Layer 2 Ethernet switching between its Ethernet interfaces. The IEEE 802.1Q tag logically isolates traffic (typically subscribers). IEEE 802.1Q also supports multiple classes of service.

5.2.1 Slot Compatibility

You can install the E100T-12 card in Slots 1 to 6 and 12 to 17. Multiple E-Series Ethernet cards installed in an ONS 15454 can act independently or as a single Ethernet switch. You can create logical SONET ports by provisioning STS channels to the packet switch entity within the ONS 15454. Logical ports can be created with a bandwidth granularity of STS-1. The E100T-12 supports STS-1, STS-3c, STS-6c, and STS-12c circuit sizes.

Note When making an STS-12c Ethernet circuit, the E-Series cards must be configured as single-card EtherSwitch.

5.2.2 E100T-12 Card-Level Indicators

The E100T-12 card faceplate has two card-level LED indicators, described in Table 5-4.

Table 5-4 E100T-12 Card-Level Indicators

Card-Level Indicators	Description
Red Fail LED	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the E100T-12 card. As part of the boot sequence, the FAIL LED is on until the software deems the card operational.
Green ACT LED	A green ACT LED provides the operational status of the E100T-12. If the ACT LED is green, it indicates that the E100T-12 card is active and the software is operational.
SF LED	Not used.

5.2.3 E100T-12 Port-Level Indicators

The E100T-12 card has 12 pairs of LEDs (one pair for each port) to indicate port conditions. Table 5-5 lists the port-level indicators. You can find the status of the E100T-12 card port using the LCD on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Table 5-5 E100T-12 Port-Level Indicators

LED State	Description
Amber	The port is active (transmitting and receiving data).
Solid green	The link is established.
Green light off	The connection is inactive, or traffic is unidirectional.

5.2.4 E100T-12 Compatibility

Do not use the E100T-12 card with the XC10G card. The E100T-G is compatible with the XC10G.

5.2.5 E100T-12 Card Specifications

The E100T-12 card has the following specifications:

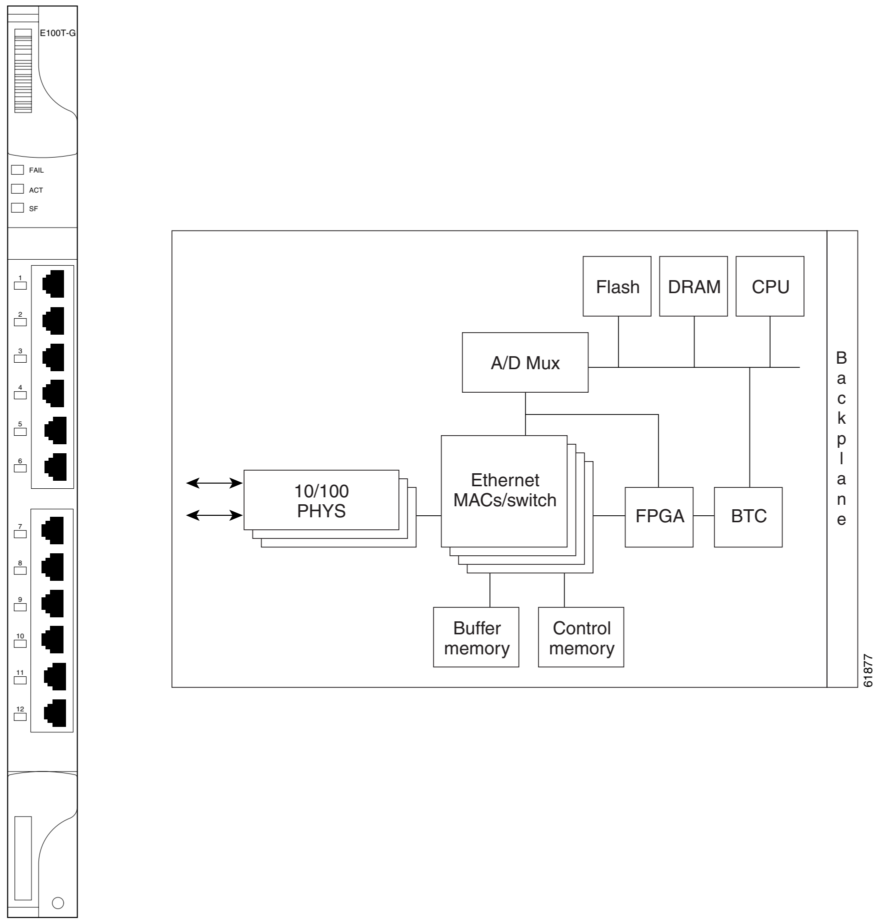
- Environmental
  - Operating temperature

    C-Temp (15454-E100T): 0 to +55 degrees Celsius (32 to 131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 65 W, 1.35 A, 221.93 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 1.0 kg (2.3 lb)
- Compliance
  - ONS 15454 cards, when installed in a system, comply with these safety standards: UL 1950, CSA C22.2 No. 950, EN 60950, IEC 60950

5.3 E100T-G Card

Use the E100T-G card when the XC10G card is in use. The ONS 15454 uses E100T-G cards for Ethernet (10 Mbps) and Fast Ethernet (100 Mbps). Each card provides 12 switched, IEEE 802.3-compliant, 10/100BaseT Ethernet ports that can independently detect the speed of an attached device (autosense) and automatically connect at the appropriate speed. The ports autoconfigure to operate at either half or full duplex and determine whether to enable or disable flow control. You can also configure Ethernet ports manually. Figure 5-2 on page 5-8 shows the faceplate and a block diagram of the card.

Figure 5-2 E100T-G Faceplate and Block Diagram



The E100T-G Ethernet card provides high-throughput, low-latency packet switching of Ethernet traffic across a SONET network while providing a greater degree of reliability through SONET self-healing protection services. This Ethernet capability enables network operators to provide multiple 10/100 Mbps access drops for high-capacity customer LAN interconnects, Internet traffic, and cable modem traffic aggregation. It enables the efficient transport and co-existence of traditional TDM traffic with packet-switched data traffic.

Each E100T-G card supports standards-based, wire-speed, Layer 2 Ethernet switching between its Ethernet interfaces. The IEEE 802.1Q tag logically isolates traffic (typically subscribers). IEEE 802.1Q also supports multiple classes of service.

Note When making an STS-12c Ethernet circuit, the E-Series cards must be configured as single-card EtherSwitch.

5.3.1 Slot Compatibility

You can install the E100T-G card in Slots 1 to 6 and 12 to 17. Multiple E-Series Ethernet cards installed in an ONS 15454 can act independently or as a single Ethernet switch. You can create logical SONET ports by provisioning a number of STS channels to the packet switch entity within the ONS 15454. Logical ports can be created with a bandwidth granularity of STS-1. The ONS 15454 supports STS-1, STS-3c, STS-6c, or STS-12c circuit sizes.

5.3.2 E100T-G Card-Level Indicators

The E100T-G card faceplate has two card-level LED indicators, described in Table 5-6.

Table 5-6 E100T-G Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the E100T-G card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
Green ACT LED	A green ACT LED provides the operational status of the E100T-G. If the ACT LED is green it indicates that the E100T-G card is active and the software is operational.
SF LED	Not used.

5.3.3 E100T-G Port-Level Indicators

The E100T-G card has 12 pairs of LEDs (one pair for each port) to indicate port conditions (Table 5-7). You can find the status of the E100T-G card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

Table 5-7 E100T-G Port-Level Indicators

LED State	Description
Yellow (A)	Port is active (transmitting and/or receiving data). By default, indicates the transmitter is active but can be software controlled to indicate link status, duplex status, or receiver active.
Solid Green (L)	Link is established. By default, indicates the link for this port is up, but can be software controlled to indicate duplex status, operating speed, or collision.

5.3.4 E100T-G Card Specifications

The E100T-G card has the following specifications:

- Environmental
  - Operating temperature:
    C-Temp (15454-E100T-G): 0 to +55 degrees Celsius (32 to 131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 65 W, 1.35 A, 221.93 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 1.0 kg (2.3 lb)
- Compliance
  - ONS 15454 cards, when installed in a system, comply with these safety standards: UL 1950, CSA C22.2 No. 950, EN 60950, IEC 60950

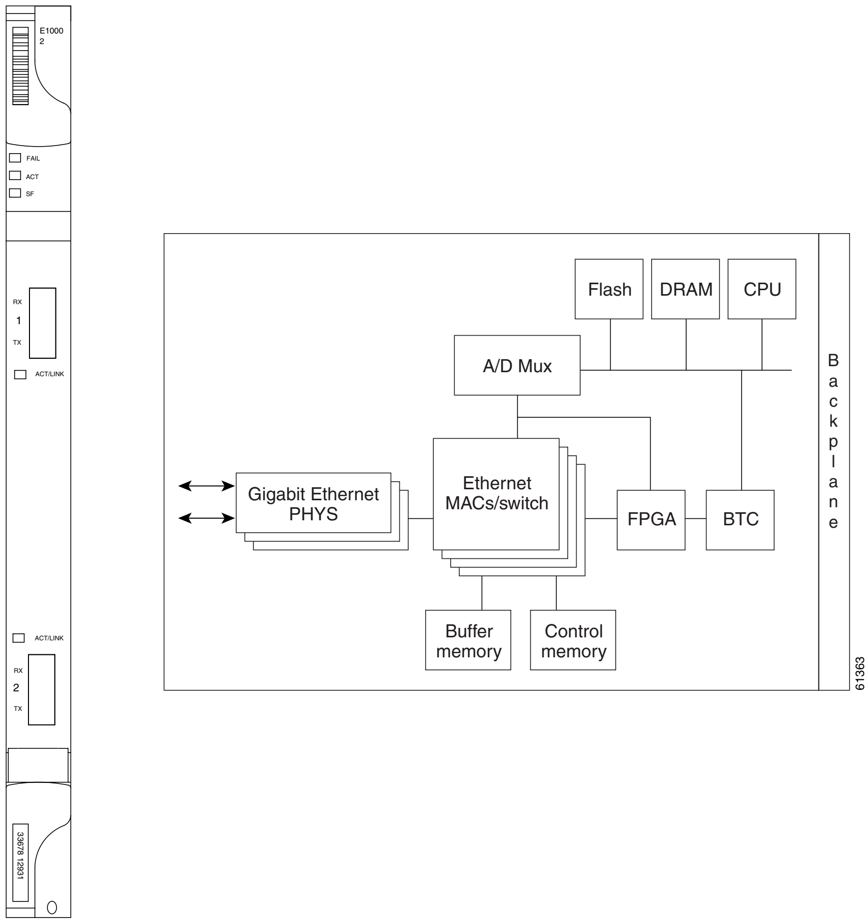
5.4 E1000-2 Card

The ONS 15454 uses E1000-2 cards for Gigabit Ethernet (1000 Mbps). The E1000-2 card provides two IEEE-compliant, 1000-Mbps ports for high-capacity customer LAN interconnections. Each port supports full-duplex operation.

The E1000-2 card uses GBIC modular receptacles for the optical interfaces. For details, see the "5.10 GBICs and SFPs" section on page 5-28.

Figure 5-3 on page 5-11 shows the card faceplate and a block diagram of the card.

Figure 5-3 E1000-2 Faceplate and Block Diagram



The E1000-2 Gigabit Ethernet card provides high-throughput, low-latency packet switching of Ethernet traffic across a SONET network while providing a greater degree of reliability through SONET self-healing protection services. This enables network operators to provide multiple 1000-Mbps access drops for high-capacity customer LAN interconnects. It enables efficient transport and co-existence of traditional TDM traffic with packet-switched data traffic.

Each E1000-2 card supports standards-based, Layer 2 Ethernet switching between its Ethernet interfaces and SONET interfaces on the ONS 15454. The IEEE 802.1Q VLAN tag logically isolates traffic (typically subscribers).

Multiple E-Series Ethernet cards installed in an ONS 15454 can act together as a single switching entity or as independent single switches supporting a variety of SONET port configurations.

You can create logical SONET ports by provisioning STS channels to the packet switch entity within the ONS 15454. Logical ports can be created with a bandwidth granularity of STS-1. The ONS 15454 supports STS-1, STS-3c, STS-6c, or STS-12c circuit sizes.

Note When making an STS-12c circuit, the E-Series cards must be configured as single-card EtherSwitch.

5.4.1 Slot Compatibility

You can install the E1000-2 card in Slots 1 to 6 and 12 to 17. The E1000-2 is compatible with the XC or XCVT cross-connect cards, but not the XC10G. The E1000-2-G is compatible with the XC10G.

5.4.2 E1000-2 Card-Level Indicators

The E1000-2 card faceplate has two card-level LED indicators, described in Table 5-8.

Table 5-8 E1000-2 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the E1000-2 card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
Green ACT LED	A green ACT LED provides the operational status of the E1000-2. When the ACT LED is green it indicates that the E1000-2 card is active and the software is operational.
SF LED	Not used.

5.4.3 E1000-2 Port-Level Indicators

The E1000-2 card has one bicolor LED per port (Table 5-9). When the green LINK LED is on, carrier is detected, meaning an active network cable is installed. When the green LINK LED is off, an active network cable is not plugged into the port, or the card is carrying unidirectional traffic. The amber port ACT LED flashes at a rate proportional to the level of traffic being received and transmitted over the port.

Table 5-9 E1000-2 Port-Level Indicators

LED State	Description
Amber	The port is active (transmitting and receiving data).
Solid green	The link is established.
Green light off	The connection is inactive, or traffic is unidirectional.

5.4.4 E1000-2 Compatibility

The E1000-2 is compatible with XC or XCVT cross-connect cards. The XC10G requires the E1000-2-G.

5.4.5 E1000-2 Card Specifications

The E1000-2 card has the following specifications:

- Environmental
  - Operating temperature:

    C-Temp (15454-E1000-2): 0 to +55 degrees Celsius (32 to 131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 53.50 W, 1.11 A, 182.67 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 0.9 kg (2.1 lb)
- Compliance
  - ONS 15454 cards, when installed in a system, comply with these safety standards: UL 1950, CSA C22.2 No. 950, EN 60950, IEC 60950
  - Eye safety compliance: Class I (21 CFR 1040.10 and 1040.11) and Class 1M (IEC 60825-1 2001-01) laser products

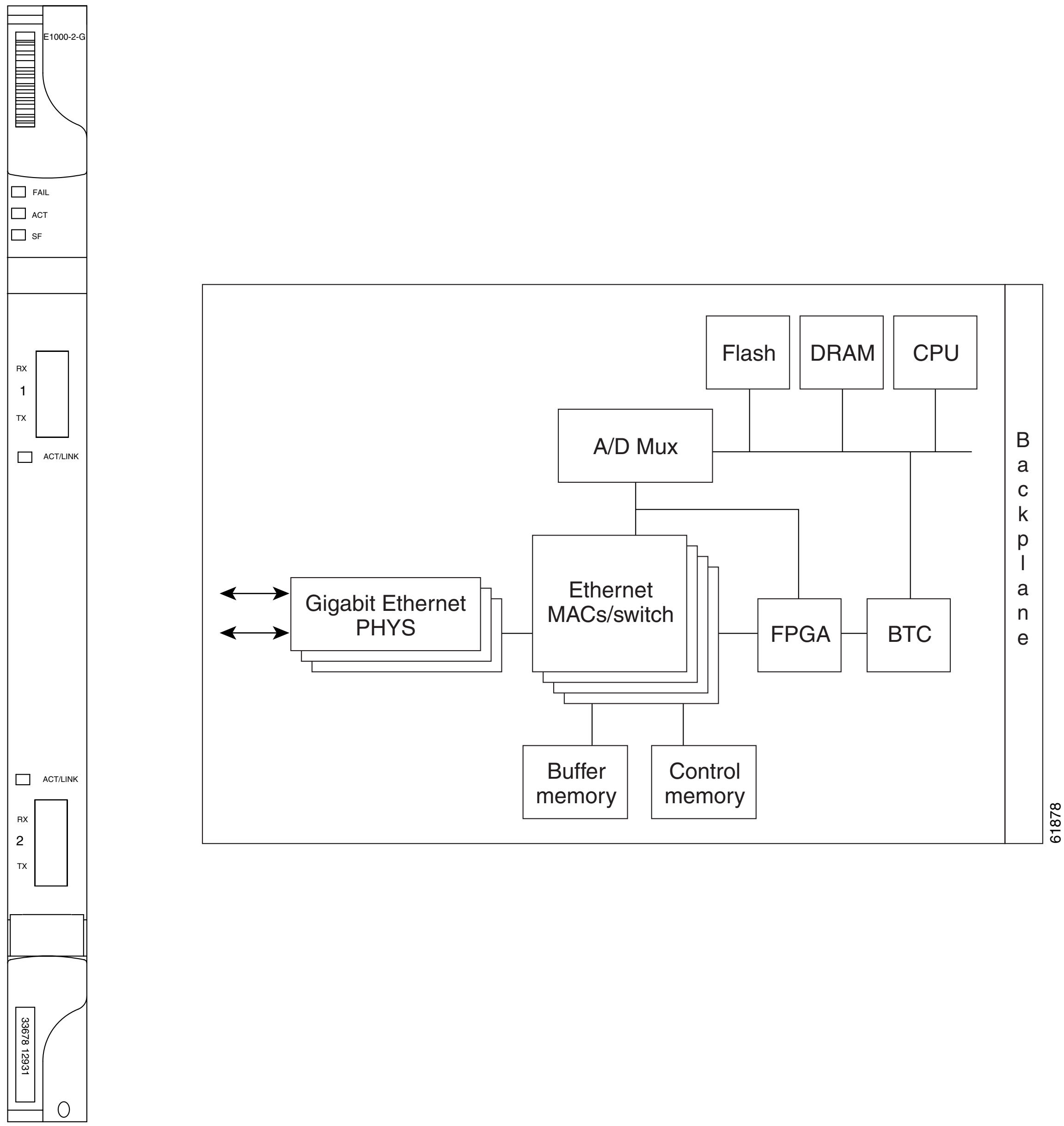
5.5 E1000-2-G Card

Use the E1000-2-G with the XC10G card. The ONS 15454 uses E1000-2-G cards for Gigabit Ethernet (1000 Mbps). The E1000-2-G card provides two IEEE-compliant, 1000-Mbps ports for high-capacity customer LAN interconnections. Each port supports full-duplex operation.

The E1000-2-G card uses GBIC modular receptacles for the optical interfaces. For details, see the "5.10 GBICs and SFPs" section on page 5-28.

Figure 5-4 on page 5-14 shows the card faceplate and a block diagram of the card.

Figure 5-4 E1000-2-G Faceplate and Block Diagram



The E1000-2-G Gigabit Ethernet card provides high-throughput, low-latency packet switching of Ethernet traffic across a SONET network while providing a greater degree of reliability through SONET self-healing protection services. This enables network operators to provide multiple 1000-Mbps access drops for high-capacity customer LAN interconnects. It enables efficient transport and co-existence of traditional TDM traffic with packet-switched data traffic.

Each E1000-2-G card supports standards-based, Layer 2 Ethernet switching between its Ethernet interfaces and SONET interfaces on the ONS 15454. The IEEE 802.1Q VLAN tag logically isolates traffic (typically subscribers).

Multiple E-Series Ethernet cards installed in an ONS 15454 can act together as a single switching entity or as independent single switches supporting a variety of SONET port configurations.

You can create logical SONET ports by provisioning STS channels to the packet switch entity within the ONS 15454. Logical ports can be created with a bandwidth granularity of STS-1. The ONS 15454 supports STS-1, STS-3c, STS-6c, or STS-12c circuit sizes.

Note When making an STS-12c Ethernet circuit, the E-Series cards must be configured as a single-card EtherSwitch.

5.5.1 E1000-2-G Compatibility

The E1000-2-G is compatible with XC10G, XC, or XCVT cross-connect cards. You can install the card in Slots 1 to 6 and 12 to 17.

5.5.2 E1000-2-G Card-Level Indicators

The E1000-2-G card faceplate has two card-level LED indicators, described in Table 5-10.

Table 5-10 E1000-2-G Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the E1000-2-G card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
Green ACT LED	A green ACT LED provides the operational status of the E1000-2-G. If the ACT LED is green it indicates that the E1000-2-G card is active and the software is operational.
SF LED	The SF LED is not used in the current release.

5.5.3 E1000-2-G Port-Level Indicators

The E1000-2-G card has one bicolor LED per port (Table 5-11). When the green LINK LED is on, carrier is detected, meaning an active network cable is installed. When the green LINK LED is off, an active network cable is not plugged into the port, or the card is carrying unidirectional traffic. The amber port ACT LED flashes at a rate proportional to the level of traffic being received and transmitted over the port.

Table 5-11 E1000-2-G Port-Level Indicators

LED State	Description
Amber	The port is active (transmitting and receiving data).
Solid green	The link is established.
Green light off	The connection is inactive, or traffic is unidirectional.

5.5.4 E1000-2-G Card Specifications

The E1000-2-G card has the following specifications:

- Environmental
  - Operating temperature:

    C-Temp (15454-E1000-2-G): 0 to +55 degrees Celsius (32 to 131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 53.50 W, 1.11 A, 182.67 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 0.9 kg (2.1 lb)
- Compliance
  - ONS 15454 cards, when installed in a system, comply with these safety standards: UL 1950, CSA C22.2 No. 950, EN 60950, IEC 60950
  - Eye Safety Compliance: Class I (21 CFR 1040.10 and 1040.11) and Class 1M (IEC 60825-1 2001-01) laser products

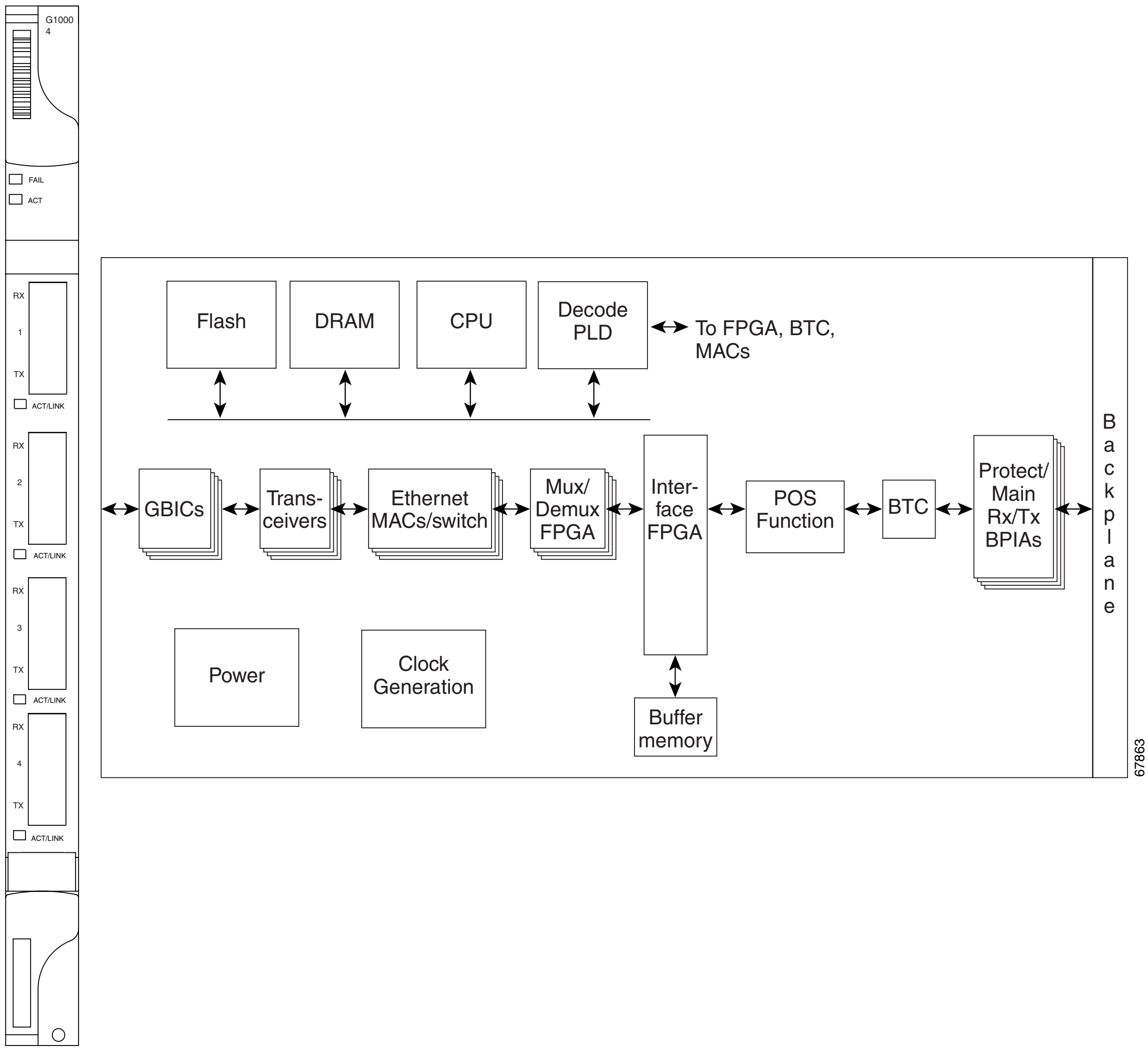
5.6 G1000-4 Card

The G1000-4 card requires the XC10G card. The ONS 15454 uses G1000-4 cards for Gigabit Ethernet (1000 Mbps). The G1000-4 card provides four ports of IEEE-compliant, 1000-Mbps interfaces. Each port supports full-duplex operation for a maximum bandwidth of OC-48 on each card.

The G1000-4 card uses GBIC modular receptacles for the optical interfaces. For details, see the "5.10 GBICs and SFPs" section on page 5-28.

Figure 5-5 on page 5-17 shows the card faceplate and the block diagram of the card.

Figure 5-5 G1000-4 Faceplate and Block Diagram



The G1000-4 Gigabit Ethernet card provides high-throughput, low latency transport of Ethernet encapsulated traffic (IP and other Layer 2 or Layer 3 protocols) across a SONET network. Carrier-class Ethernet transport is achieved by hitless (< 50 ms) performance in the event of any failures or protection switches (such as 1+1 automatic protection switching [APS], path protection, or bidirectional line switch ring [BLSR]). Full provisioning support is possible via Cisco Transport Controller (CTC), Transaction Language One (TL1), or Cisco Transport Manager (CTM).

The circuit sizes supported are STS-1, STS-3c, STS-6c, STS-9c, STS-12c, STS-24c, and STS-48c.

5.6.1 STS-24c Restriction

Due to hardware constraints, the card imposes an additional restriction on the combinations of circuits that can be dropped onto a G-Series card. These restrictions are transparently enforced by the ONS 15454, and you do not need to keep track of restricted circuit combinations.

When a single STS-24c terminates on a card, the remaining circuits on that card can be another single STS-24c or any combination of circuits of STS-12c size or less that add up to no more than 12 STSs (that is a total of 36 STSs on the card).

If STS-24c circuits are not being dropped on the card, the full 48 STSs bandwidth can be used with no restrictions (for example, using either a single STS-48c or 4 STS-12c circuits).

Note The STS-24c restriction only applies when a single STS-24c circuit is dropped; therefore, you can easily minimize the impact of this restriction. Group the STS-24c circuits together on a card separate from circuits of other sizes. The grouped circuits can be dropped on other G-Series cards on the ONS 15454.

5.6.2 G1000-4 Card-Level Indicators

The G1000-4 card faceplate has two card-level LED indicators, described in Table 5-12.

Table 5-12 G1000-4 Card-Level Indicators

Card-Level LEDs	Description
FAIL LED (red)	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the G1000-4 card. As part of the boot sequence, the FAIL LED is turned on, and it turns off if the software is deemed operational. The red FAIL LED blinks when the card is loading software.
ACT LED (green)	A green ACT LED provides the operational status of the G1000-4. If the ACT LED is green, it indicates that the G1000-4 card is active and the software is operational.

5.6.3 G1000-4 Port-Level Indicators

The G1000-4 card has one bicolor LED per port. Table 5-13 describes the status that each color represents.

Table 5-13 G1000-4 Port-Level Indicators

Port-Level LED Status	Description
Off	No link exists to the Ethernet port.
Steady amber	A link exists to the Ethernet port, but traffic flow is inhibited. For example, an unconfigured circuit, an error on line, or a nonenabled port might inhibit traffic flow.
Solid green	A link exists to the Ethernet port, but no traffic is carried on the port.
Flashing green	A link exists to the Ethernet port, and traffic is carried on the port. The LED flash rate reflects the traffic rate for the port.

5.6.4 G1000-4 Compatibility

The G1000-4 card requires Cisco ONS 15454 Release 3.2 or later system software and the XC10G cross-connect card. You can install the card in Slots 1 to 6 and 12 to 17, for a total shelf capacity of 48 Gigabit Ethernet ports. The practical G1000-4 port per shelf limit is 40, because at least two slots are typically filled by OC-N trunk cards such as the OC-192.

5.6.5 G1000-4 Card Specifications

The G1000-4 card has the following specifications:

- Environmental
  - Operating temperature:

    C-Temp (15454-G1000-4): 0 to +55 degrees Celsius (32 to 131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 63.00 W, 1.31 A, 215.11 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 0.9 kg (2.1 lb)

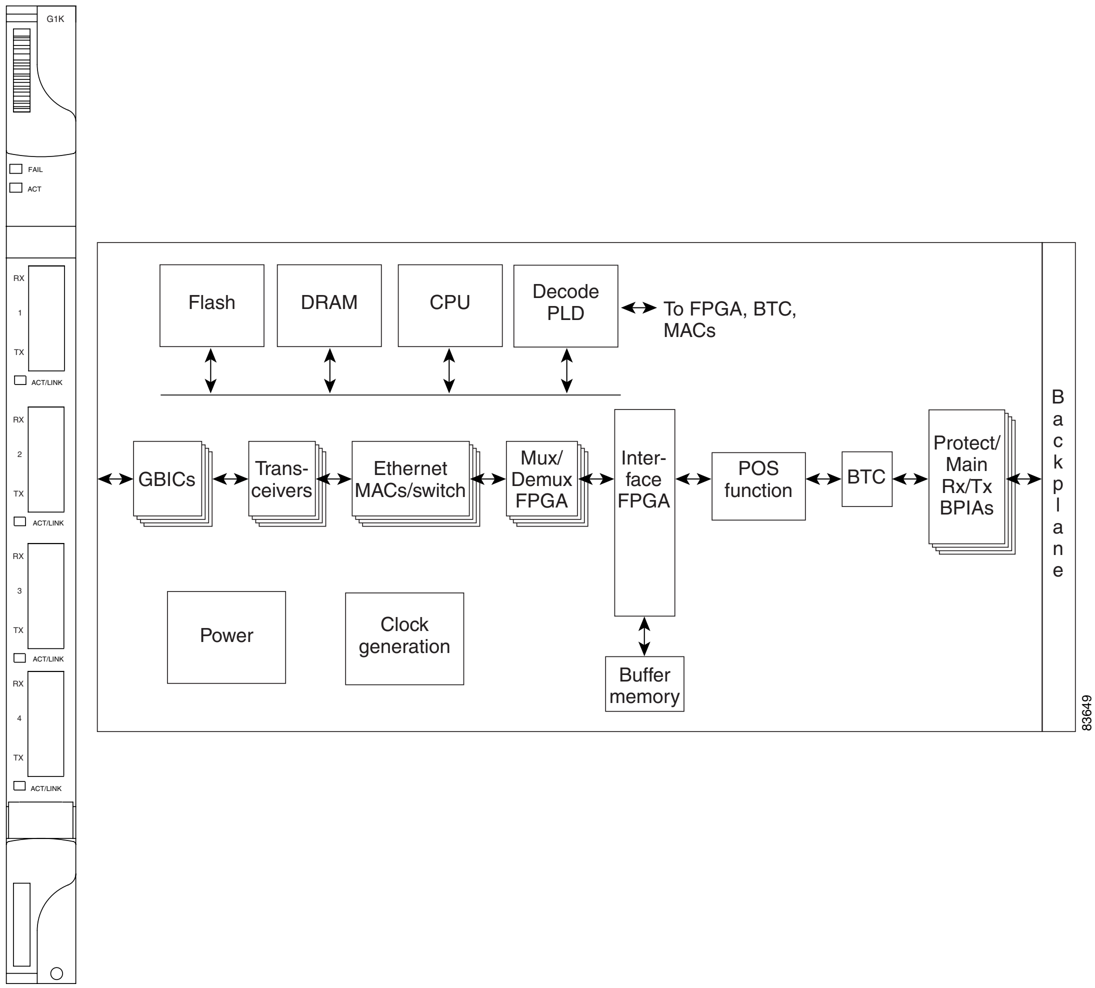
5.7 G1K-4 Card

The G1K-4 card is the functional equivalent of the G1000-4 card and provides four ports of IEEE-compliant, 1000-Mbps interfaces. Each interface supports full-duplex operation for a maximum bandwidth of 1 Gbps or 2 Gbps bidirectional per port, and 2.5 Gbps or 5 Gbps bidirectional per card. Each port autonegotiates for full duplex and IEEE 802.3x flow control. The G1K-4 card uses GBIC modular receptacles for the optical interfaces. For details, see the "5.10 GBICs and SFPs" section on page 5-28.

Figure 5-6 on page 5-20 shows the card faceplate and the block diagram of the card.

Warning **Class 1 laser product.**

Figure 5-6 G1K-4 Faceplate and Block Diagram



Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.**

The G1K-4 Gigabit Ethernet card provides high-throughput, low-latency transport of Ethernet encapsulated traffic (IP and other Layer 2 or Layer 3 protocols) across a SONET network while providing a greater degree of reliability through SONET self-healing protection services. Carrier-class Ethernet transport is achieved by hitless (< 50 ms) performance in the event of any failures or protection switches (such as 1+1 APS, path protection, BLSR, or optical equipment protection) and by full provisioning and manageability, as in SONET service. Full provisioning support is possible via CTC or CTM. Each G1K-4 card performs independently of the other cards in the same shelf.

5.7.1 STS-24c Restriction

Due to hardware constraints, the card imposes an additional restriction on the combinations of circuits that can be dropped onto a G-Series card. These restrictions are transparently enforced by the ONS 15454, and you do not need to keep track of restricted circuit combinations.

When a single STS-24c terminates on a card, the remaining circuits on that card can be another single STS-24c or any combination of circuits of STS-12c size or less that add up to no more than 12 STSs (that is a total of 36 STSs on the card).

If STS-24c circuits are not being dropped on the card, the full 48 STSs bandwidth can be used with no restrictions (for example, using either a single STS-48c or 4 STS-12c circuits).

Note The STS-24c restriction only applies when a single STS-24c circuit is dropped; therefore, you can easily minimize the impact of this restriction. Group the STS-24c circuits together on a card separate from circuits of other sizes. The grouped circuits can be dropped on other G-Series cards on the ONS 15454.

5.7.2 G1K-4 Compatibility

When installed in ONS 15454s running software prior to Software Release 4.0, the G1K-4 cards require the XC10G card to operate. Software R4.0 and later identifies G1K-4 cards as G1K-4s upon physical installation. Software prior to R4.0 identifies both G1000-4 and G1K-4 cards as G1000-4s upon physical installation.

You can install the G1K-4 card in Slots 1 to 6 and 12 to 17, for a total shelf capacity of 48 Gigabit Ethernet ports. (The practical limit is 40 ports because at least two slots are typically populated by optical cards such as OC-192).

However, when installed on an ONS 15454 running Software R4.0 and later, the G1K-4 card is not limited to installation in ONS 15454s with XC10G cards but can also be installed in ONS 15454s with XC and XCVT cards. When used with XC and XCVT cards on an ONS 15454 running Release 4.0 and later, the G1K-4 is limited to the high-speed slots (Slots 5, 6, 12, and 13).

5.7.3 G1K-4 Card-Level Indicators

The G1K-4 card faceplate has two card-level LED indicators, described in Table 5-14.

Table 5-14 G1K-4 Card-Level Indicators

Card-Level LEDs	Description
FAIL LED (red)	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the G1K-4 card. As part of the boot sequence, the FAIL LED is turned on, and it goes off when the software is deemed operational. The red FAIL LED blinks when the card is loading software.
ACT LED (green)	A green ACT LED provides the operational status of the G1K-4. If the ACT LED is green, it indicates that the G1K-4 card is active and the software is operational.

5.7.4 G1K-4 Port-Level Indicators

The G1K-4 card has four bicolor LEDs (one LED per port). Table 5-15 describes the status that each color represents.

Table 5-15 G1K-4 Port-Level Indicators

Port-Level LED Status	Description
Off	No link exists to the Ethernet port.
Steady amber	A link exists to the Ethernet port, but traffic flow is inhibited. For example, a lack of circuit setup, an error on the line, or a nonenabled port might inhibit traffic flow.
Solid green	A link exists to the Ethernet port, but no traffic is carried on the port.
Flashing green	A link exists to the Ethernet port, and traffic is carried on the port. The LED flash rate reflects the traffic rate for the port.

5.7.5 G1K-4 Card Specifications

The G1K-4 card has the following specifications:

- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 63.00 W, 1.31 A at –48 V, 215.1 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Depth with backplane connector: 235 mm (9.250 in.)
  - Weight not including clam shell: 0.9 kg (2.1 lb)
- Compliance

  ONS 15454 optical cards, when installed in a system, comply with these standards:
  - Safety: IEC 60950, EN 60950, UL 60950, CSA C22.2 No. 60950, TS 001, AS/NZS 3260, IEC 60825-1, IEC 60825-2, 21 CFR 1040-10, and 21 CFR 1040.11
  - Class 1 laser product

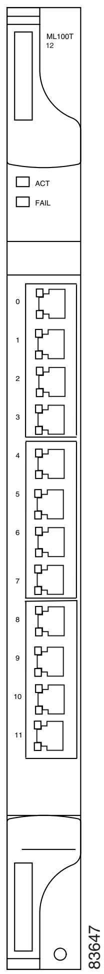
5.8 ML100T-12 Card

The ML100T-12 card provides 12 ports of IEEE 802.3-compliant, 10/100 interfaces. Each interface supports full-duplex operation for a maximum bandwidth of 200 Mbps per port and 2.488 Gbps per card. Each port independently detects the speed of an attached device (autosenses) and automatically connects at the appropriate speed. The ports autoconfigure to operate at either half or full duplex and can determine whether to enable or disable flow control. For ML-Series configuration information, see the *Cisco ONS 15454 SONET/SDH ML-Series Multilayer Ethernet Card Software Feature and Configuration Guide.*

Figure 5-7 shows the card faceplate.

Caution Shielded twisted-pair cabling should be used for inter-building applications.

Figure 5-7 ML100T-12 Faceplate



The card features two virtual packet over SONET (POS) ports with a maximum combined bandwidth of STS-48. The ports function in a manner similar to OC-N card ports, and each port carries an STS circuit with a size of STS-1, STS-3c, STS-6c, STS-9c, STS-12c, or STS-24c. For step-by-step instructions on configuring an ML-Series card SONET STS circuit, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide.*

The ML-Series POS ports supports virtual concatenation (VCAT) of SONET circuits and a software link capacity adjustment scheme (SW-LCAS). The ML-Series card supports a maximum of two VCAT groups with each group corresponding to one of the POS ports. Each VCAT group can contain two circuit members. An ML-Series card supports STS-1c-2v, STS-3c-2v and STS-12c-2v. For step-by-step instructions on configuring an ML-Series card SONET VCAT circuit, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide.*

5.8.1 ML100T-12 Card-Level Indicators

The ML00T-12 card supports two card-level LED indicators. The card-level indicators are described in Table 5-16.

Table 5-16 ML100T-12 Card-Level Indicators

Card-Level LEDs	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the ML100T-12 card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
Green ACT LED	A green ACT LED provides the operational status of the ML100T-12. If the ACT LED is green, it indicates that the ML100T-12 card is active and the software is operational.

5.8.2 ML100T-12 Port-Level Indicators

The ML100T-12 card provides a pair of LEDs for each Fast Ethernet port: an amber LED for activity (ACT) and a green LED for LINK. The port-level indicators are described in Table 5-17.

Table 5-17 ML100T-12 Port-Level Indicators

Port-Level Indicators	Description
ACT LED (Amber)	A steady amber LED indicates a link is detected, but there is an issue inhibiting traffic. A blinking amber LED means traffic is flowing.
LINK LED (Green)	A steady green LED indicates that a link is detected, but there is no traffic. A blinking green LED flashes at a rate proportional to the level of traffic being received and transmitted over the port.
Both ACT and LINK LED	Unlit green and amber LEDs indicate no traffic.

5.8.3 ML100T-12 Slot Compatibility

The ML100T-12 card works in Slots 1 to 6 or 12 to 17 with the XC10G cross-connect card. It works only in high-speed slots (Slots 5, 6, 12, or 13) with the XC or XCVT cross-connect card.

5.8.4 ML100T-12 Card Specifications

The ML100T-12 card has the following specifications:

- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)

- Operating humidity: 5 to 95%, noncondensing
- Power consumption: 53.00 W, 1.10 A at –48 V, 181.0 BTU/hr

- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Depth with backplane connector: 235 mm (9.250 in.)
  - Weight not including clam shell: 1.0 kg (2.3 lb)
- Compliance

  ONS 15454 cards, when installed in a system, comply with these safety standards: IEC 60950, EN 60950, UL 60950, CSA C22.2 No. 60950, TS 001, and AS/NZS 3260

5.9 ML1000-2 Card

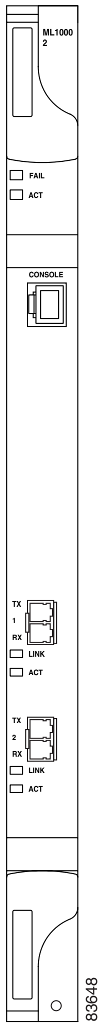
The ML1000-2 card provides two ports of IEEE-compliant, 1000-Mbps interfaces. Each interface supports full-duplex operation for a maximum bandwidth of 2 Gbps per port and 4 Gbps per card. Each port autoconfigures for full duplex and IEEE 802.3x flow control.

SFP modules are offered as separate orderable products for maximum customer flexibility. For details, see the “5.10 GBICs and SFPs” section on page 5-28.

Figure 5-8 on page 5-26 shows the ML1000-2 card faceplate.

Warning **Class 1 laser product.**

Figure 5-8 ML1000-2 Faceplate



Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.**

The card features two virtual packet over SONET (POS) ports with a maximum combined bandwidth of STS-48. The ports function in a manner similar to OC-N card ports, and each port carries an STS circuit with a size of STS-1, STS-3c, STS-6c, STS-9c, STS-12c, or STS-24c. For step-by-step instructions on configuring an ML-Series card SONET STS circuit, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide.*

The ML-Series POS ports supports VCAT of SONET circuits and a software link capacity adjustment scheme (SW-LCAS). The ML-Series card supports a maximum of two VCAT groups with each group corresponding to one of the POS ports. Each VCAT group can contain two circuit members. An ML-Series card supports STS-1c-2v, STS-3c-2v and STS-12c-2v. For step-by-step instructions on configuring an ML-Series card SONET VCAT circuit, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide.*

5.9.1 ML1000-2 Card-Level Indicators

The ML1000-2 card faceplate has two card-level LED indicators, described in Table 5-18.

Table 5-18 ML1000-2 Card-Level Indicators

Card-Level LEDs	Description
SF LED (Red)	The red FAIL LED indicates that the card's processor is not ready or that a catastrophic software failure occurred on the ML1000-2 card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
ACT LED (Green)	A green ACT LED provides the operational status of the ML1000-2. When the ACT LED is green, it indicates that the ML1000-2 card is active and the software is operational.

5.9.2 ML1000-2 Port-Level Indicators

The ML1000-2 card has three LEDs for each of the two Gigabit Ethernet ports, described in Table 5-18.

Port-Level Indicators	Description
ACT LED (Amber)	A steady amber LED indicates a link is detected, but there is an issue inhibiting traffic. A blinking amber LED means traffic flowing.
LINK LED (Green)	A steady green LED indicates that a link is detected, but there is no traffic. A blinking green LED flashes at a rate proportional to the level of traffic being received and transmitted over the port.
Both ACT and LINK LED	Unlit green and amber LEDs indicate no traffic.

5.9.3 Slot Compatibility

The ML1000-2 card works in Slots 1 to 6 or 12 to 17 with the XC10G cross-connect card. It works only in high-speed slots (Slots 5, 6, 12, or 13) with the XC or XCVT cross-connect card.

5.9.4 ML1000-2 Card Specifications

The ML1000-2 card has the following specifications:

- Environmental
  - Operating temperature: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 49.00 W, 1.02 A at –48 V, 167.3 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)

- Depth with backplane connector: 235 mm (9.250 in.)
- Weight not including clam shell: 2.1 lb (0.9 kg)

- Compliance

  ONS 15454 optical cards, when installed in a system, comply with these standards:

  - Safety: IEC 60950, EN 60950, UL 60950, CSA C22.2 No. 60950, TS 001, AS/NZS 3260, IEC 60825-1, IEC 60825-2, 21 CFR 1040-10, and 21 CFR 1040.11
  - Class 1 laser product

5.10 GBICs and SFPs

The ONS 15454 Ethernet cards use industry standard small form-factor pluggable connectors (SFPs) and Gigabit Interface Converter (GBIC) modular receptacles. The ML-Series Gigabit Ethernet cards use standard Cisco SFPs. The Gigabit E-Series card and the G-Series card use standard Cisco GBICs. With Software Release 4.1 and later, G-Series cards can also be equipped with dense wavelength division multiplexing (DWDM) and coarse wavelength division multiplexing (CWDM) GBICs to function as Gigabit Ethernet transponders.

For all Ethernet cards, the type of GBIC or SFP plugged into the card is displayed in CTC and TL1. Cisco offers SFPs and GBICs as separate orderable products.

Table 5-19 lists specifications for the non-WDM GBICs and SFPs.

Table 5-19 GBIC and SFP Specifications (non-WDM)

Parameter	1000BaseSX GBIC	1000BaseLX GBIC	1000BaseZX GBIC	1000BaseSX SFP	1000BaseLX SFP
Product Name	15454-GBIC-SX	15454-GBIC-LX	15454-GBIC-ZX	15454-SFP-LC-SX	15454-SFP-LC-LX
E1000-2-G/E1000-2	Compatible	Compatible	Not Compatible	Not Compatible	Not Compatible
G1K-4/G1000-4	Compatible	Compatible	Compatible	Not Compatible	Not Compatible
ML1000-2	Not Compatible	Not Compatible	Not Compatible	Compatible	Compatible
IEEE Compliant	Yes	Yes	Yes	Yes	Yes
Center Wavelength (Nominal)	850 nm	1310 nm	1550 nm	850 nm	1310 nm
Central Wavelength (Spectral Range)	770 to 860 nm	1270 to 1355 nm	1540 to 1570 nm	770 to 860 nm	1270 to 1355 nm
Temperature Range (Ambient)	–5 to +55 Celsius	–5 to +55 Celsius	–5 to +50 Celsius	–5 to +55 Celsius	–5 to +55 Celsius
Transmitter Output Power (minimum)	–9.5 dBm	–11 dBm	0 dBm	9.5 dBm	11 dBm
Optical Input Power (Rx)-Minimum	–17 dBm	–19 dBm	–24 dBm	–17 dBm	–19 dBm
Optical Input Power (Rx)-Maximum	0 dBm	–3 dBm	–1 dBm	0 dBm	–3 dBm

Table 5-19 GBIC and SFP Specifications (non-WDM) (continued)

Parameter	1000BaseSX GBIC	1000BaseLX GBIC	1000BaseZX GBIC	1000BaseSX SFP	1000BaseLX SFP
Operating Range for 62.5-micron multimode fiber	220 meters	550 meters [1]	Not Compatible	220 meters	550 meters[1]
Operating Range for 50-micron multimode fiber	550 meters	550 meters[1]	Not Compatible	550 meters	550 meters[1]
Operating Range for 10-micron singlemode fiber	Not Compatible	10 Kilometers	70 Kilometers	Not Compatible	10 Kilometers

1. When using an LX SFP or LX GBIC with multimode fiber, you must install a mode-conditioning patch cord between the SFP/GBIC and the multimode fiber cable on both the transmit and receive ends of the link. The mode-conditioning patch cord is required for link distances less than 100 m (328 feet) or greater than 300 m (984 feet). The mode-conditioning patch cord prevents overdriving the receiver for short lengths of multimode fiber and reduces differential mode delay for long lengths of multimode fiber.

5.10.1 DWDM and CWDM Gigabit Interface Converters

DWDM and CWDM GBICs operate in the ONS 15454 G-Series card when the card is configured in Gigabit Ethernet Transponding mode or in Ethernet over SONET mode. DWDM and CWDM GBICs are both wavelength division multiplexing (WDM) technologies and operate over single-mode fibers with SC connectors. Cisco CWDM GBIC technology uses a 20-nm wavelength grid and Cisco ONS 15454 DWDM GBIC technology uses a 1-nm wavelength grid. CTC displays the specific wavelengths of the installed CWDM or DWDM GBICs. DWDM wavelengths are spaced closer together and require more precise lasers than CWDM. The DWDM spectrum allows for optical signal amplification. For more information on G-Series card transponding mode, see the "5.10 GBICs and SFPs" section on page 5-28.

The DWDM and CWDM GBICs receive across the full 1300-nm and 1500-nm bands, which includes all CWDM, DWDM, LX, ZX wavelengths, but transmit on one specified wavelength. This capability can be exploited in some of the G-Series transponding modes by receiving wavelengths that do not match the specific transmission wavelength.

Note G1000-4 cards support CWDM and DWDM GBICs. G1K-4 cards with the Common Language Equipment Identification (CLEI) code of WM5IRWPCAA (manufactured after August 2003) support CWDM and DWDM GBICs. G1K-4 cards manufactured prior to August 2003 do not support CWDM or DWDM GBICs.

Caution Operating temperature of the DWDM GBICs is –5 degrees C to 40 degrees C (23 degrees F to 104 degrees F).

The ONS 15454 supported CWDM GBICs reach up to 100 to 120 km over single mode fiber and support eight wavelengths:

- 1470 nm
- 1490 nm
- 1510 nm
- 1530 nm
- 1550 nm

- 1570 nm
- 1590 nm
- 1610 nm

The ONS 15454 supported DWDM GBICs support 32 different wavelengths in the red and blue bands. Paired with optical amplifiers, such as the Cisco ONS 15216, the DWDM GBICs allow maximum unregenerated spans of approximately 300 km (Table 5-20).

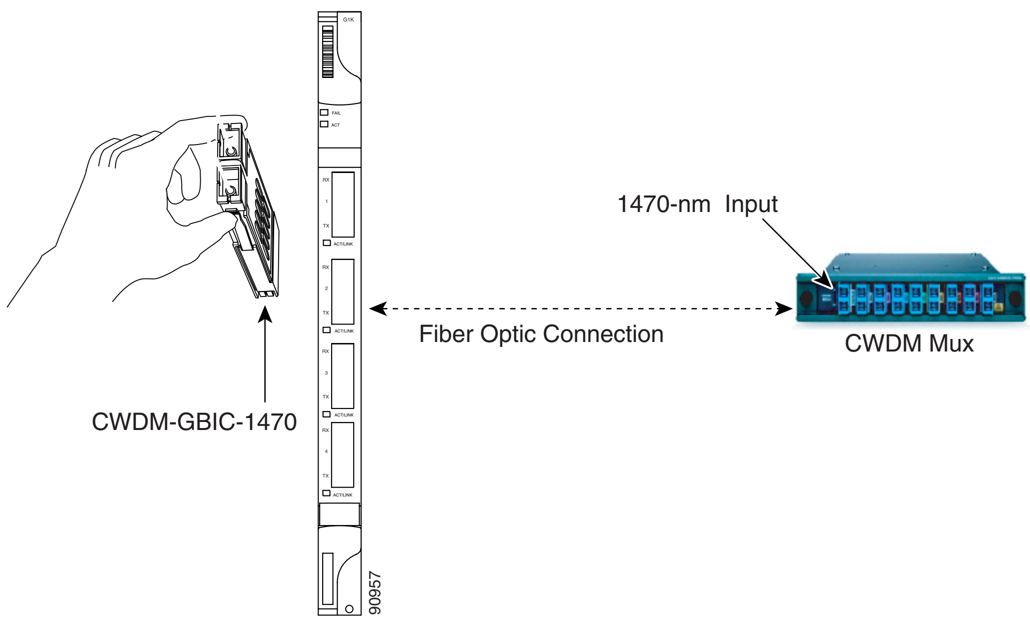
Table 5-20 32 ITU-100 GHz Wavelengths Supported by DWDM GBICs

Blue Band	1530.33 nm	1531.12 nm	1531.90 nm	1532.68 nm	1534.25 nm	1535.04 nm	1535.82 nm	1536.61 nm
	1538.19 nm	1538.98 nm	1539.77 nm	1540.56 nm	1542.14 nm	1542.94 nm	1543.73 nm	1544.53 nm
Red Band	1546.12 nm	1546.92 nm	1547.72 nm	1548.51 nm	1550.12 nm	1550.92 nm	1551.72 nm	1552.52 nm
	1554.13 nm	1554.94 nm	1555.75 nm	1556.55 nm	1558.17 nm	1558.98 nm	1559.79 nm	1560.61 nm

5.10.1.1 Placement of CWDM or DWDM GBICs

CWDM or DWDM GBICs for the G-Series card come in set wavelengths and are not provisionable. The wavelengths are printed on each GBIC, for example, CWDM-GBIC-1490. The user must insert the specific GBIC transmitting the wavelength required to match the input of the CWDM/DWDM device for successful operation (Figure 5-9 on page 5-30). Follow your site plan or network diagram for the required wavelengths.

Figure 5-9 CWDM GBIC with Wavelength Appropriate for Fiber-Connected Device

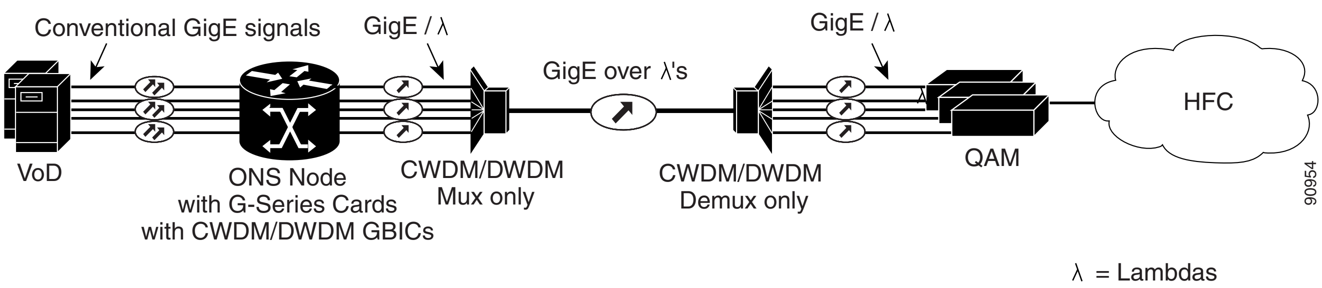


The *Cisco ONS 15454 Procedure Guide* contains specific procedures for attaching optical fiber to GBICs and inserting GBICs into the G-Series card.

5.10.1.2 Example of CWDM or DWDM GBIC Application

A G-Series card equipped with CWDM or DWDM GBICs supports the delivery of unprotected Gigabit Ethernet service over Metro DWDM and video-on-demand (VoD) transport networks (Figure 5-10). It can be used in short-haul and long-haul applications.

Figure 5-10 G-Series with CWDM/DWDM GBICs in Cable Network



DWDM Cards

This chapter describes Cisco ONS 15454 dense wavelength-division multiplexing (DWDM) card features and functions. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

Chapter topics include:

6.1 DWDM Card Overview

The DWDM card overview section summarizes card functions, power consumption, and temperature ranges.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. See the "1.13.1 Card Slot Requirements" section on page 1-43 for a list of slots and symbols.

6.1.1 DWDM Cards

ONS 15454 DWDM cards are grouped into the following categories:

- Optical service channel cards provide bidirectional channels that connect all the ONS 15454 DWDM nodes and transport general-purpose information without affecting the client traffic. ONS 15454 optical service channel cards include the Optical Service Channel Module (OSCM) and the Optical Service Channel and Combiner/Separator Module (OSC-CSM).
- Optical amplifier cards are used in amplified DWDM nodes, including hub nodes, amplified OADM nodes, and line amplified nodes. The cards are composed of three main modules: an optical plug-in, a microprocessor, and a DC/DC converter. Optical amplifier cards include the Optical Preamplifier (OPT-PRE) and Optical Booster (OPT-BST) amplifier.
- Dispersion compensation units are installed in the ONS 15454 dispersion compensation shelf when optical preamplifier cards are installed in the DWDM node. Each DCU module can compensate a maximum of 65 km of single-mode fiber (SMF-28) span. DCUs can be cascaded to extend the compensation to 130 km.
- Multiplexer and demultiplexer cards multiplex and demultiplex DWDM optical channels. The cards are composed of three main modules: optical plug-in, microprocessor, and the DC/DC converter. ONS 15454 multiplexer and demultiplexer cards include the 32-Channel Multiplexer (32 MUX-O), the 32-Channel Demultiplexer (32 DMX-O), and the 4-Channel Multiplexer/Demultiplexer (4MD-xx.x).
- Optical Add/Drop Multiplexer (OADM) cards are mainly divided into two groups: band OADM and channel OADM cards. Band OADM cards add and drop one or four bands of adjacent channels; they include the 4-Band OADM (AD-4B-xx.x) and the 1-Band OADM (AD-1B-xx.x). Channel OADM cards add and drop one, two, or four adjacent channels; they include the 4-Channel OADM (AD-4C-xx.x), the 2-Channel OADM (AD-2C-xx.x) and the 1-Channel OADM (AD-1C-xx.x). The cards are composed of three main modules: optical plug-in, microprocessor, and the DC/DC converter.

Table 6-1 lists the Cisco ONS 15454 DWDM cards.

Table 6-1 DWDM Cards for the ONS 15454

Card	Port Description	For Additional Information...
Optical Service Channel Modules		
OSCM	The OSCM has one set of optical ports and one Ethernet port located on the faceplate. It operates in Slots 8 and 10.	See the "6.2 OSCM Card" section on page 6-8.
OSC-CSM	The OSC-CSM has three sets of optical ports and one Ethernet port located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.3 OSC-CSM Card" section on page 6-13.
Optical Amplifiers		
OPT-PRE	The OPT-PRE amplifier has five optical ports (three sets) located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.4 OPT-PRE Amplifier" section on page 6-18.
OPT-BST	The OPT-BST amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.5 OPT-BST Amplifier" section on page 6-23.

Table 6-1 DWDM Cards for the ONS 15454 (continued)

Card	Port Description	For Additional Information...
Multiplexer and Demultiplexer Cards		
32 MUX-O	The 32 MUX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "6.6 32 MUX-O Card" section on page 6-28.
32 DMX-O	The 32 DMX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16	See the "6.7 32 DMX-O Card" section on page 6-32.
4MD-xx.x	The 4MD-xx.x card has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.8 4MD-xx.x Card" section on page 6-36.
Optical Add/Drop Multiplexer Cards		
AD-1C-xx.x	The AD-1C-xx.x card has three sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.9 AD-1C-xx.x Card" section on page 6-42.
AD-2C-xx.x	The AD-2C-xx.x card has four sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.10 AD-2C-xx.x Card" section on page 6-47.
AD-4C-xx.x	The AD-4C-xx.x card has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.11 AD-4C-xx.x Card" section on page 6-52.
AD-1B-xx.x	The AD-1B-xx.x card has three sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.12 AD-1B-xx.x Card" section on page 6-57.
AD-4B-xx.x	The AD-4B-xx.x card has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "6.13 AD-4B-xx.x Card" section on page 6-64.

6.1.2 Card Power Requirements

Table 6-2 lists power requirements for individual cards.

Table 6-2 Individual Card Power Requirements

Card Name	Watts	Amperes	BTU/Hr
OSCM	Nominal 23 W	Nominal 0.48 A	Nominal 78.48 BTUs
	Maximum 26 W	Maximum 0.54 A	Maximum 88.71 BTUs
OSC-CSM	Nominal 24 W	Nominal 0.5 A	Nominal 81.89 BTUs
	Maximum 27 W	Maximum 0.56 A	Maximum 92.12 BTUs
OPT-PRE	Minimum 25 W	Minimum 0.52 A	Minimum 85.3 BTUs
	Nominal 30 W	Nominal 0.56 A	Nominal 102.36 BTUs
	Maximum39 W	Maximum 0.81 A	Maximum 88.71 BTUs

Table 6-2 Individual Card Power Requirements (continued)

Card Name	Watts	Amperes	BTU/Hr
OPT-BST	Nominal 30 W Maximum 39 W	Nominal 0.63 A Maximum 0.81 A	Nominal 102.36 BTUs Maximum 88.71 BTUs
32 MUX-O	Nominal 16 W Maximum 25 W	Nominal 0.33 A Maximum 0.52 A	Nominal 54.59 BTUs Maximum 85.3 BTUs
32 DMX-O	Nominal 16 W Maximum 25 W	Nominal 0.33 A Maximum 0.52 A	Nominal 54.59 BTUs Maximum 85.3 BTUs
4MD-xx.x	Nominal 17 W Maximum 25 W	Nominal 0.35 A Maximum 0.52 A	Nominal 58.0 BTUs Maximum 85.3 BTUs
AD-1C-xx.x	Nominal 17 W Maximum 25 W	Nominal 0.35 A Maximum 0.52 A	Nominal 58.0 BTUs Maximum 85.3 BTUs
AD-2C-xx.x	Nominal 17 W Maximum 25 W	Nominal 0.35 A Maximum 0.52 A	Nominal 58.0 BTUs Maximum 85.3 BTUs
AD-4C-xx.x	Nominal 17 W Maximum 25 W	Nominal 0.35 A Maximum 0.52 A	Nominal 58.0 BTUs Maximum 85.3 BTUs
AD-1B-xx.x	Nominal 17 W Maximum 25 W	Nominal 0.35 A Maximum 0.52 A	Nominal 58.0 BTUs Maximum 85.3 BTUs
AD-4B-xx.x	Nominal 17 W Maximum 25 W	Nominal 0.35 A Maximum 0.52 A	Nominal 58.0 BTUs Maximum 85.3 BTUs

6.1.3 Card Temperature Ranges

Table 6-3 shows C-Temp and I-Temp compliant cards and their product names.

Note The I-Temp symbol is displayed on the faceplate of an I-Temp compliant card. A card without this symbol is C-Temp compliant.

Table 6-3 Optical Card Temperature Ranges and Product Names for the ONS 15454

Card	C-Temp Product Name (+23 to +131 degrees Fahrenheit, –5 to +55 degrees Celsius)	I-Temp Product Name (–40 to +149 degrees Fahrenheit, –40 to +65 degrees Celsius)
OSCM	OSCM	—
OSC-CSM	OSC-CSM	—
OPT-PRE	OPT-PRE	—
OPT-BST	OPT-BST	—
32 MUX-O	32 MUX-O	—
32 DMX-O	32 DMX-O	—

Table 6-3 Optical Card Temperature Ranges and Product Names for the ONS 15454 (continued)

Card	C-Temp Product Name (+23 to +131 degrees Fahrenheit, –5 to +55 degrees Celsius)	I-Temp Product Name (–40 to +149 degrees Fahrenheit, –40 to +65 degrees Celsius)
4MD-xx.x	4MD-xx.x	—
AD-1B-xx.x	AD-1B-xx.x	—
AD-2C-xx.x	AD-2C-xx.x	—
AD-4B-xx.x	AD-4B-xx.x	—
AD-1C-xx.x	AD-1C-xx.x	—
AD-4C-xx.x	AD-4C-xx.x	—

6.1.4 Multiplexer, Demultiplexer, and OADM Card Interface Classes

The 32MUX-O, 32WSS, 32DMX, 32 DMX-O, 4MD-xx.x, AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x cards have different input and output optical channel signals, depending upon the interface card where the input signal originates. The input interface cards have been grouped in classes listed in Table 6-4. The subsequent tables list the optical performances and output power of each interface class.

Table 6-4 ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder with forward error correction (FEC) or 10-Gbps muxponder with FEC
B	10-Gbps multirate transponder without FEC
C	OC-192 LR ITU
D	2.5-Gbps multirate transponder, both protected and unprotected, with FEC enabled
E	2.5-Gbps multirate transponder, both protected and unprotected, without FEC enabled
F	2.5-Gbps multirate transponder, both protected and unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz

10-Gbps cards that provide signal input to OADM cards have the optical performances listed in Table 6-5. 2.5-Gbps card interface performances are listed in Table 6-6 on page 6-6.

Table 6-5 10-Gbps Interface Optical Performances

Parameter	Class A		Class B		Class C	
Type	Power limited	OSNR[1] limited	Power limited	OSNR limited	Power limited	OSNR limited
Optical signal to noise ratio (OSNR) sensitivity	23 dB	9 dB	23 dB	9 dB	23 dB	9 dB

Table 6-5 10-Gbps Interface Optical Performances (continued)

Parameter	Class A		Class B		Class C	
Power sensitivity	–24 dBm	–18 dBm	–20 dBm	–20 dBm	–22 dBm	–22 dBm
Dispersion power penalty	2 dB	0 dB	3 dB	4 dB	2 dB	2 dB
Dispersion OSNR penalty	0 dB	2 dB	0 dB	0 dB	0 dB	0 dB
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm	+/–800 ps/nm	+/–1,200 ps/nm	+/–1,000 ps/nm
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps	
Regeneration	3R[2]		3R		3R	
FEC	Yes		Yes		Yes	
Threshold	Optimum		Average		Average	
Maximum BER[3]	10^{-15}		10^{-12}		10^{-12}	
Power overload	–8 dBm		–8 dBm		–9 dBm	
Transmitted power range	0 ÷ (+2) dBm		0 ÷ (+2) dBm		+3 ÷ (+6) dBm	

1. OSNR = optical signal-to-noise ratio
2. 3R = retime, reshape, and regenerate
3. BER = bit error rate

Table 6-6 2.5-Gbps Interface Optical Performances

Parameter	Class D		Class E		Class F		Class G	
Type	**Power limited**	**OSNR limited**	**Power limited**	**OSNR limited**	**Power limited**	**OSNR limited**	**Power limited**	**OSNR limited**
OSNR sensitivity	14 dB	7 dB	14 dB	11 dB	15 dB	15 dB	14 dB	14 dB
Power sensitivity	–31 dBm	–23 dBm	–28 dBm	–23 dBm	–24 dBm	–24 dBm	–27 dBm	–24 dBm
Dispersion power penalty	2 dB	0 dB	2 dB	0 dB	3 dB	3 dB	2 dB	2 dB
Dispersion OSNR penalty	0 dB	2 dB	0 dB	2 dB	0 dB	0 dB	0 dB	0 dB
Dispersion compensating tolerance	–1,200 to +5,400 ps/nm		–1,200 to +5,400 ps/nm		–1,200 to +2,720 ps/nm		–1,200 to +5,400 ps/nm	
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps		2.5 Gbps	
Regeneration	3R		3R		3R		3R	
FEC	Yes		No		No		No	
Threshold	Average		Average		Average		Average	

Table 6-6 2.5-Gbps Interface Optical Performances (continued)

Parameter	Class D	Class E	Class F	Class G
Maximum BER	10^{-15}	10^{-12}	10^{-12}	10^{-12}
Power overload	–9 dBm	–10 dBm	–9 dBm	–9 dBm
Transmitted power range	–4.5 to +1 dBm	–4.5 to +1 dBm	–4.5 to +1 dBm	–2 to 0 dBm

Tables 6-7 and 6-8 give the transmit output power ranges of 10-Gbps and 2.5-Gbps interfaces, respectively. These values, decreased by patch cord and connector losses, are also the input power values for the OADM cards.

Table 6-7 10-Gbps Interface Transmit Output Power Range or OADM Input Power Range

Parameter	Value					
	Class A		Class B		Class C	
	Min.	Max.	Min.	Max.	Min.	Max.
Power at Tx	0 dBm	+2 dBm	0 dBm	+2 dBm	+3 dBm	+6 dBm

Table 6-8 2.5-Gbps Interface Transmit Output Power Range or OADM Input Power Range

Parameter	Value							
	Class A		Class B		Class C		Class D	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Power at Tx	–4.5 dBm	+1 dBm	–4.5 dBm	+1 dBm	–4.5 dBm	+1 dBm	–2 dBm	0 dBm

6.1.5 DWDM Card Channel Allocation Plan

ONS 15454 DWDM multiplexers, demultiplexers, channel OADM, and band OADM cards are designed for use with specific channels. In most cases, the channels for these cards are either numbered (1 to 32) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with ONS 15454.

Table 6-9 lists the channel IDs and wavelengths assigned to the DWDM channels.

Table 6-9 DWDM Channel Allocation Plan

Channel Number	Channel ID	Frequency (THz)	Wavelength (nm)
1	30.3	195.9	1530.33
2	31.2	195.8	1531.12
3	31.9	195.7	1531.90
4	32.6	195.6	1532.68
5	34.2	195.4	1534.25

Table 6-9 DWDM Channel Allocation Plan (continued)

Channel Number	Channel ID	Frequency (THz)	Wavelength (nm)
6	35.0	195.3	1535.04
7	35.8	195.2	1535.82
8	36.6	195.1	1536.61
9	38.1	194.9	1538.19
10	38.9	194.8	1538.98
11	39.7	194.7	1539.77
12	40.5	194.6	1540.56
13	42.1	194.4	1542.14
14	42.9	194.3	1542.94
15	43.7	194.2	1543.73
16	44.5	194.1	1544.53
17	46.1	193.9	1546.12
18	46.9	193.8	1546.92
19	47.7	193.7	1547.72
20	48.5	193.6	1548.51
21	50.1	193.4	1550.12
22	50.9	193.3	1550.92
23	51.7	193.2	1551.72
24	52.5	193.1	1552.52
25	54.1	192.9	1554.13
26	54.9	192.8	1554.94
27	55.7	192.7	1555.75
28	56.5	192.6	1556.55
29	58.1	192.4	1558.17
30	58.9	192.3	1558.98
31	59.7	192.2	1559.79
32	60.6	192.1	1560.61

6.2 OSCM Card

An optical service channel (OSC) is a bidirectional channel connecting two adjacent nodes in a DWDM ring. For every DWDM node (except Terminal Nodes), two different OSC termination are present, one for the West side and another for the East. The channel transports OSC overhead that is used to manage ONS 15454 DWDM networks. The OSC signal uses the 1510-nm wavelength and does not affect client traffic. The primary purpose of this channel is to carry clock synchronization and orderwire channel communications for the DWDM network. It also provides transparent links between each node in the network. The OSC is an OC-3 formatted signal.

There are two versions of the OSC modules: the OSCM, and the OSC-CSM, which contains an OSC wavelength combiner and separator component in addition to the OSC module. For information about the OSC-CSM, see the "6.3 OSC-CSM Card" section on page 6-13. Figure 6-1 shows the OSCM faceplate.

Figure 6-1 OSCM Faceplate

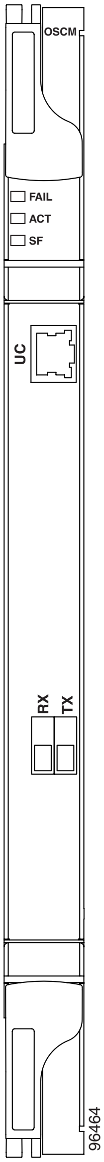
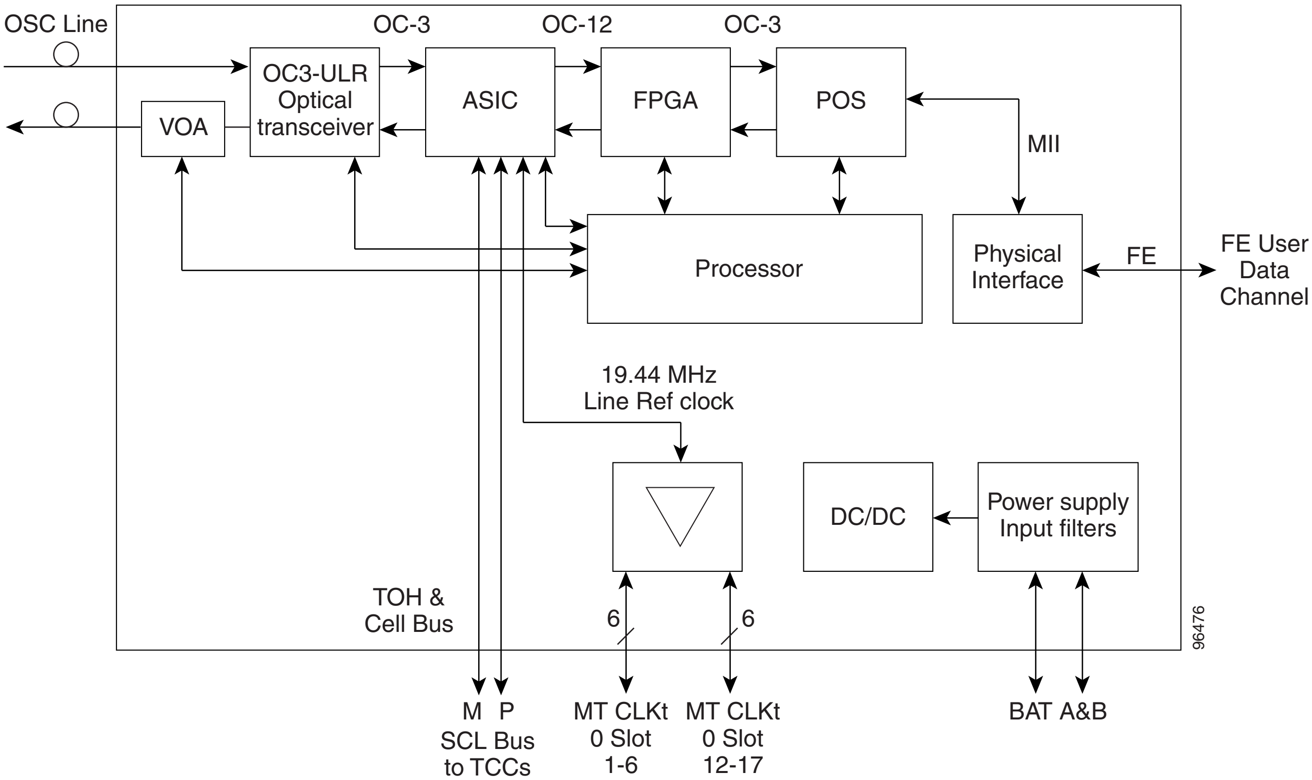


Figure 6-2 shows the OSCM block diagram.

Figure 6-2 OSCM Block Diagram



The OSCM is used in amplified nodes that include the OPT-BST booster amplifier. The OPT-BST includes the required OSC wavelength combiner and separator component. The OSCM cannot be used in nodes where you use OC-N cards, electrical cards, or cross-connect cards. The OSCM uses Slots 8 and 10, which are also cross-connect card slots.

The OSCM supports the following features:

- OC-3 formatted OSC
- Supervisory data channel (SDC) forwarded to the TCC2 cards for processing
- Distribution of the synchronous clock to all nodes in the ring
- 100BaseT FE user data channel (UDC)
- Monitoring functions such as orderwire support and optical safety

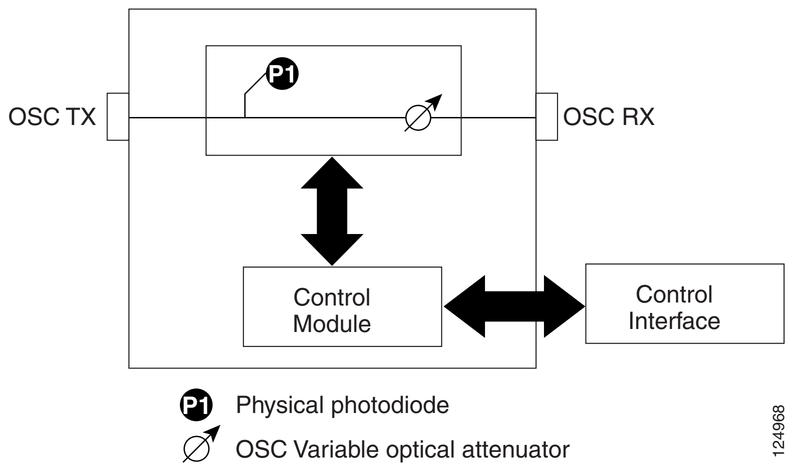
The OC-3 section data communications channel (SDCC) overhead bytes are used for network communications. An optical transceiver terminates the OC-3, then it is regenerated and converted into an electrical signal. The SDCC bytes are forwarded to the active and standby TCC2 cards for processing via the system communication link (SCL) bus on the backplane. Orderwire bytes (E1, E2, F1) are also forwarded via the SCL bus to the TCC2 for forwarding to the AIC-I card.

The payload portion of the OC-3 is used to carry the fast Ethernet UDC. The frame is sent to a packet over SONET (POS) processing block that extracts the Ethernet packets and makes them available at the RJ-45 connector.

The OSCM, which resides in the cross-connect slots and follows the ONS 15454 backplane architecture, distributes the reference clock information by removing it from the incoming OC-3 signal and then sending it to the DWDM cards. The DWDM cards then forward the clock information to the active and standby TCC2 cards.

Figure 6-3 shows the block diagram of the VOA within the OSCM.

Figure 6-3 OSCM VOA Optical Module Functional Block Diagram



6.2.1 Power Monitoring

Physical photodiode P1 monitors the power for the OSCM card. The returned power level value is calibrated to the OSC TX port. See Table 6-10.

Table 6-10 OSCM VOA Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1	Output OSC	OSC TX

6.2.2 OSCM Card-Level Indicators

The OSCM card has three card-level LED indicators, described in Table 6-11.

Table 6-11 OSCM Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OSCM is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BER on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.2.3 OSCM Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The OSCM has one OC-3 optical port located on the faceplate. One long-reach OSC transmits and receives the OSC to and from another DWDM node. Both data communications network (DCN) data and far-end (FE) payload are carried on this link.

6.2.4 OSCM Card Specifications

The OSCM card has the following specifications:

- Line
  - Bit rate: 155 Mbps
  - Code: Scrambled non-return to zero (NRZ)
  - Loopback modes: None
  - Connector: Duplex LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.957
- Transmitter OSC signal
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –5 dBm
  - Nominal wavelength: 1510-nm +/–10 nm
  - Variable optical attenuator (VOA) necessary in the transmit path to adjust the in-fiber optical power level
- Receiver OSC signal
  - Maximum receiver level: –8 dBm at 10^{-10} BER
  - Minimum receiver level: –40 dBm at 10^{-10} BER
  - Span budget: 40-dB span budget (about 150 km assuming fiber path loss equals 0.25 dB/km)
  - Jitter tolerance: Telcordia GR-253/G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)
  - Depth: 9.00 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.3 OSC-CSM Card

An optical service channel (OSC) is a bidirectional channel connecting all the nodes in a ring. The channel transports OSC overhead that is used to manage ONS 15454 DWDM networks. The OSC uses the 1510-nm wavelength and does not affect client traffic. The primary purpose of this channel is to carry clock synchronization and orderwire channel communications for the DWDM network. It also provides transparent links between each node in the network. The OSC is an OC-3 formatted signal.

There are two versions of the OSC modules: the OSCM, and the OSC-CSM which contains a combiner and separator module in addition to the OSC module. For information about the OSCM, see the "6.2 OSCM Card" section on page 6-8. Figure 6-4 shows the OSC-CSM faceplate.

Figure 6-4 OSC-CSM Faceplate

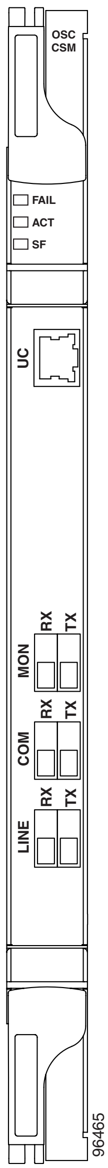


Figure 6-5 shows the OSC-CSM block diagram.

Figure 6-5 OSC-CSM Block Diagram

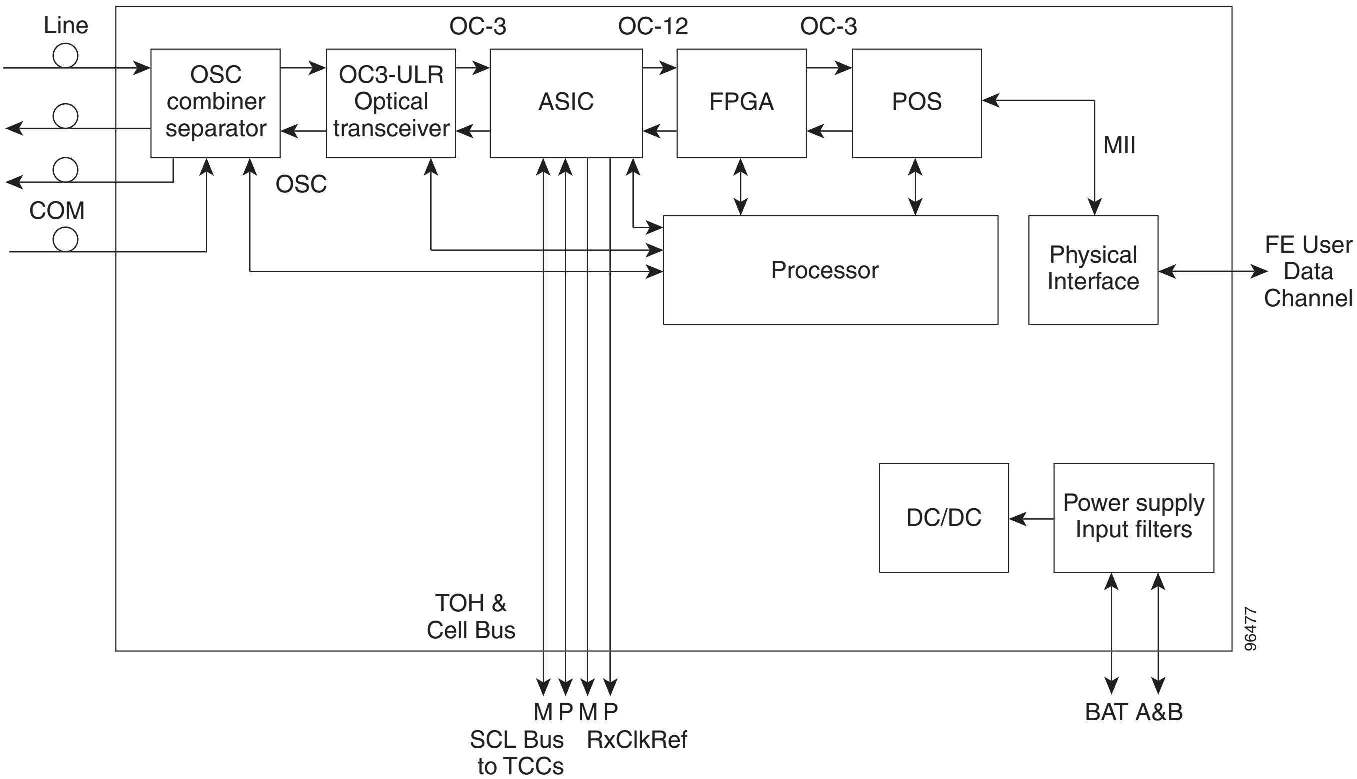
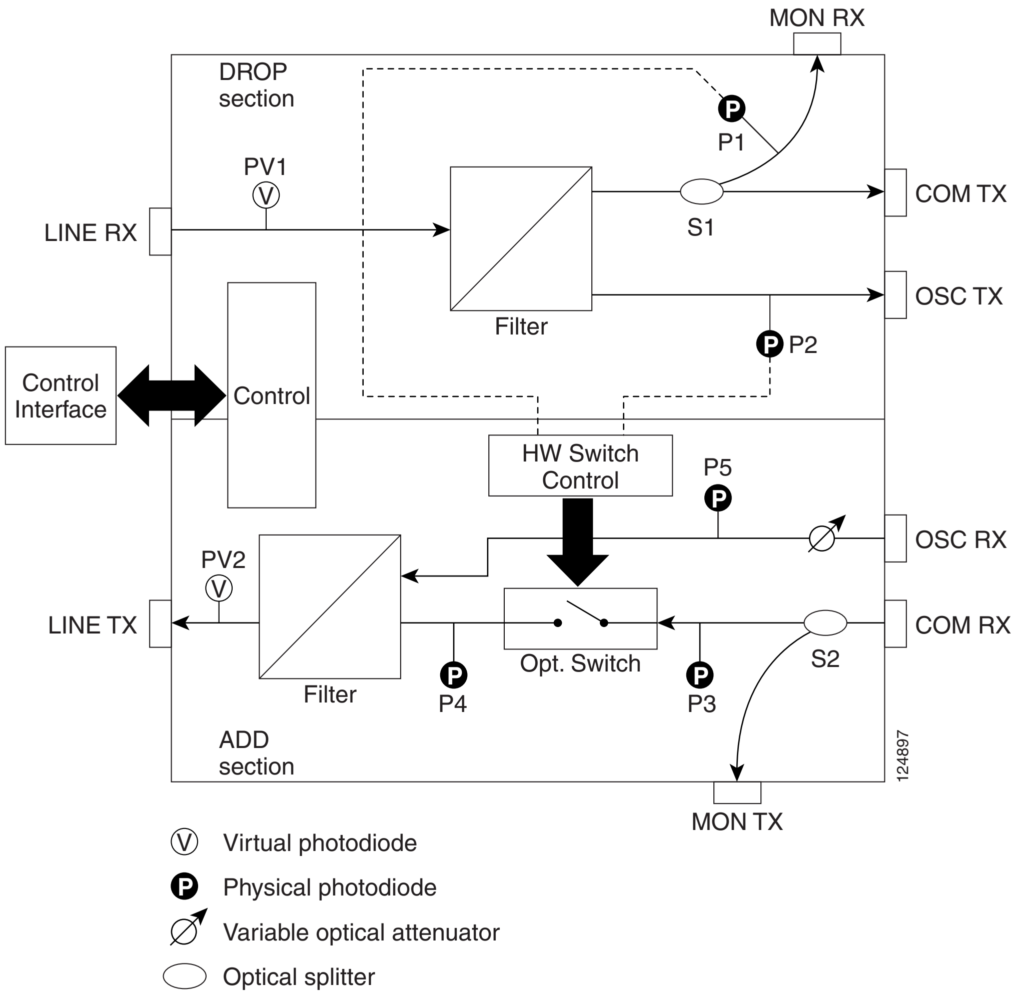


Figure 6-6 shows the OSC-CSM optical module functional block diagram.

Figure 6-6 OSC-CSM Optical Module Functional Block Diagram



The OSC-CSM is used in unamplified nodes. This means that the booster amplifier with the OSC wavelength combiner and separator is not required for OSC-CSM operation. The OSC-CSM can be installed in Slots 1 to 6 and 12 to 17. The cross-connect cards enable functionality on the OC-N cards and electrical cards.

The OSC-CSM supports the following features:

- Optical combiner and separator module for multiplexing and demultiplexing the optical service channel to or from the wavelength division multiplexing (WDM) signal
- OC-3 formatted OSC
- Supervisory data channel (SDC) forwarded to the TCC2 cards for processing
- Distribution of the synchronous clock to all nodes in the ring
- 100BaseT FE UDC
- Monitoring functions such as orderwire support and optical safety
- Optical safety: Signal loss detection and alarming, fast transmitted power shut down by means of an optical 1x1 switch
- Optical safety remote interlock (OSRI), a feature capable of shutting down the optical output power

- Automatic laser shutdown (ALS), a safety mechanism used in the event of a fiber cut

The WDM signal coming from the line is passed through the OSC combiner and separator, where the OSC signal is extracted from the WDM signal. The WDM signal is sent along with the remaining channels to the COM port (label on the front panel) for routing to the OADM or amplifier units, while the OSC signal is sent to an optical transceiver.

The OSC is an OC-3 formatted signal. The OC-3 SDCC overhead bytes are used for network communications. An optical transceiver terminates the OC-3, and then it is regenerated and converted into an electrical signal. The SDCC bytes are forwarded to the active and standby TCC2 cards for processing via the SCL bus on the backplane. Orderwire bytes (E1, E2, F1) are also forwarded via the SCL bus to the TCC2 for forwarding to the AIC-I card.

The payload portion of the OC-3 is used to carry the fast Ethernet UDC. The frame is sent to a POS processing block that extracts the Ethernet packets and makes them available at the RJ-45 front panel connector.

The OSC-CSM distributes the reference clock information by removing it from the incoming OC-3 signal and then sending it to the active and standby TCC2s. The clock distribution is different form the OSCM card because the OSC-CSM does not use Slot 8 or 10 (cross-connect card slots).

Note S1 and S2 (see Figure 6-6) are optical splitters with a splitter ratio of 2:98. The result is that the power at the MON TX port is about 17 dB lower than the relevant power at the COM RX port, and the power at the MON RX port is about 20 dB lower than the power at the COM TX port. The difference is due to the presence of a tap coupler for the P1 photodiode.

6.3.1 Power Monitoring

Physical photodiodes P1, P2, P3, and P5 monitor the power for the OSC-CSM card. Their function is as follows:

- P1 and P2: The returned power value is calibrated to the LINE RX port, including the insertion loss of the previous filter (the reading of this power dynamic range has been brought backward towards the LINE RX output).
- P3: The returned value is calibrated to the COM RX port.
- P5: The returned value is calibrated to the LINE TX port, including the insertion loss of the subsequent filter.

The returned power level values are calibrated to the ports as shown in Table 6-12.

Table 6-12 OSC-CSM Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1	Out Com	LINE RX
P2	Input OSC	LINE RX
P3	In Com	COM RX
P5	Output Osc	LINE TX

6.3.2 OSC-CSM Card-Level Indicators

The OSC-CSM card has three card-level LED indicators, described in Table 6-13.

Table 6-13 OSC-CSM Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OSC-CSM is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BER on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.3.3 OSC-CSM Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The OSC-CSM has a UC port and three sets of ports located on the faceplate.

6.3.4 OSC-CSM Card Specifications

The OSC-CSM card has the following specifications:

- Line
  - Bit rate: 155 Mbps
  - Code: Scrambled NRZ
  - Loopback modes: None
  - Connector: Duplex LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.957
- Transmitter OSC signal
  - Maximum transmitter output power: –2 dBm
  - Minimum transmitter output power: –24 dBm
  - Nominal wavelength: 1510-nm +/–10 nm
  - VOA is necessary in the transmit path to adjust the in-fiber optical power level
- Receiver OSC signal
  - Maximum receiver level: –8 dBm at 10^{-10} BER
  - Minimum receiver level: –40 dBm at 10^{-10} BER

> **Note** The minimum acceptable power level for the OSC receiver signal is -40dBm. Set the LOS-P alarm threshold accordingly in the same power range.

> **Note** The minimum power level that CTC can read is -41dBm. CTC reports all values lower than -41dBm as -41.1dBm and not the actual measured value. When CTC reports -41.1dBm, the OSC-CSM card raises a LOS-P alarm.

  - Span loss budget: 35- dB span budget (approximately 140 km assuming that the fiber path loss is equal to 0.25 dB/km
  - Jitter tolerance: Telcordia GR-253/G.823 compliant
- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)
  - Depth: 9.00 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.4 OPT-PRE Amplifier

Optical amplifiers are used in amplified nodes, such as hub nodes, amplified OADM nodes, and line amplifier nodes. There are two forms of amplifiers, the Optical Preamplifier (OPT-PRE) and the Optical Booster (OPT-BST) amplifier. For more information about the OPT-BST card, see the "6.5 OPT-BST Amplifier" section on page 6-23. The optical amplifier card architecture includes an optical plug-in module with a controller that manages optical power, laser current, and temperature control loops. The amplifier also manages communication with the TCC2, and operations, administration, maintenance, and provisioning (OAM&P) functions such as provisioning, controls, and alarms.

Optical amplifiers have a linear power feature that enables them to be kept in the constant gain mode if the gain is less than 28 dB. However, for longer span solutions it is necessary to place the amplifier in constant power mode. In constant power mode, automatic power control (APC) requirements change. This is because span loss degradation does not effect the system and amplifiers are not able to automatically modify the output power for variations in the number of channels when provisioning changes and a failure occurs.

Figure 6-7 shows the OPT-PRE amplifier faceplate.

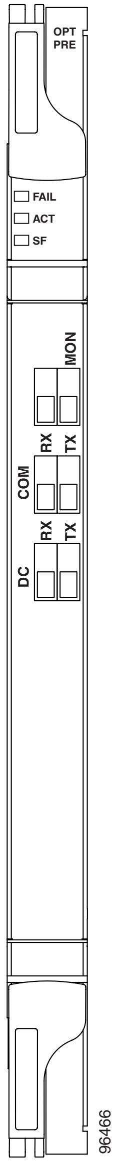


Figure 6-7 OPT-PRE Faceplate

Figure 6-8 shows the OPT-PRE block diagram.

Figure 6-8 OPT-PRE Block Diagram

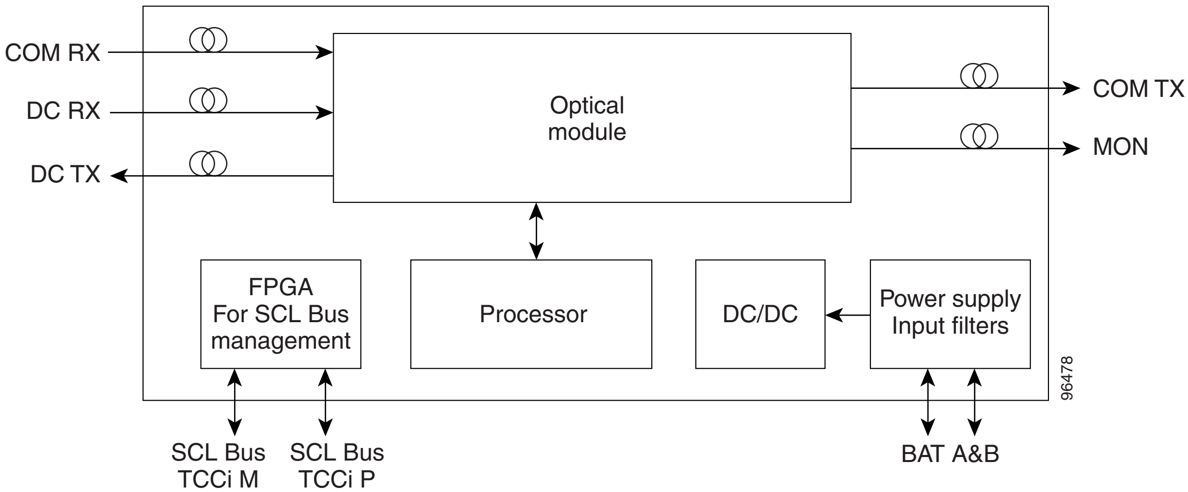
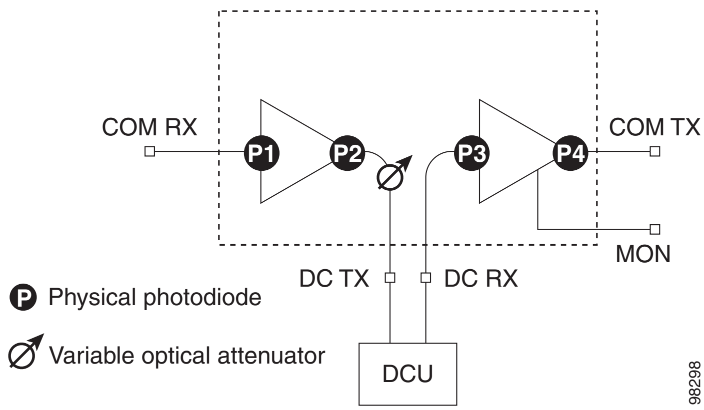


Figure 6-9 shows the OPT-PRE optical module functional block diagram.

Figure 6-9 OPT-PRE Optical Module Functional Block Diagram



The OPT-PRE is designed to support 64 channels at 50-GHz channel spacing, but currently, Software R4.6 supports 32 channels at 100 GHz. The OPT-PRE is a C-band DWDM, two-stage erbium-doped fiber amplifier (EDFA) with mid-amplifier loss (MAL) for allocation to a dispersion compensation unit (DCU). To control the gain tilt, the OPT-PRE is equipped with a built-in VOA. The VOA can also be used to pad the DCU to a reference value. You can install the OPT-PRE in Slots 1 to 6 and 12 to 17.

The OPT-PRE features:

- Fixed gain mode with programmable tilt
- True variable gain
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power

- Fixed output power mode (mode used during provisioning)
- MAL for fiber-based DCU
- Amplified spontaneous emissions (ASE) compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- Optical safety features that include signal loss detection and alarming, fast power down control and reduced maximum output power in safe power mode
- Four signal photodiodes to monitor the input and output optical power of the two amplifier stages through CTC
- An optical output port for external monitoring

Note The optical splitter has a ratio of 1:99. The result is that the power at the MON port is about 20 dB lower than the power at the COM TX port.

6.4.1 Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-PRE card. The returned power level values are calibrated to the ports as shown in Table 6-14.

Table 6-14 OPT-PRE Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1	Input Com	COM RX
P2	Output DC	DC TX
P3	Input DC	DC RX
P4	Output COM (Total Output)	COM TX
	Output COM (Signal Output)	

6.4.2 OPT-PRE Amplifier Card-Level Indicators

The OPT-PRE amplifier has three card-level LED indicators, described in Table 6-15.

Table 6-15 OPT-PRE Amplifier Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-PRE is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.4.3 OPT-PRE Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The OPT-PRE amplifier has five optical ports located on the faceplate. MON is the output monitor port. COM Rx is the input signal port. COM Tx is the output signal port. DC Rx is the MAL input signal port. DC Tx is the MAL output signal port.

6.4.4 OPT-PRE Amplifier Specifications

The OPT-PRE amplifier has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm
  - Gain ripple (peak to valley): 1.5 dB
  - MAL range (for DCU): 3 to 9 dB
  - Gain range: 5 to 38.5 dBm in constant power mode, 5 to 28 dBm in constant gain mode
  - Minimum gain (standard range): 5.0 dBm

    Maximum gain (standard range with programmable gain tilt): 21 dBm

    Maximum gain (extended range with uncontrolled gain tilt): 38.5 dBm
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 17.5 dBm
  - Maximum output power (with full channel load): 17 dB
  - Minimum output power (with one channel): –1 dBm
  - Input power (Pin) range at full channel load: –21.5 to 12 dBm
  - Input power (Pin) range at single channel load: –39.5 to –6 dBm
  - Noise figure at G^3 21 dB = 6.5 dB
  - OSC filter drop (channels) insertion loss maximum: 1 dB
  - OSC filter drop (OSC) insertion loss maximum: 1.8 dB
  - OSC filter add (OSC) insertion loss maximum: 1.3 dB
  - Optical connectors: LC-UPC/2
- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 85%, noncondensing
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.92 in. (24 mm)
  - Depth: 9.00 in. (240 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.5 OPT-BST Amplifier

Optical amplifiers are used in amplified nodes such as hub nodes, amplified OADM nodes, and line amplifier nodes. There are two forms of amplifiers, the Optical Preamplifier (OPT-PRE) and the Optical Booster (OPT-BST) amplifier. The optical amplifier card architecture includes an optical plug-in module with a controller that manages optical power, laser current, and temperature control loops. The amplifier also manages communication with the TCC2 and OAM&P functions such as provisioning, controls, and alarms.

Optical amplifiers have a linear power feature that enables them to be kept in the constant gain mode. The OPT-BST gain range is 5 to 20 dB in constant gain mode and output power mode. In constant power mode, automatic power control (APC) requirements change. This is because span loss degradation does not effect the system and amplifiers are not able to automatically modify the output power for variations in the number of channels when provisioning changes and a failure occurs.

Figure 6-10 shows the OPT-BST amplifier faceplate.

Figure 6-10 OPT-BST Faceplate

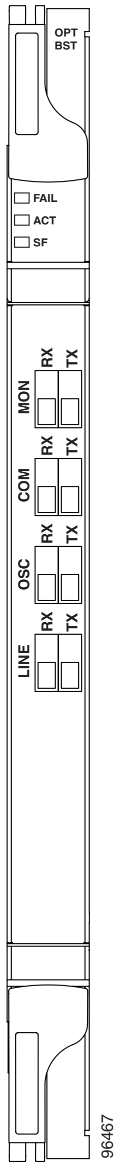


Figure 6-11 shows the OPT-BST amplifier block diagram.

Figure 6-11 OPT-BST Block Diagram

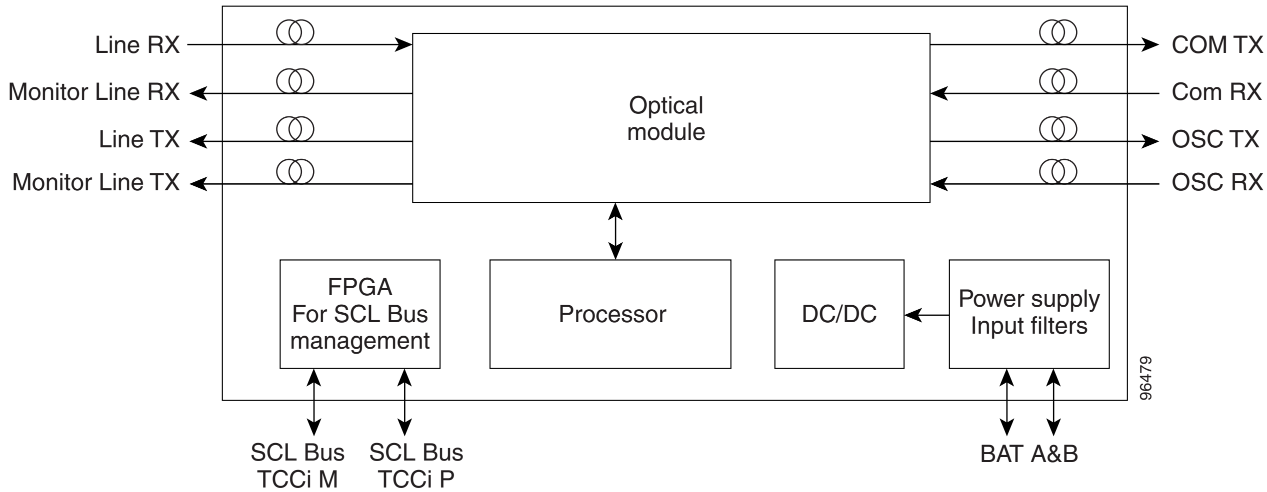


Figure 6-12 shows the OPT-BST optical module functional block diagram.

Figure 6-12 OPT-BST Optical Module Functional Block Diagram

The OPT-BST is designed to support 64 channels at 50-GHz channel spacing, but currently, Software R4.6 supports 32 channels at 100 GHz. The OPT-BST is a C-band DWDM EDFA with OSC add-and-drop capability. When an ONS 15454 has an OPT-BST installed, it is only necessary to have the OSCM to process the OSC. You can install the OPT-BST in Slots 1 to 6 and 12 to 17. To control the gain tilt, the OPT-BST is equipped with a built-in VOA.

The OPT-BST features include:

- Fixed gain mode (with programmable tilt)
- True variable gain

- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- MAL for fiber based DCU
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- Optical safety features, including signal loss detection and alarming, fast power down control, and reduced maximum output power in safe power mode
- OSRI, which is a feature capable of shutting down the optical output power or reducing the power to a safe level (automatic power reduction)
- ALS, which is a safety mechanism used in the event of a fiber cut

Note The optical splitters each have a ratio of 1:99. The result is that the power at the MON TX and MON RX ports is about 20 dB lower than the power at the COM TX and COM RX ports.

6.5.1 Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-BST card. The returned power level values are calibrated to the ports as shown in Table 6-16.

Table 6-16 OPT-BST Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1	Input Com	COM RX
P2	Output Line (Total Output)	LINE TX
	Output Line (Signal Output)	
P3	Output COM	LINE RX
P4	Output OSC	

6.5.2 OPT-BST Amplifier-Level Indicators

The OPT-BST amplifier has three card-level LED indicators, described in Table 6-17.

Table 6-17 OPT-BST Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.

Table 6-17 OPT-BST Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the OPT-BST is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.5.3 OPT-BST Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The OPT-BST amplifier has eight optical ports located on the faceplate. MON Rx is the output monitor port (receive section). MON Tx is the output monitor port. COM Rx is the input signal port. LINE Tx is the output signal port. LINE Rx is the input signal port (receive section). COM Tx is the output signal port (receive section). OSC Rx is the OSC add input port. OSC Tx is the OSC drop output port.

6.5.4 OPT-BST Amplifier Specifications

The OPT-BST amplifier has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Gain range: 5 to 20 dBm with programmable gain tilt
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 17.5 dBm
  - Maximum output power (with full channel load): 17 dB
  - Minimum output power (with one channel): –1 dBm
  - Input power (Pin) range at full channel load: –3 to 12 dBm
  - Input power (Pin) range at single channel load: –21 to –6 dBm
  - Noise figure at G^3 20 dB = 6 dB
  - OSC filter drop (channels) insertion loss maximum: 1 dB
  - OSC filter drop (OSC) insertion loss maximum: 1.8 dB
  - OSC filter add (OSC) insertion loss maximum: 1.3 dB
  - Optical connectors: LC-UPC/2
- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 85%, noncondensing

- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.92 in. (24 mm)
  - Depth: 9.00 in. (240 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.6 32 MUX-O Card

The 32-channel multiplexer card (32 MUX-O) multiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32 MUX-O card takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16. The 32 MUX-O features include:

- Arrayed waveguide grating (AWG), which enables full multiplexing functions for the channels.
- Each single-channel port is equipped with VOAs for automatic optical power regulation prior to multiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- Each single-channel port is monitored using a photodiode to enable automatic power regulation.
- An additional optical monitoring port with 1/99 splitting ratio is available.

Figure 6-13 shows the 32 MUX-O faceplate.

Figure 6-13 32 MUX-O Faceplate

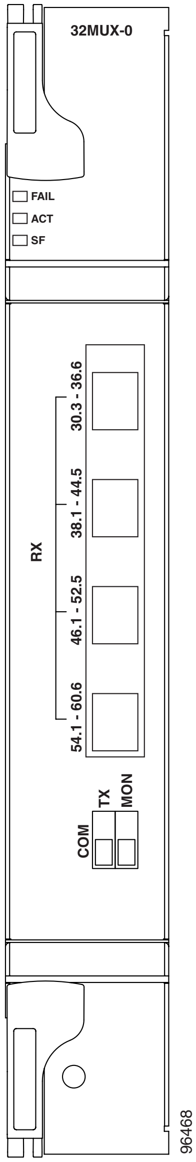


Figure 6-14 shows the 32 MUX-O block diagram.

Figure 6-14 32 MUX-O Block Diagram

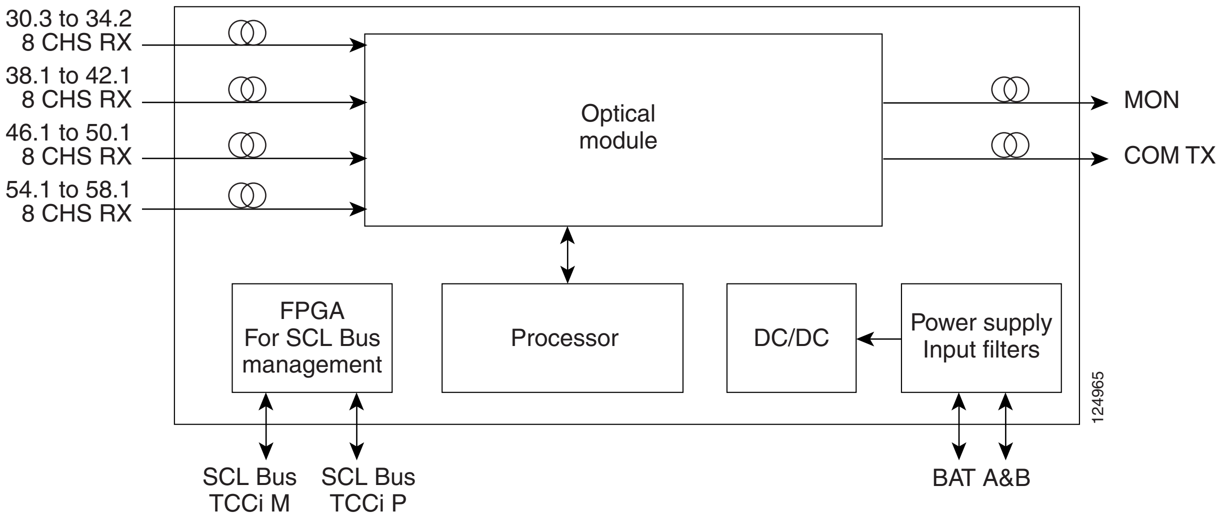
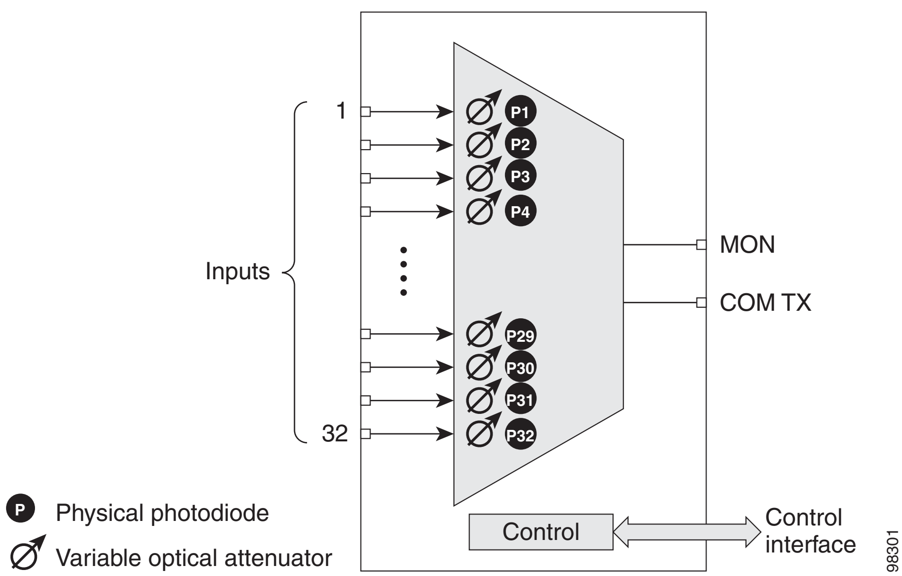


Figure 6-15 shows the 32MUX-O optical module functional block diagram.

Figure 6-15 32MUX-O Optical Module Functional Block Diagram



6.6.1 Power Monitoring

Physical photodiodes P1 through P32 monitor the power for the 32 MUX-O card. The returned power level values are calibrated to the ports as shown in Table 6-18.

Table 6-18 32 MUX-O Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1 - P32	ADD	COM TX

6.6.2 32 MUX-O Card-Level Indicators

The 32 MUX-O card has three card-level LED indicators, described in Table 6-19.

Table 6-19 32 MUX-O Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32 MUX-O is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.6.3 32 MUX-O Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 32 MUX-O card has five sets of ports located on the faceplate.

COM Tx is the line output. MON is the optical monitoring port. The xx.x-yy.y Rx ports represent the four groups of 8 channels ranging from xx.x wavelength to yy.y wavelength according to the channel plan.

6.6.4 32 MUX-O Card Specifications

The 32 MUX-O card optical specifications are listed in Table 6-20.

Note For power specifications, refer to the "6.1.4 Multiplexer, Demultiplexer, and OADM Card Interface Classes" section on page 6-5.

Table 6-20 32 MUX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Tx filter shape (–1 dB bandwidth)	All standard operating procedure (SOP) and within whole operating temperature range	In 1/32—Out beginning of life (BOL)	+/– 180	+/– 300	pm
		In 1/32—Out end of life (EOL)	+/– 160		
Insertion loss	All SOP and within whole operating temperature range	In 1/32—Out BOL	4	8.0	dB
		In 1/32—Out EOL		8.5	
Variable optical attenuation (VOA) dynamic range	—	—	25		dB
Optical monitor tap-splitting ratio on monitor port	Optical monitor port with respect to output port in multiplexer only	—	19	21	dB
Maximum optical input power	—	—	300	—	mW

The 32 MUX-O card has the following additional specifications:

- Environmental
  - Operating temperature:
    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95% relative humidity (RH)
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 1.84 in. (46.8 mm)
  - Depth: 9.00 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.7 32 DMX-O Card

The 32-Channel Demultiplexer (32 DMX-O) card demultiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32 DMX-O takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16. The DMX-O features include:

- AWG that enables the full demultiplexing functions.
- Each single-channel port is equipped with VOAs for automatic optical power regulation after demultiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- Each single-channel port is monitored using a photodiode to enable automatic power regulation.

Figure 6-16 shows the 32 DMX-O card faceplate.

Figure 6-16 32 DMX-O Faceplate

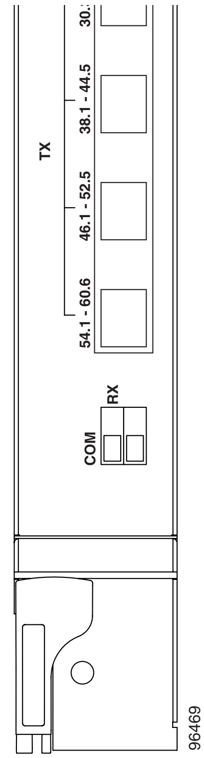


Figure 6-17 shows the 32 DMX-O block diagram.

Figure 6-17 32 DMX-O Block Diagram

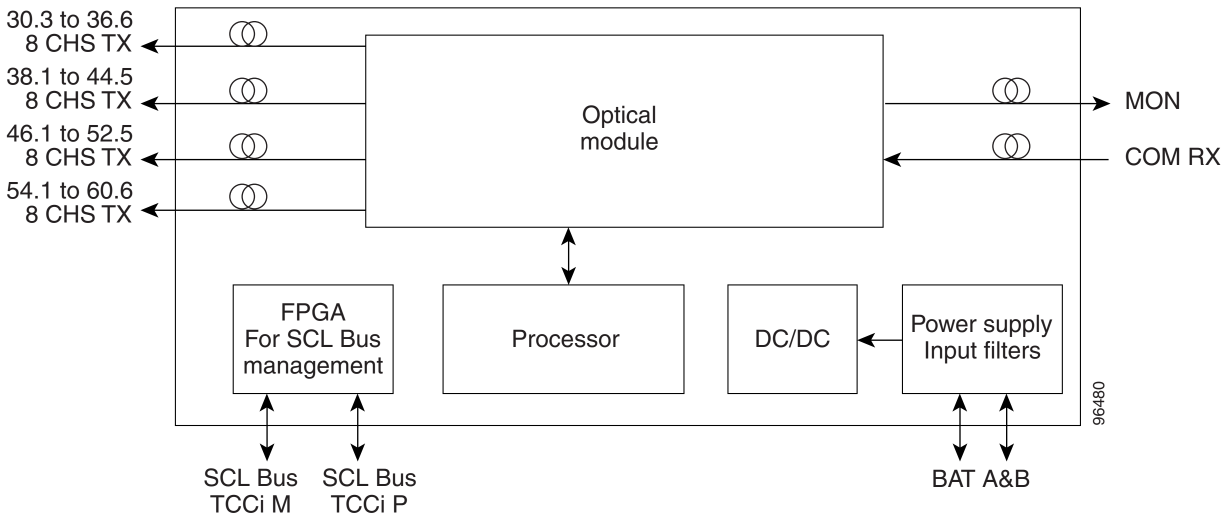
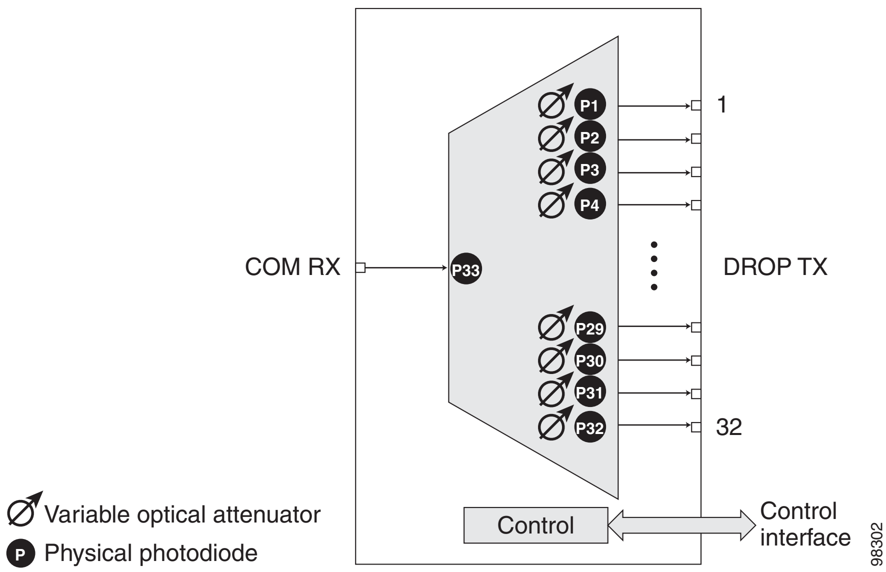


Figure 6-18 shows the 32 DMX-O optical function block diagram.

Figure 6-18 32 DMX-O Optical Function Diagram



6.7.1 Power Monitoring

Physical photodiodes P1 through P32 and P33 monitor the power for the 32 DMX-O card. The returned power level values are calibrated to the ports as shown in Table 6-21.

Table 6-21 32 DMX-O Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1 - P32	DROP	DROP TX Channel
P33	INPUT COM	COM RX

6.7.2 32 DMX-O Card-Level Indicators

The 32 DMX-O card has three card-level LED indicators, described in Table 6-22.

Table 6-22 32 DMX-O Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32 DMX-O is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.7.3 32 DMX-O Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 32 DMX-O card has five sets of ports located on the faceplate. MON is the output monitor port. COM Rx is the line output. The xx.x-yy.y Tx ports represent the four groups of eight channels ranging from xx.x wavelength to yy.y wavelength according to the channel plan.

6.7.4 32 DMX-O Card Specifications

The 32 DMX-O card optical specifications are listed in Table 6-23.

Note For power specifications, refer to the "6.1.4 Multiplexer, Demultiplexer, and OADM Card Interface Classes" section on page 6-5.

Table 6-23 32 DMX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Rx filter shape (–1 dB bandwidth)	All SOP and within whole operating temperature range	In 1/32—Out BOL	+/– 180	+/– 300	pm
		In 1/32—Out EOL	+/– 160		
Insertion loss	All SOP and within whole operating temperature range	In 1/32—Out BOL	4	8.0	dB
		In 1/32—Out EOL		8.5	
VOA dynamic range	—	—	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 32 DMX-O card has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95% RH
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 1.84 in. (46.8 mm)
  - Depth: 9.00 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.8 4MD-xx.x Card

The 4-Channel Multiplexer/Demultiplexer (4MD-xx.x) card multiplexes and demultiplexes four 100-GHz-spaced channels identified in the channel plan. The 4MD-xx.x card is designed to be used with band OADMs (both AD-1B-xx.x and AD-4B-xx.x). There are eight versions of this card that correspond with the eight sub-bands specified in Table 6-24. The 4MD-xx.x can be installed in Slots 1 to 6 and 12 to 17.

The 4MD-xx.x has the following features implemented inside a plug-in optical module:

- Passive cascade of interferential filters perform the channel multiplex/demultiplex function.
- Software controlled VOAs at every port of the multiplex section to regulate the optical power of each multiplexed channel.
- Software monitored photodiodes at the input and output multiplexer and demultiplexer ports for power control and safety purposes.
- Software-monitored “virtual photodiodes” at the common DWDM output and input ports. A “virtual photodiode” is a firmware calculation of the optical power at that port. This calculation is based on the single channel photodiode reading and insertion losses of the appropriated paths.

Table 6-24 shows the band IDs and the add/drop channel IDs for the 4MD-xx.x card.

Table 6-24 4MD-xx.x Channel Sets

Band IDs	Add/Drop Channel IDs
Band 30.3 (A)	30.3, 31.2, 31.9, 32.6
Band 34.2 (B)	34.2, 35.0, 35.8, 36.6
Band 38.1 (C)	38.1, 38.9, 39.7, 40.5
Band 42.1 (D)	42.1, 42.9, 43.7, 44.5
Band 46.1 (E)	46.1, 46.9, 47.7, 48.5
Band 50.1 (F)	50.1, 50.9, 51.7, 52.5
Band 54.1 (G)	54.1, 54.9, 55.7, 56.5
Band 58.1 (H)	58.1, 58.9, 59.7, 60.6

Figure 6-19 shows the 4MD-xx.x faceplate.

Figure 6-19 4MD-xx.x Faceplate

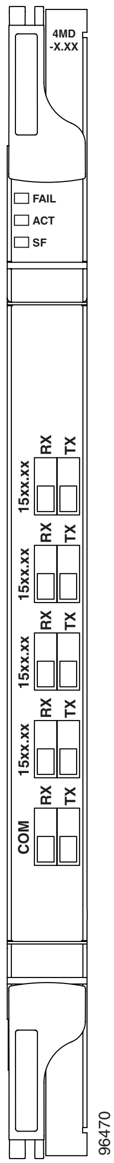


Figure 6-20 shows the 4MD-xx.x block diagram.

Figure 6-20 4MD-xx.x Block Diagram

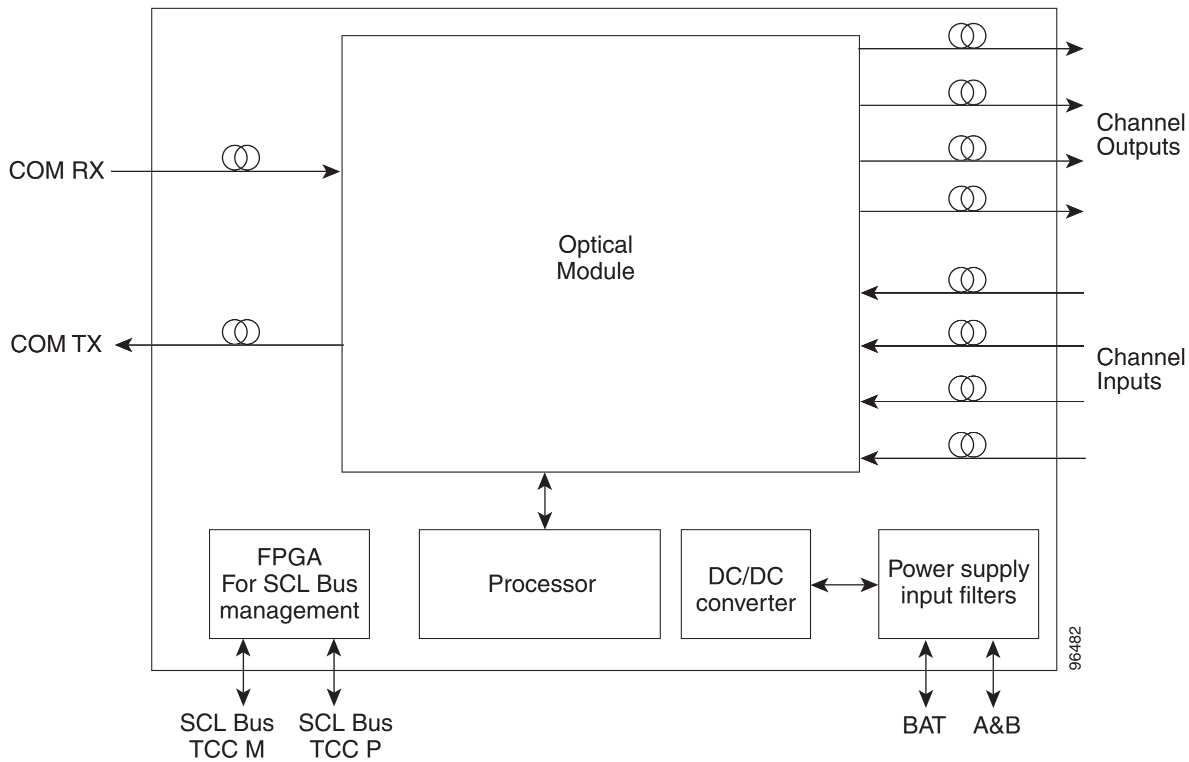
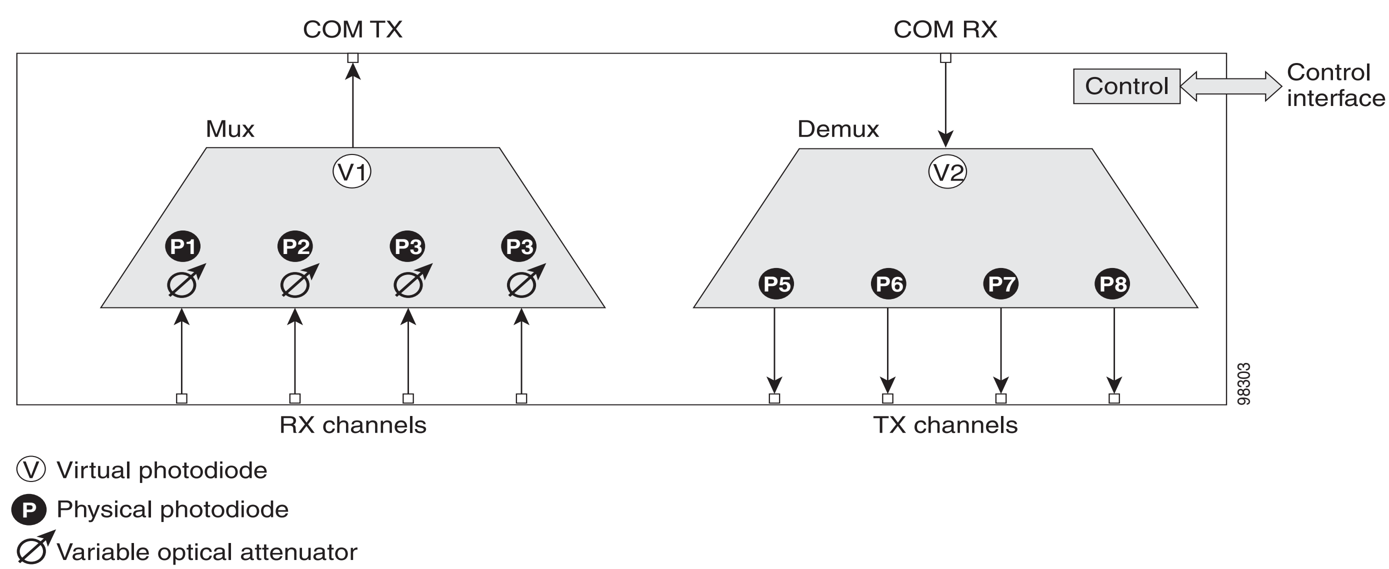


Figure 6-21 shows the 4MD-xx.x optical function block diagram.

Figure 6-21 4MD-xx.x Optical Function Diagram



The Optical Module shown in Figure 6-21 is optically passive and consists of a cascade of interferential filters that perform the channel mux/demux functions.

VOAs are present in every input path of the multiplex section in order to regulate the optical power of each multiplexed channel. Some optical input and output ports are monitored by means of photodiodes implemented both for power control and for safety purposes. An internal control manages VOA settings and functionality as well as photodiode detection and alarm thresholds. The power at the main output and input ports is monitored through the use of "virtual photodiodes." A virtual photodiode is implemented in the firmware of the plug-in module. This firmware calculates the power on a port, summing the measured values from all single channel ports (and applying the proper path insertion loss) then providing the TCC2 with the obtained value.

6.8.1 Power Monitoring

Physical photodiodes P1 through P8, and virtual photodiodes V1 and V2 monitor the power for the 4MD-xx.x card. The returned power level values are calibrated to the ports as shown in Table 6-25.

Table 6-25 4MD-xx.x Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1 - P4	ADD	COM TX
P5 - P8	DROP	DROP TX Channel
V1	OUT COM	COM TX
V2	IN COM	COM RX

6.8.2 4MD-xx.x Card-Level Indicators

The 4MD-xx.x card has three card-level LED indicators, described in Table 6-26.

Table 6-26 4MD-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 4MD-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.8.3 4MD-xx.x Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 4MD-xx.x card has five sets of ports located on the faceplate. COM Rx is the line input. COM Tx is the line output. The 15xx.x Tx ports represent demultiplexed channel Outputs 1 to 4. The 15xx.x Rx ports represent multiplexed channel Inputs 1 to 4.

6.8.4 4MD-xx.x Card Specifications

The 4MD-xx.x card optical specifications are listed in Table 6-27.

Note For power specifications, refer to the "6.1.2 Card Power Requirements" section on page 6-3.

Table 6-27 32 MUX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Trx filter shape (–0.5 dB bandwidth TrxBW$_2$)	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx COM Rx—yy.yy Tx COM Rx—zz.zz Tx COM Rx—kk.kk Tx xx.xx Rx—COM Tx yy.yy Rx—COM Tx zz.zz Rx—COM Tx kk.kk Rx—COM Tx	+/– 180	—	pm
Insertion loss demultiplexer section	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx	—	1.9	dB
		COM Rx—yy.yy Tx	—	2.4	dB
		COM Rx—zz.zz Tx	—	2.8	dB
		COM Rx—kk.kk Tx	—	3.3	dB
Insertion loss multiplexer section	All SOP and within whole operating temperature range (Two connectors included)	xx.xx Rx—COM Tx	—	3.6	dB
		yy.yy Rx—COM Tx	—	3.2	dB
		zz.zz Rx—COM Tx	—	3.0	dB
		kk.kk Rx—COM Tx	—	2.6	dB
VOA dynamic range	—	—	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 4MD-xx.x card has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: 5 to 95% RH
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)

  - Depth: 9.00 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.9 AD-1C-xx.x Card

The 1-Channel OADM (AD-1C-xx.x) card passively adds or drops one of the 32 channels utilized within the 100-GHz-spacing of the DWDM card system. Thirty-two versions of this card—each designed only for use with one wavelength—are used in the ONS 15454 DWDM system. Each wavelength version of the card has a different part number.

The AD-1C-xx.x can be installed in Slots 1 to 6 and 12 to 17.

The AD-1C-xx.x has the following internal features:

- Two passive optical interferential filters perform the channel add and drop functions.
- One software-controlled VOA regulates the optical power of the inserted channel.
- Software-controlled VOA regulates the insertion loss of the express optical path.
- Internal control of the VOA settings and functions, photodiode detection, and alarm thresholds.
- Software-monitored virtual photodiodes (firmware calculations of port optical power) at the common DWDM output and input ports.

Figure 6-22 shows the AD-1C-xx.x faceplate.

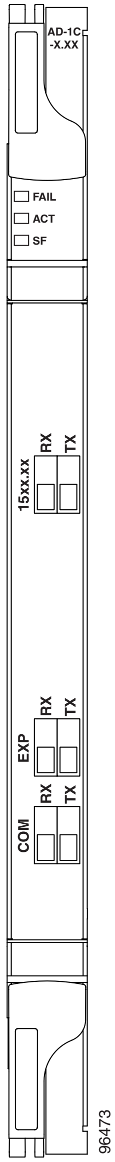


Figure 6-22 AD-1C-xx.x Faceplate

Figure 6-23 shows the AD-1C-xx.x block diagram.

Figure 6-23 AD-1C-xx.x Block Diagram

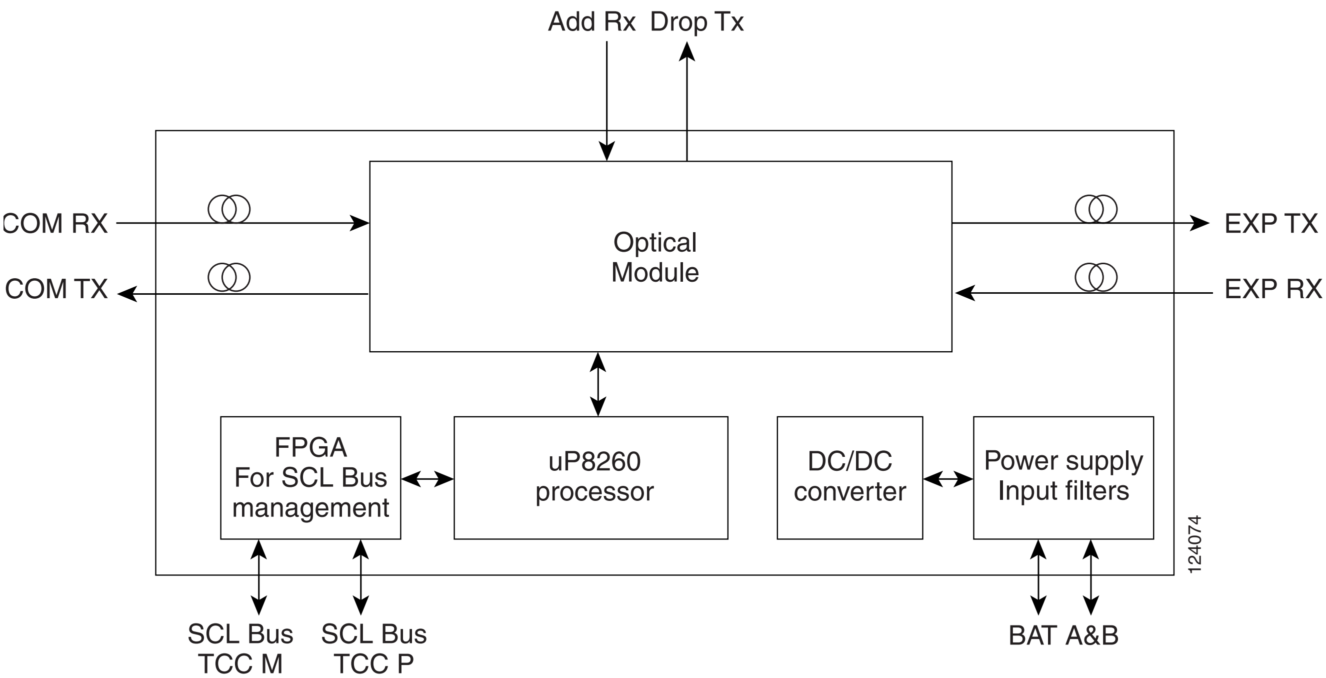
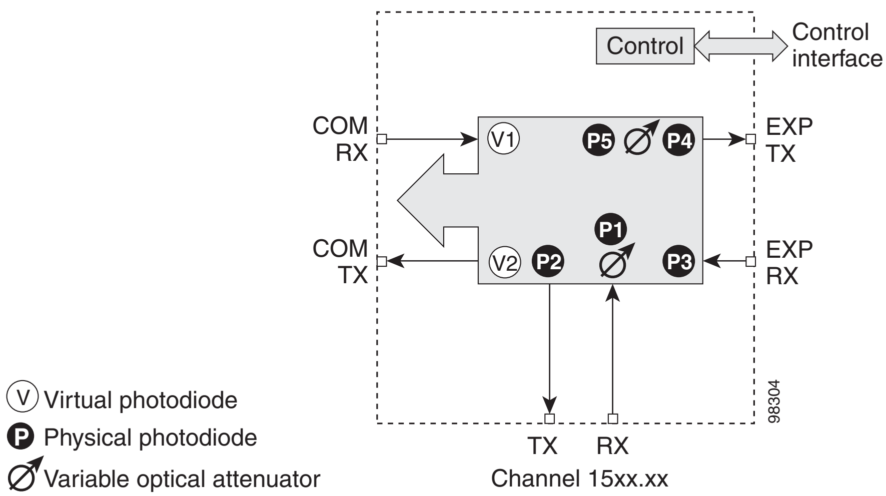


Figure 6-24 shows the AD-1C-xx.x optical module functional block diagram.

Figure 6-24 AD-1C-xx.x Optical Module Functional Block Diagram



6.9.1 Power Monitoring

Physical photodiodes P1 through P4, and virtual photodiodes V1 and V2 monitor the power for the AD-1C-xx.x card. The returned power level values are calibrated to the ports as shown in Table 6-28.

Table 6-28 AD-1C-xx.x Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1	ADD	COM TX
P2	DROP	DROP TX Channel
P3	IN EXP	EXP RX
P4	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

6.9.2 AD-1C-xx.x Card-Level Indicators

The AD-1C-xx.x card has three card-level LED indicators, described in Table 6-29.

Table 6-29 AD-1C-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-1C-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The SF LED also illuminates when the transmitting and receiving fibers are incorrectly connected. When the fibers are properly connected, the LED turns off.

6.9.3 AD-1C-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-1C-xx.x has six LC-PC-II optical ports: two for add/drop channel client input and output, two for express channel input and output, and two for communication.

6.9.4 AD-1C-xx.x Card Specifications

Table 6-30 lists the AD-1C-xx.x optical specifications.

Table 6-30 AD-1C-xx.x Card Optical Specifications

Parameter	Condition	Note	Min	Max	Unit
Trx filter shape (–0.5 dB bandwidth) $TrxBW_2$	COM Rx—xx.xx Tx xx.xx Rx—COM Tx	All SOP and within whole operating temperature range	+/– 180	—	pm
Rfx filter shape (–0.5 dB bandwidth) $RfxBW_2$	COM Rx—Exp Tx Exp Rx—COM Tx	All SOP and within whole operating temperature range	+/– 180	—	pm
Insertion loss (drop section)	COM Rx—xx.xx Tx	All SOP and within whole operating temperature range (two connectors included)	—	2.0	dB
Insertion loss (express section)	COM Rx—Exp Tx Exp Rx—COM Tx	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	—	2.4 or 1.2	dB
Insertion loss (add section)	xx.xx Rx—COM Tx	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	—	2.6	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

AD-1C-xx.x optical input and output power vary with amplifier output levels and the class of transponder interfaces used. See Table 6-4 on page 6-5 through Table 6-8 on page 6-7 for this information.

The AD-1C-xx.x card has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: Telcordia GR-63 5.1.1.3 compliant; 5 to 95% RH
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)
  - Depth: 9.0 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.10 AD-2C-xx.x Card

The 2-Channel OADM (AD-2C-xx.x) card passively adds or drops two adjacent 100-GHz channels within the same band. Sixteen versions of this card—each designed for use with one pair of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions.

Each version of the card has a different part number.

The AD-2C-xx.x has the following features:

- Passive cascade of interferential filters perform the channel add and drop functions.
- Two software-controlled VOAs in the add section, one for each add port, regulate the optical power of inserted channels.
- Software-controlled VOAs regulate insertion loss on express channels.
- Internal control of the VOA settings and functions, photodiode detection, and alarm thresholds.
- Software-monitored virtual photodiodes (firmware calculation of port optical power) at the common DWDM output and input ports.

The AD-2C-xx.x cards are provisioned for the wavelength pairs in Table 6-31. In this table, channel IDs are given rather than wavelengths. To compare channel IDs with the actual wavelengths they represent, see Table 6-9 on page 6-7.

Table 6-31 AD-2C-xx.x Channel Pairs

Band ID	Add/Drop Channel ID
Band 30.3 (A)	30.3, 31.2
	31.9, 32.6
Band 34.2 (B)	34.2, 35.0
	35.8, 36.6
Band 38.1 (C)	38.1, 38.9
	39.7, 40.5
Band 42.1 (D)	42.1, 42.9
	43.7, 44.5
Band 46.1 (E)	46.1, 46.9
	47.7, 48.5
Band 50.1 (F)	50.1, 50.9
	51.7, 52.5
Band 54.1 (G)	54.1, 54.9
	55.7, 56.5
Band 58.1 (H)	58.1, 58.9
	59.7, 60.6

Figure 6-25 shows the AD-2C-xx.x faceplate.

Figure 6-25 AD-2C-xx.x Faceplate

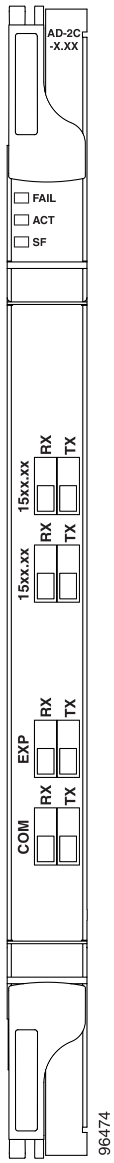


Figure 6-26 shows the AD-2C-xx.x block diagram.

Figure 6-26 AD-2C-xx.x Block Diagram

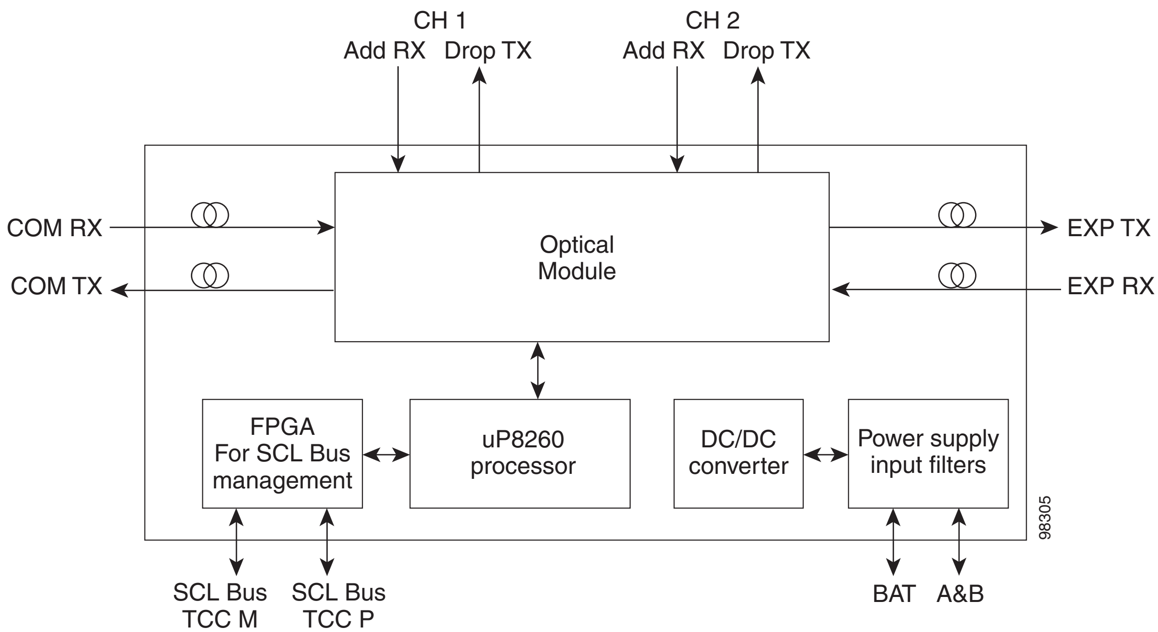
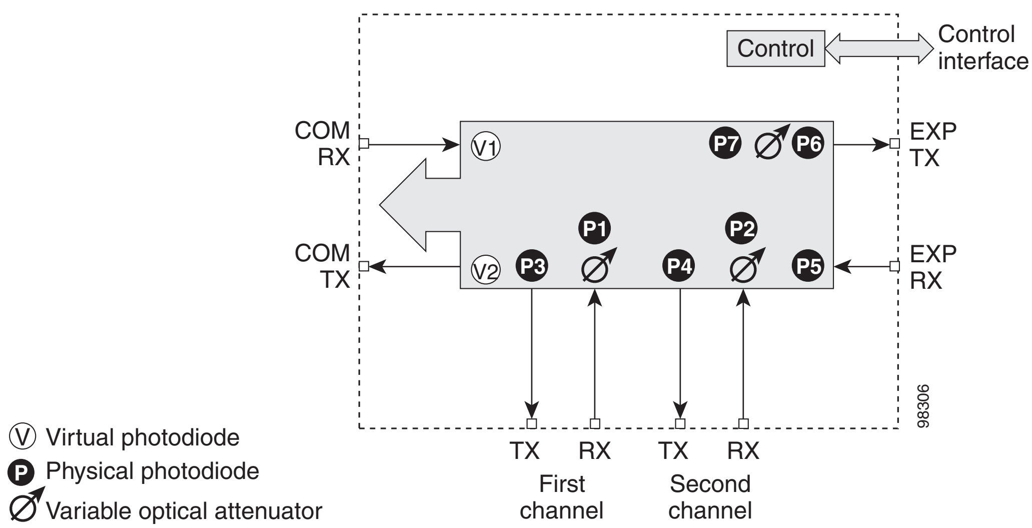


Figure 6-27 shows the AD-2C-xx.x optical function block diagram.

Figure 6-27 AD-2C-xx.x Optical Function Diagram



6.10.1 Power Monitoring

Physical photodiodes P1 through P6, and virtual photodiodes V1 and V2 monitor the power for the AD-2C-xx.x card. The returned power level values are calibrated to the ports as shown in Table 6-32.

Table 6-32 AD--2C-xx.x Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1 and P2	ADD	COM TX
P3 and P4	DROP	DROP TX Channel
P5	IN EXP	EXP RX
P6	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

6.10.2 AD-2C-xx.x Card-Level Indicators

The AD-2C-xx.x card has three card-level LED indicators, described in Table 6-33.

Table 6-33 AD-2C-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-2C-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.10.3 AD-2C-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-2C-xx.x card has eight LC-PC-II optical ports: four for add/drop channel client input and output, two for express channel input and output, and two for communication.

6.10.4 AD-2C-xx.x Card Specifications

Table 6-34 lists the AD-2C-xx.x optical specifications.

Table 6-34 AD-2C-xx.x Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Trx filter shape (–0.5 dB bandwidth) $TrxBW_2$	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx COM Rx—yy.yy Tx	+/– 180	—	pm
		xx.xx Rx—COM Tx yy.yy Rx—COM Tx			
Rfx filter shape (–0.5 dB bandwidth) $RfxBW_2$	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	+/– 180	—	pm
Insertion loss (drop section)	All SOP and within whole operating temperature range (two connectors included)	COM Rx—xx.xx Tx	—	2.0	dB
		COM Rx—yy.yy Tx		2.4	
Insertion loss (express section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	COM Rx—Exp Tx	—	2.7	dB
		Exp Rx—COM Tx		1.6	
Insertion loss (add section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	3.1	dB
		yy.yy Rx—COM Tx		2.7	
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

AD-2C-xx.x optical input and output power vary with amplifier output levels and the class of transponder interfaces used. See Table 6-4 on page 6-5 through Table 6-8 on page 6-7 for this information.

The AD-2C-xx.x has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: Telcordia GR-63 5.1.1.3 compliant; 5 to 95% RH
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)
  - Depth: 9.0 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.11 AD-4C-xx.x Card

The 4-Channel OADM (AD-4C-xx.x) card passively adds or drops all four 100-GHz-spaced channels within the same band. Eight versions of this card—each designed for use with one band of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. There are eight versions of this card with eight part numbers.

The AD-4C-xx.x has the following features:

- Passive cascade of interferential filters perform the channel add and drop functions.
- Four software-controlled VOAs in the add section, one for each add port, regulate the optical power of inserted channels.
- Two software-controlled VOAs regulate insertion loss on express and drop path, respectively.
- Internal control of the VOA settings and functions, photodiode detection, and alarm thresholds.
- Software-monitored virtual photodiodes (firmware calculation of port optical power) at the common DWDM output and input ports.

The AD-4C-xx.x cards are provisioned for the wavelength pairs in Table 6-35 on page 6-52. In this table, channel IDs are given rather than wavelengths. To compare channel IDs with the actual wavelengths they represent, see Table 6-9 on page 6-7.

Table 6-35 AD-4C-xx.x Channel Sets

Band ID	Add/Drop Channel IDs
Band 30.3 (A)	30.3, 31.2, 31.9, 32.6
Band 34.2 (B)	34.2, 35.0, 35.8, 36.6
Band 38.1 (C)	38.1, 38.9, 39.7 40.5
Band 42.1 (D)	42.1, 42.9, 43.7, 44.5
Band 46.1 (E)	46.1, 46.9, 47.7, 48.5
Band 50.1 (F)	50.1, 50.9, 51.7, 52.5
Band 54.1 (G)	54.1, 54.9, 55.7, 56.5
Band 58.1 (H)	58.1, 58.9, 59.7, 60.6

Figure 6-28 shows the AD-4C-xx.x faceplate.

Figure 6-28 AD-4C-xx.x Faceplate

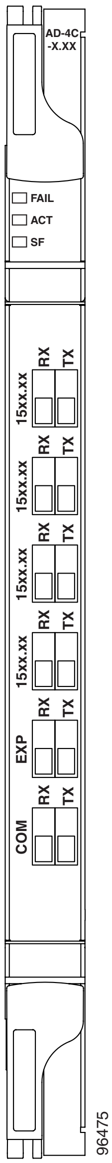


Figure 6-29 shows the AD-4C-xx.x block diagram.

Figure 6-29 AD-4C-xx.x Block Diagram

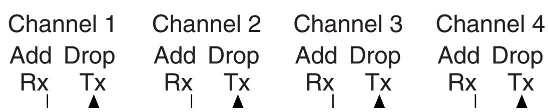
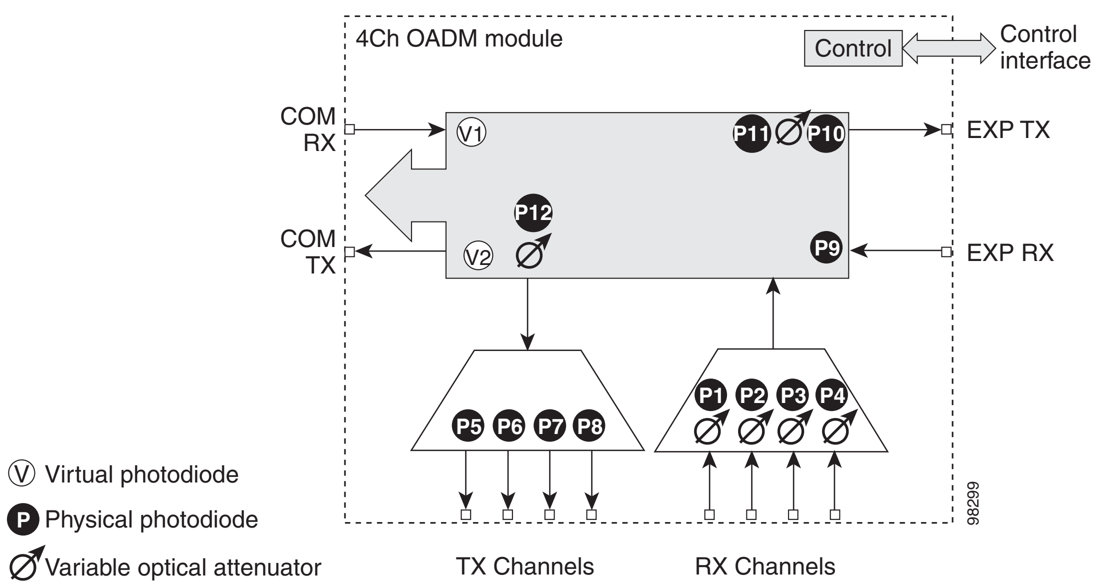


Figure 6-30 shows the AD-4C-xx.x optical module functional block diagram.

Figure 6-30 AD-4C-xx.x Optical Module Functional Block Diagram



6.11.1 Power Monitoring

Physical photodiodes P1 through P10, and virtual photodiodes V1 and V2 monitor the power for the AD-4C-xx.x card. The returned power level values are calibrated to the ports as shown in Table 6-36.

Table 6-36 AD-4C-xx.x Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1 - P4	ADD	COM TX
P5 - P8	DROP	DROP TX Channel
P9	IN EXP	EXP RX
P10	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

6.11.2 AD-4C-xx.x Card-Level Indicators

The AD-4C-xx.x card has three card-level LED indicators, described in Table 6-37.

Table 6-37 AD-4C-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-4C-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.11.3 AD-4C-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-4C-xx.x card has 12 LC-PC-II optical ports: eight for add/drop channel client input and output, two for express channel input and output, and two for communication.

6.11.4 AD-4C-xx.x Card Specifications

Table 6-38 lists the AD-4C-xx.x optical specifications.

Table 6-38 AD-4C-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid	See Table 6-9	—	—	—	—
Trx filter shape (–0.5 dB bandwidth) $TrxBW_2$	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx COM Rx—yy.yy Tx COM Rx—zz.zz Tx COM Rx—kk.kk Tx	+/– 180	—	pm
		xx.xx Rx—COM Tx yy.yy Rx—COM Tx			
Rfx filter shape (–1 dB bandwidth) $RfxBW_2$	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	—	—	pm
Insertion loss (drop section)	All SOP and within whole operating temperature range (two connectors included)	COM Rx—xx.xx Tx	—	5.5	dB
		COM Rx—yy.yy Tx		5.0	
		COM Rx—zz.zz Tx		4.5	
		COM Rx—kk.kk Tx		4.1	
Insertion loss (express section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	COM Rx—Exp Tx	—	2.7	dB
		Exp Rx—COM Tx		1.2	
Insertion loss (add section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	3.9	dB
		yy.yy Rx—COM Tx		4.3	
		zz.zz Rx—COM Tx		4.5	
		kk.kk Rx—COM Tx		4.9	
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

AD-4C-xx.x optical input and output power vary with amplifier output levels and the class of transponder interfaces used. See Table 6-4 on page 6-5 through Table 6-8 on page 6-7 for this information.

The AD-4C-xx.x has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: Telcordia GR-63 5.1.1.3 compliant; 5 to 95% RH
- Dimensions
  - Height: 12.650 in. (321.3 mm)

- Width: 0.92 in. (23.4 mm)
- Depth: 9.0 in. (228.6 mm)

- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.12 AD-1B-xx.x Card

The 1-Band OADM (AD-1B-xx.x) card passively adds or drops a single band of four adjacent 100-GHz-spaced channels. Eight versions of this card with eight different part numbers—each version designed for use with one band of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. This card can be used when there is asymmetric adding and dropping on each side (east or west) of the node; a band can be added or dropped on one side but not on the other.

The AD-1B xx.x can be installed in Slots 1 to 6 and 12 to17.

The AD-1B-xx.x has the following features:

- Passive interferential filters perform the channel add and drop functions.
- Two software-controlled VOAs regulate the optical power flowing in the express and drop OADM paths (drop section).
- Output power of the dropped band is set by changing the attenuation of the VOA drop.
- The VOA express is used to regulate the insertion loss of the express path.
- Internal controlled VOA settings and functions, photodiode detection, and alarm thresholds.
- Software-monitored virtual photodiode (firmware calculation of port optical power) at the common DWDM output.

Figure 6-31 shows the AD-1B-xx.x faceplate.

Figure 6-31 AD-1B-xx.x Faceplate

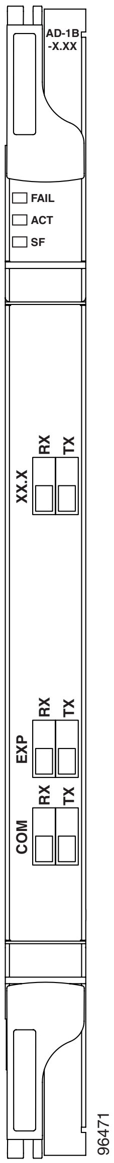


Figure 6-32 shows the AD-1B-xx.x block diagram.

Figure 6-32 AD-1B-xx.x Block Diagram

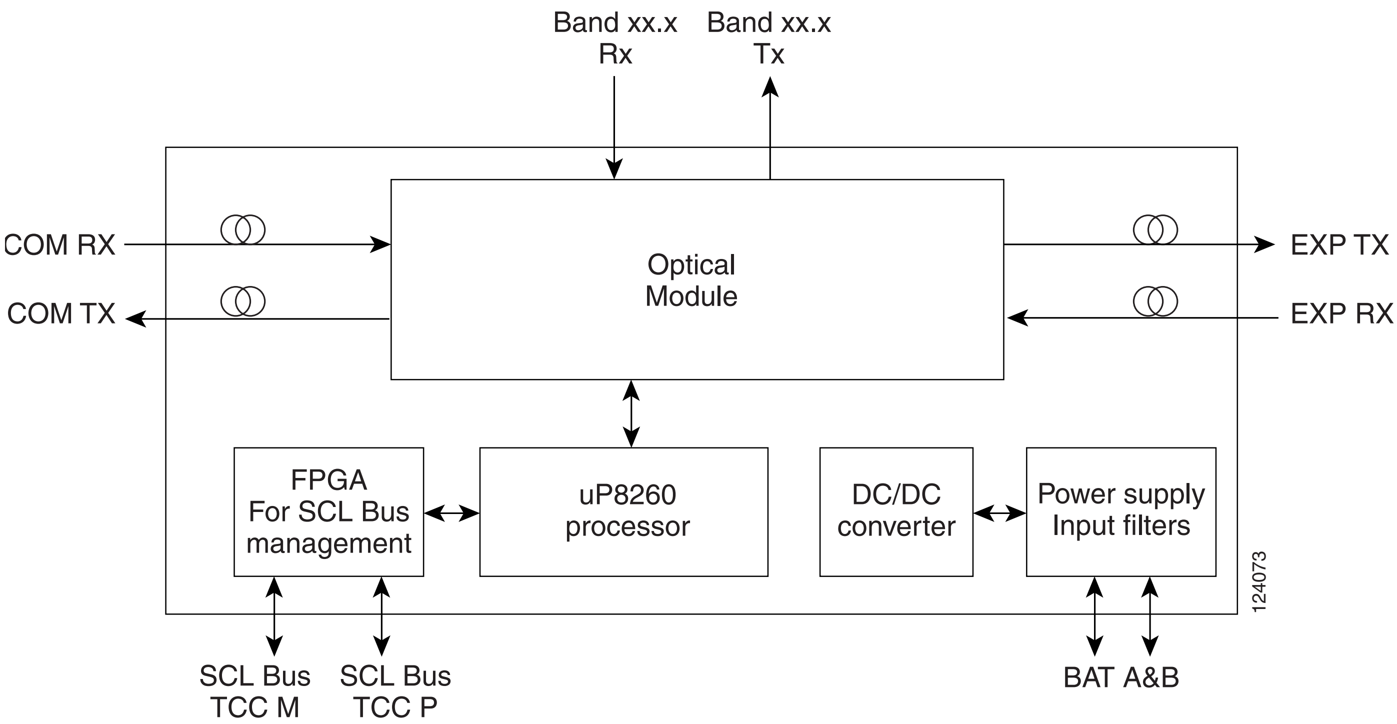
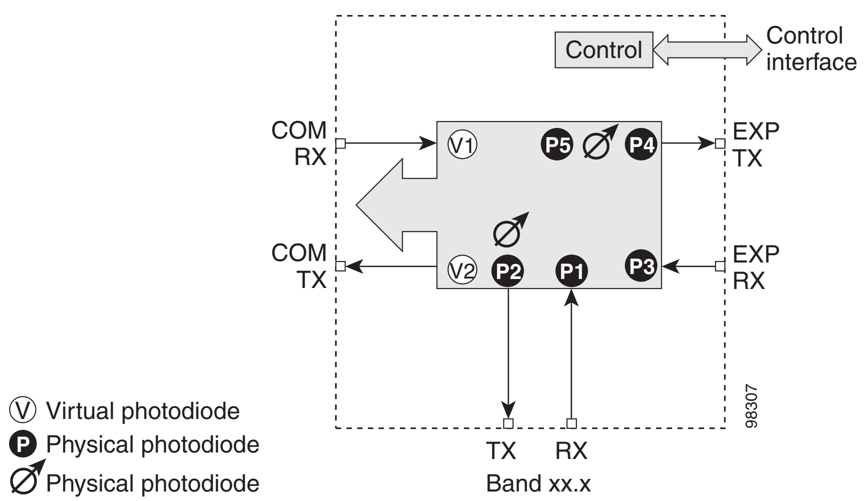


Figure 6-33 shows the AD-1B-xx.x optical module functional block diagram.

Figure 6-33 AD-1B-xx.x Optical Module Functional Block Diagram



6.12.1 Power Monitoring

Physical photodiodes P1 through P4, and virtual photodiodes V1 and V2 monitor the power for the AD-1B-xx.x card. The returned power level values are calibrated to the ports as shown in Table 6-39.

Table 6-39 AD-1B-xx.x Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1	ADD	BAND RX
P2	DROP	BAND TX
P3	IN EXP	EXP RX
P4	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

6.12.2 AD-1B-xx.x Card-Level Indicators

The AD-1B-xx.x card has three card-level LED indicators, described in Table 6-40.

Table 6-40 AD-1B-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-1B-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.12.3 AD-1B-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-1B-xx.x has six LC-PC-II optical ports: two for add/drop channel client input and output, two for express channel input and output, and two for communication.

6.12.4 AD-1B-xx.x Card Specifications

Table 6-41 lists the unit names, band IDs, channel IDs, frequencies, and wavelengths assigned to the eight versions of the AD-1B-xx.x card.

Table 6-41 AD-1B-xx.x Channel Allocation Plan by Band

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-1B-30.3	B30.3	30.3	195.9	1530.33
		30.7	195.85	1530.72
		31.1	195.8	1531.12
		31.5	195.75	1531.51
		31.9	195.7	1531.90
		32.2	195.65	1532.29
		32.6	195.6	1532.68
		33.3	195.55	1533.07
AD-1B-34.2	B34.2	34.2	195.4	1534.25
		34.6	195.35	1534.64
		35.0	195.3	1535.04
		35.4	195.25	1535.43
		35.8	195.2	1535.82
		36.2	195.15	1536.22
		36.6	195.1	1536.61
		37.0	195.05	1537.00
AD-1B-38.1	B38.1	38.1	194.9	1538.19
		38.5	194.85	1538.58
		38.9	194.8	1538.98
		39.3	194.75	1539.37
		39.7	194.7	1539.77
		40.1	194.65	1540.16
		40.5	194.6	1540.56
		40.9	194.55	1540.95
AD-1B-42.2	B42.1	42.1	194.4	1542.14
		42.5	194.35	1542.54
		42.9	194.3	1542.94
		43.3	194.25	1543.33
		43.7	194.2	1543.73
		44.1	194.15	1544.13
		44.5	194.1	1544.53
		44.9	194.05	1544.92

Table 6-41 AD-1B-xx.x Channel Allocation Plan by Band (continued)

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-1B-46.1	B46.1	46.1	193.9	1546.12
		46.5	193.85	1546.52
		46.9	193.8	1546.92
		47.3	193.75	1547.32
		47.7	193.7	1547.72
		48.1	193.65	1548.11
		48.5	193.6	1548.51
		48.9	193.55	1548.91
AD-1B-50.1	B50.1	50.1	193.4	1550.12
		50.5	193.35	1550.52
		50.9	193.3	1550.92
		51.3	193.25	1551.32
		51.7	193.2	1551.72
		52.1	193.15	1552.12
		52.5	193.1	1552.52
		52.9	193.05	1552.93
AD-1B-54.1	B54.1	54.1	192.9	1554.13
		54.5	192.85	1554.54
		54.9	192.8	1554.94
		55.3	192.75	1555.34
		55.7	192.7	1555.75
		56.1	192.65	1556.15
		56.5	192.6	1556.96
		56.9	192.55	1556.96
AD-1B-58.1	B58.1	58.1	192.4	1558.17
		58.5	192.35	1558.58
		58.9	192.3	1558.98
		59.3	192.25	1559.39
		59.7	192.2	1559.79
		60.2	192.15	1560.20
		60.6	192.1	1560.61
		61.0	192.05	1561.01

Table 6-42 lists AD-1B-xx.x optical specifications.

Table 6-42 AD-1B-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
–1 dB bandwidth	All SOP and within whole operating environmental range	COM Rx—Band Tx Band Rx—COM Tx	3.6	—	nm
–1 dB bandwidth	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	Refer to Table 6-43.		nm
Insertion loss (drop section)	All SOP and within whole operating environmental range; two connectors included, VOA set at minimum attenuation	COM Rx—Band Tx	—	3.0	dB
Insertion loss (express section)	All SOP and within whole operating environmental range; two connectors included	Exp Rx—COM Tx	—	1.6	dB
	All SOP and within whole operating environmental range; two connectors included, VOA set at its minimum attenuation	COM Rx—Exp Tx		2.2	
Insertion loss (add section)	All SOP and within whole operating environmental range; two connectors included	Band Rx—COM Tx	—	2.2	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

Table 6-43 lists the range of wavelengths for the receive (express) band.

Table 6-43 AD-1B-xx.x Transmit and Receive Dropped Band Wavelength Ranges

	Rx (Express) Band	
Tx (Dropped) Band	Left Side (nm)	Right Side (nm)
B30.3	—	Wavelengths 1533.825 or higher
B34.2	Wavelengths 1533.395 or lower	Wavelengths 1537.765 or higher
B38.1	Wavelengths 1537.325 or lower	Wavelengths 1541.715 or higher
42.1	Wavelengths 1541.275 or lower	Wavelengths 1545.695 or higher
46.1	Wavelengths 1545.245 or lower	Wavelengths 1549.695 or higher
50.1	Wavelengths 1549.235 or lower	Wavelengths 1553.705 or higher
54.1	Wavelengths 1553.255 or lower	Wavelengths 1557.745 or higher
58.1	Wavelengths 1557.285 or lower	—

AD-1B-xx.x optical input and output power vary with amplifier output levels and the class of transponder interfaces used. See Table 6-4 on page 6-5 through Table 6-8 on page 6-7 for this information.

The AD-1B-xx.x card has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: Telcordia GR-63 5.1.1.3 compliant; 5 to 95% RH
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)
  - Depth: 9.0 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

6.13 AD-4B-xx.x Card

The 4-Band OADM (AD-4B-xx.x) card passively adds or drops four bands of four adjacent 100-GHz-spaced channels. Two versions of this card with different part numbers—each version designed for use with one set of bands—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. This card can be used when there is asymmetric adding and dropping on each side (east or west) of the node; a band can be added or dropped on one side but not on the other.

The AD1B-xx.x can be installed in Slots 1 to 6 and 12 to 17.

The AD-4B-xx.x has the following features:

- Five software-controlled VOAs regulate the optical power flowing in the OADM paths.
- Output power of each dropped band is set by changing the attenuation of each VOA drop.
- The VOA express is used to regulate the insertion loss of the express path.
- Internal controlled VOA settings and functions, photodiode detection, and alarm thresholds.
- Software-monitored virtual photodiode (firmware calculation of port optical power) at the common DWDM output port.

Figure 6-34 shows the AD-4B-xx.x faceplate.

Figure 6-34 AD-4B-xx.x Faceplate

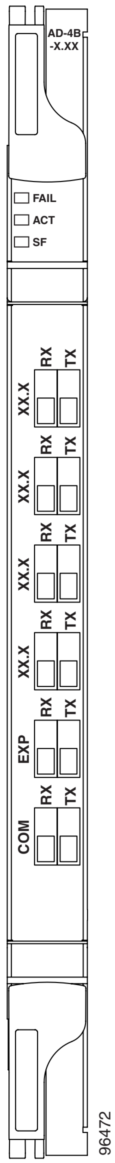


Figure 6-35 shows the AD-4B-xx.x block diagram.

Figure 6-35 AD-4B-xx.x Block Diagram

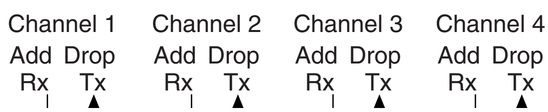
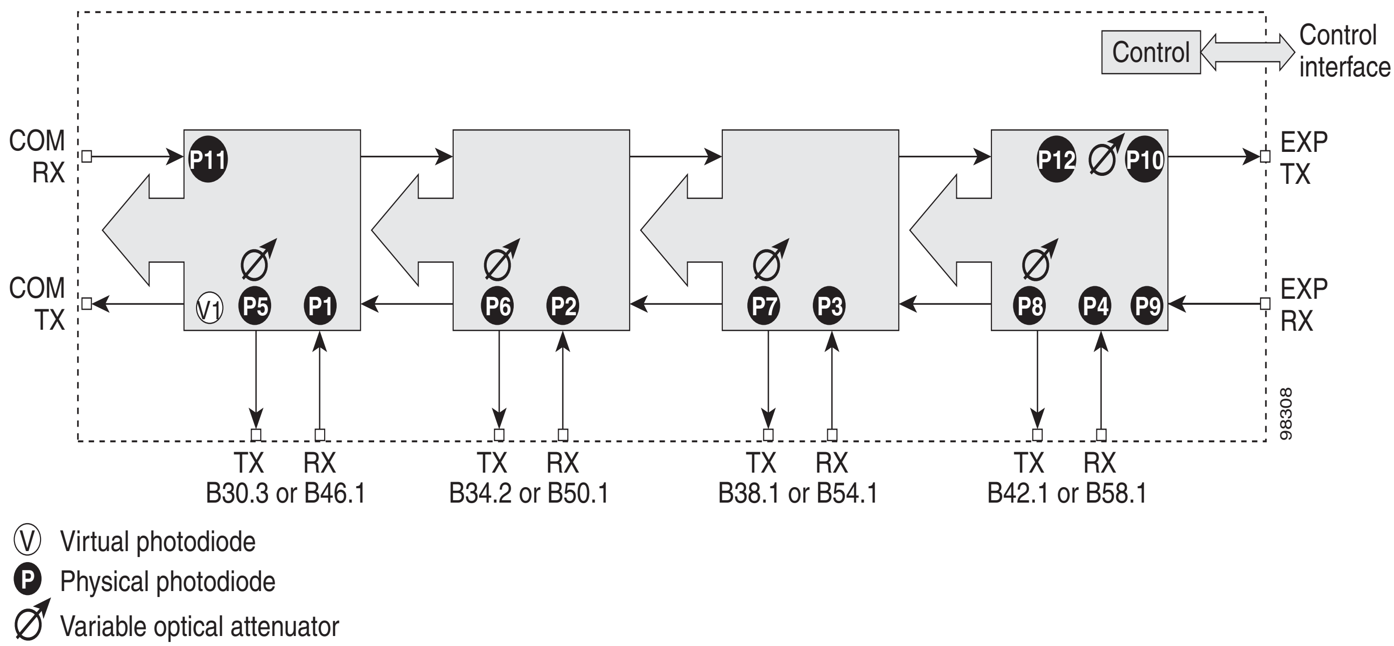


Figure 6-36 shows the AD-4B-xx.x optical module functional block diagram.

Figure 6-36 AD-4B-xx.x Optical Module Functional Block Diagram



6.13.1 Power Monitoring

Physical photodiodes P1 through P11, and virtual photodiode V1 monitor the power for the AD-4B-xx.x card. The returned power level values are calibrated to the ports as shown in Table 6-44.

Table 6-44 AD-4B-xx.x Port Calibration

Photodiode	CTC "Type" Name	Calibrated to Port
P1 - P4	ADD	COM TX
P5 - P8	DROP	DROP Channel TX
P9	IN EXP	EXP RX
P10	OUT EXP	EXP TX
P11	IN COM	COM RX
V1	OUT COM	COM TX

6.13.2 AD-4B-xx.x Card-Level Indicators

The AD-4B-xx.x card has three card-level LED indicators, described in Table 6-45.

Table 6-45 AD-4B-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-4B-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

6.13.3 AD-4B-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-4B-xx.x has 12 LC-PC-II optical ports: eight for add/drop band client input and output, two for express channel input and output, and two for communication.

6.13.4 AD-4B-xx.x Card Specifications

Table 6-46 lists the unit names, band IDs, channel IDs, frequencies, and wavelengths assigned to the two versions of the card.

Table 6-46 AD-4B-xx.x Channel Allocation Plan by Band

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-4B-30.3	B30.3	30.3	195.9	1530.33
		30.7	195.85	1530.72
		31.1	195.8	1531.12
		31.5	195.75	1531.51
		31.9	195.7	1531.90
		32.2	195.65	1532.29
		32.6	195.6	1532.68
		33.3	195.55	1533.07
	B34.2	34.2	195.4	1534.25
		34.6	195.35	1534.64
		35.0	195.3	1535.04
		35.4	195.25	1535.43
		35.8	195.2	1535.82
		36.2	195.15	1536.22
		36.6	195.1	1536.61
		37.0	195.05	1537.00
	B38.1	38.1	194.9	1538.19
		38.5	194.85	1538.58
		38.9	194.8	1538.98
		39.3	194.75	1539.37
		39.7	194.7	1539.77
		40.1	194.65	1540.16
		40.5	194.6	1540.56
		40.9	194.55	1540.95
	B42.1	42.1	194.4	1542.14
		42.5	194.35	1542.54
		42.9	194.3	1542.94
		43.3	194.25	1543.33
		43.7	194.2	1543.73
		44.1	194.15	1544.13
		44.5	194.1	1544.53
		44.9	194.05	1544.92

Table 6-46 AD-4B-xx.x Channel Allocation Plan by Band (continued)

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-4B-46.1	B46.1	46.1	193.9	1546.12
		46.5	193.85	1546.52
		46.9	193.8	1546.92
		47.3	193.75	1547.32
		47.7	193.7	1547.72
		48.1	193.65	1548.11
		48.5	193.6	1548.51
		48.9	193.55	1548.91
	B50.1	50.1	193.4	1550.12
		50.5	193.35	1550.52
		50.9	193.3	1550.92
		51.3	193.25	1551.32
		51.7	193.2	1551.72
		52.1	193.15	1552.12
		52.5	193.1	1552.52
		52.9	193.05	1552.93
	B54.1	54.1	192.9	1554.13
		54.5	192.85	1554.54
		54.9	192.8	1554.94
		55.3	192.75	1555.34
		55.7	192.7	1555.75
		56.1	192.65	1556.15
		56.5	192.6	1556.96
		56.9	192.55	1556.96
	B58.1	58.1	192.4	1558.17
		58.5	192.35	1558.58
		58.9	192.3	1558.98
		59.3	192.25	1559.39
		59.7	192.2	1559.79
		60.2	192.15	1560.20
		60.6	192.1	1560.61
		61.0	192.05	1561.01

Table 6-47 lists AD-4B-xx.x optical specifications.

Table 6-47 AD-4B-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
–1 dB bandwidth	All SOP and within whole operating environmental range	COM Rx—Band Tx Band Rx—COM Tx	3.6	—	nm
–1 dB bandwidth	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	Refer to Table 6-48.		nm
Insertion loss (drop section)	All SOP and within whole operating environmental range; two connectors included, VOA set at minimum attenuation	COM Rx—Band Tx 30.3/46.1	—	2.9	dB
		COM Rx—Band Tx 34.2/50.1		3.3	
		COM Rx—Band Tx 38.1/54.1		3.8	
		COM Rx—Band Tx 42.1/58.1		4.5	
Insertion loss (express section)	All SOP and within whole operating environmental range; two connectors included	Exp Rx—COM Tx	—	4.9	dB
	All SOP and within whole operating environmental range; two connectors included, VOA set at its minimum attenuation	COM Rx—Exp Tx		3	
Insertion loss (add section)	All SOP and within whole operating environmental range; two connectors included	Band Rx 30.3/46.1—COM Tx	—	3.5	dB
		Band Rx 34.2/50.1—COM Tx		2.8	
		Band Rx 38.1/54.1—COM Tx		2.3	
		Band Rx 42.1/58.1—COM Tx		1.8	
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

Table 6-48 lists the range of wavelengths for the receive (express) band.

Table 6-48 AD-4B-xx.x Transmit and Receive Dropped Band Wavelength Ranges

	Rx (Express) Band	
Tx (Dropped) Band	Left Side (nm)	Right Side (nm)
B30.3	—	Wavelengths1533.825 or higher
B34.2	Wavelengths 1533.395 or lower	Wavelengths 1537.765 or higher
B38.1	Wavelengths 1537.325 or lower	Wavelengths 1541.715 or higher

Table 6-48 AD-4B-xx.x Transmit and Receive Dropped Band Wavelength Ranges (continued)

	Rx (Express) Band	
Tx (Dropped) Band	**Left Side (nm)**	**Right Side (nm)**
B42.1	Wavelengths 1541.275 or lower	Wavelengths 1545.695 or higher
B46.1	Wavelengths 1545.245 or lower	Wavelengths 1549.695 or higher
B50.1	Wavelengths 1549.235 or lower	Wavelengths 1553.705 or higher
B54.1	Wavelengths 1553.255 or lower	Wavelengths 1557.745 or higher
B58.1	Wavelengths 1557.285 or lower	—

AD-4B-xx.x optical input and output power vary with amplifier output levels and the class of transponder interfaces used. See Table 6-4 on page 6-5 through Table 6-8 on page 6-7 for this information.

The AD-4B-xx.x has the following additional specifications:

- Environmental
  - Operating temperature:

    C-Temp: –5 to +55 degrees Celsius (+23 to +131 degrees Fahrenheit)
  - Operating humidity: Telcordia GR-63 5.1.1.3 compliant; 5 to 95% RH
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.92 in. (23.4 mm)
  - Depth: 9.0 in. (228.6 mm)
- For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

Card Protection

This chapter explains the Cisco ONS 15454 card protection configurations. To provision card protection, refer to the *Cisco ONS 15454 Procedure Guide*.

Chapter topics include:

7.1 Electrical Card Protection

The ONS 15454 provides a variety of electrical card protection methods. This section describes the protection options. Figure 7-1 shows a 1:1 protection configuration and Figure 7-2 on page 7-3 shows a 1:N protection configuration.

This section covers the general concept of electrical card protection. Specific electrical card protection schemes depend on the Electrical Interface Assembly (EIA) type used on the ONS 15454 backplane. Table 7-1 on page 7-4 details the specific electrical card protection schemes.

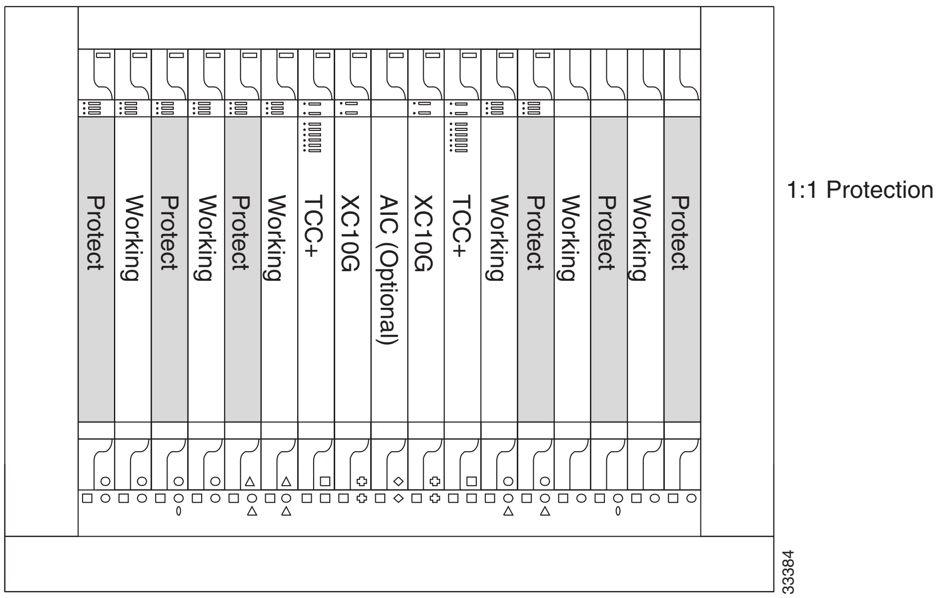
Note An ONS 15454 configuration needs at least two slots reserved for OC-N cards.

Caution When a protection switch moves traffic from the DS3-12 working/active card to the DS3-12 protect/standby card, ports on the new active/standby card cannot be placed out of service as long as traffic is switched. Lost traffic can result when a port is taken out of service, even if the DS3-12 standby card no longer carries traffic.

7.1.1 1:1 Protection

In 1:1 protection, a working card is paired with a protect card of the same type. If the working card fails, the traffic from the working card switches to the protect card. You can provision 1:1 to be revertive or nonrevertive. If revertive, traffic automatically reverts to the working card after the failure on the working card is resolved. Figure 7-1 shows the ONS 15454 in a 1:1 protection configuration. Each working card in an even-numbered slot is paired with a protect card in an odd-numbered slot: Slot 1 is protecting Slot 2, Slot 3 is protecting Slot 4, Slot 5 is protecting Slot 6, Slot 17 is protecting Slot 16, Slot 15 is protecting Slot 14, and Slot 13 is protecting Slot 12.

Figure 7-1 ONS 15454 Cards in a 1:1 Protection Configuration (SMB EIA Only)

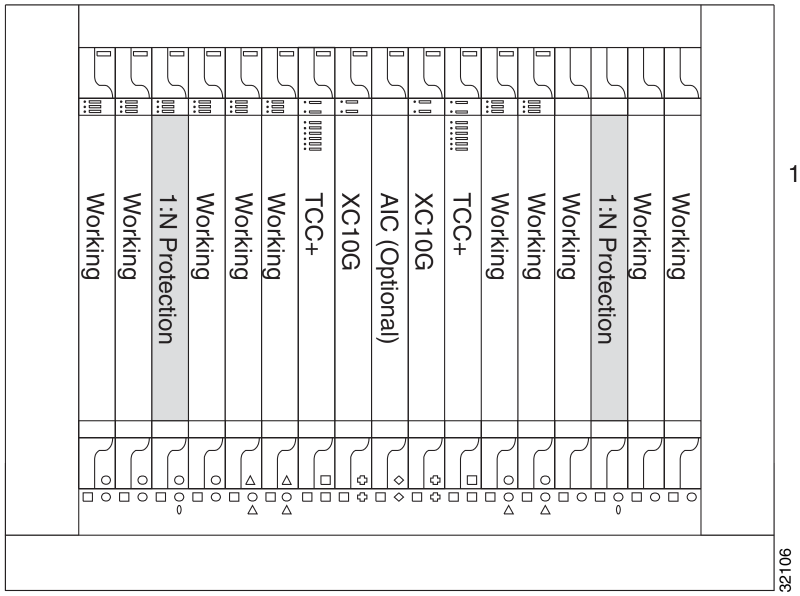


7.1.2 1:N Protection

1:N protection allows a single card to protect up to five working cards of the same speed, DS-1 or DS-3. A DS1N-14 card protects DS1-14 cards, a DS3N-12 card protects DS3-12 cards, and DS3N-12E cards protect DS3-12E cards. DS3i-N-12 cards can only protect other like DS3i-N-12 cards. The standard DS1-14, DS3-12, and DS3-12E cards provide 1:1 protection only. 1:N protection operates only at the DS-1 and DS-3 levels. 1:N cards have added circuitry to act as the protect card in a 1:N protection group. Otherwise, the card is identical to the standard card and can serve as a normal working card.

The physical DS-1 or DS-3 interfaces on the ONS 15454 backplane use the working card until the working card fails. When the node detects this failure, the protect card takes over the physical DS-1 or DS-3 electrical interfaces through the relays and signal bridging on the backplane. Figure 7-2 shows the ONS 15454 in a 1:N protection configuration. Each side of the shelf assembly has only one card protecting all of the cards on that side.

Figure 7-2 ONS 15454 Cards in a 1:N Protection Configuration (SMB EIA Only)



7.1.2.1 Revertive Switching

1:N protection supports revertive switching. Revertive switching sends the electrical interfaces (traffic) back to the original working card after the card comes back online. Detecting an active working card triggers the reversion process. There is a variable time period for the lag between detection and reversion, called the revertive delay, which you can set using the ONS 15454 software, Cisco Transport Controller (CTC). To set the revertive delay, refer to the *Cisco ONS 15454 Procedure Guide*. All cards in a protection group share the same reversion settings. 1:N protection groups default to automatic reversion.

7.1.2.2 1:N Protection Guidelines

Several rules apply to 1:N protection groups in the ONS 15454:

- Working and protect card groups must reside in the same card bank (A or B).
- The 1:N protect card must reside in Slot 3 for side A and Slot 15 for side B.
- Working cards may sit on either or both sides of the protect card.

The ONS 15454 supports 1:N equipment protection for all add-drop multiplexer (ADM) configurations (ring, linear, and terminal), as specified by Telcordia GR-253-CORE.

The ONS 15454 automatically detects and identifies a 1:N protect card when the card is installed in Slot 3 or Slot 15. However, the slot containing the 1:N card in a protection group must be manually provisioned as a protect slot because by default all cards are working cards.

For detailed procedures on setting up DS-1 and DS-3 protection groups, refer to the *Cisco ONS 15454 Procedure Guide*.

7.2 Electrical Card Protection and the Backplane

Protection schemes for electrical cards depend on the Electrical Interface Assembly (EIA) type used on the ONS 15454 backplane. The difference is due to the varying connector size. For example, because BNC connectors are larger, fewer DS3-12 cards can be supported when using a BNC connector. Table 7-1 shows the electrical card protection for each EIA type.

Note For EIA installation, refer to the *Cisco ONS 15454 Procedure Guide*.

Caution **When a protection switch moves traffic from the DS3-12 working/active card to the DS3-12 protect/standby card, ports on the new active/standby card cannot be taken out of service as long as traffic is switched. Lost traffic can result when a port is taken out of service even if the DS3-12 standby card no longer carries traffic.**

Table 7-1 Electrical Card Protection With EIA Types

Protection Rules	Standard BNC (24 per Side)	High-Density BNC (48 per Side)	SMB (84 per Side)	AMP Champ (84 per Side)
Working card slots (unprotected)	2, 4, 14 and 16	1, 2, 4, 5, 13, 14, 16 and 17	1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 16 and 17	1, 2, 3, 4, 5, 6, 12, 13, 14, 15, 16 and 17
Working card slots (1:1 protection)	2, 4, 14 and 16	2, 4, 14 and 16	2, 4, 6, 12,14,16	2, 4, 6, 12, 14, 16
Protection card slots (1:1 protection)	1, 3, 15 and 17	1, 3, 15, 17	1, 3, 5, 13, 15, 17	1, 3, 5, 13, 15, 17
Working card slots (1:N protection)	2, 4, 14 and 16	1, 2, 4, 5, 13, 14, 16 and 17	1, 2, 4, 5, 6, 12, 13, 14, 16 and 17	1, 2, 4, 5, 6, 12, 13, 14, 16 and 17
Protection card slots (1:N protection)	3 and 15	3 and 15	3 and 15	3 and 15
Unsupported electrical card slots	5, 6, 12 and 13	6 and 12	None	None

Figure 7-3 shows unprotected electrical card schemes by EIA type.

Figure 7-3 Unprotected Electrical Card Schemes for EIA Types

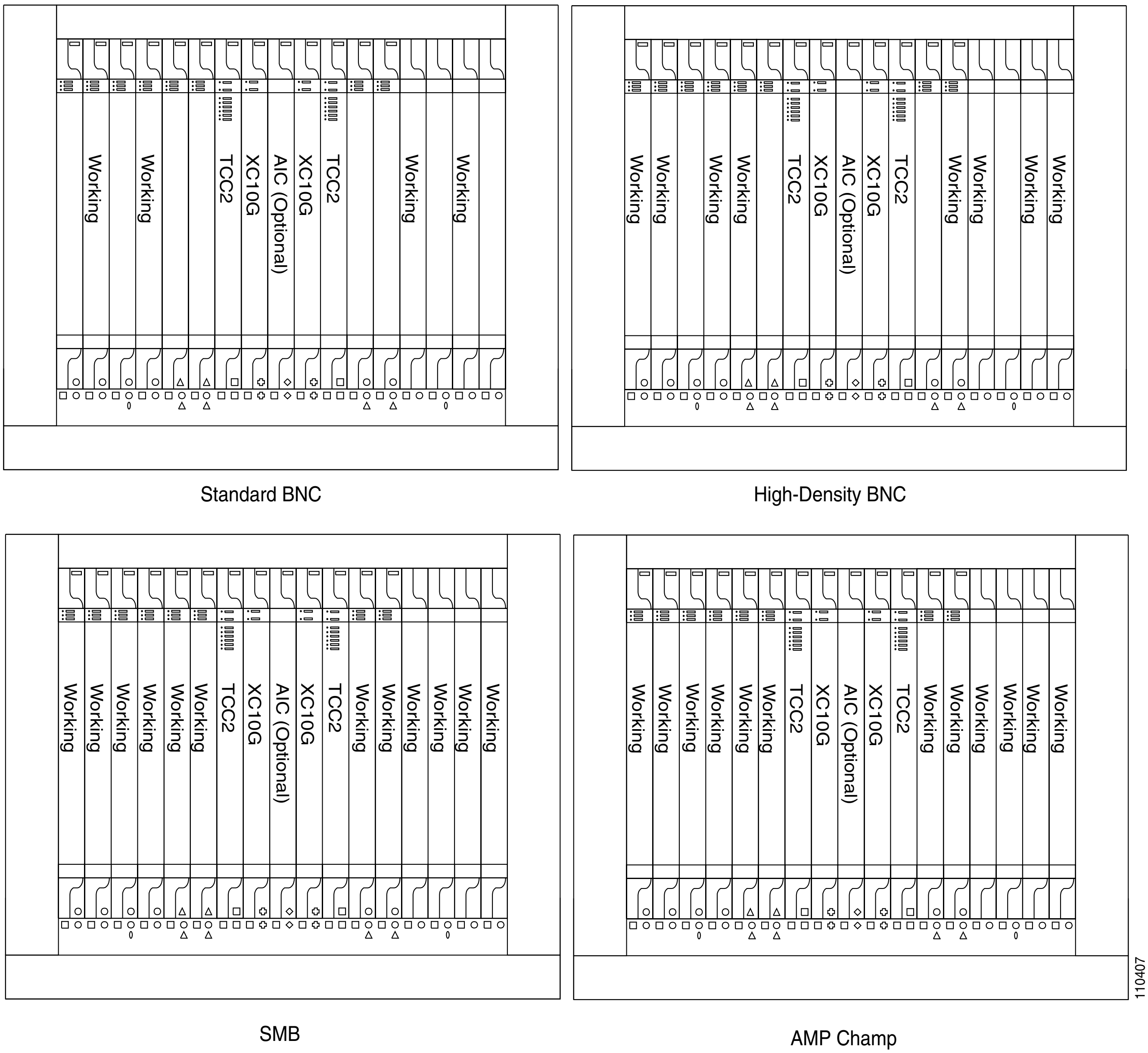


Figure 7-4 shows 1:1 protection by EIA type.

Figure 7-4 1:1 Protection Schemes for Electrical Cards with EIA Types

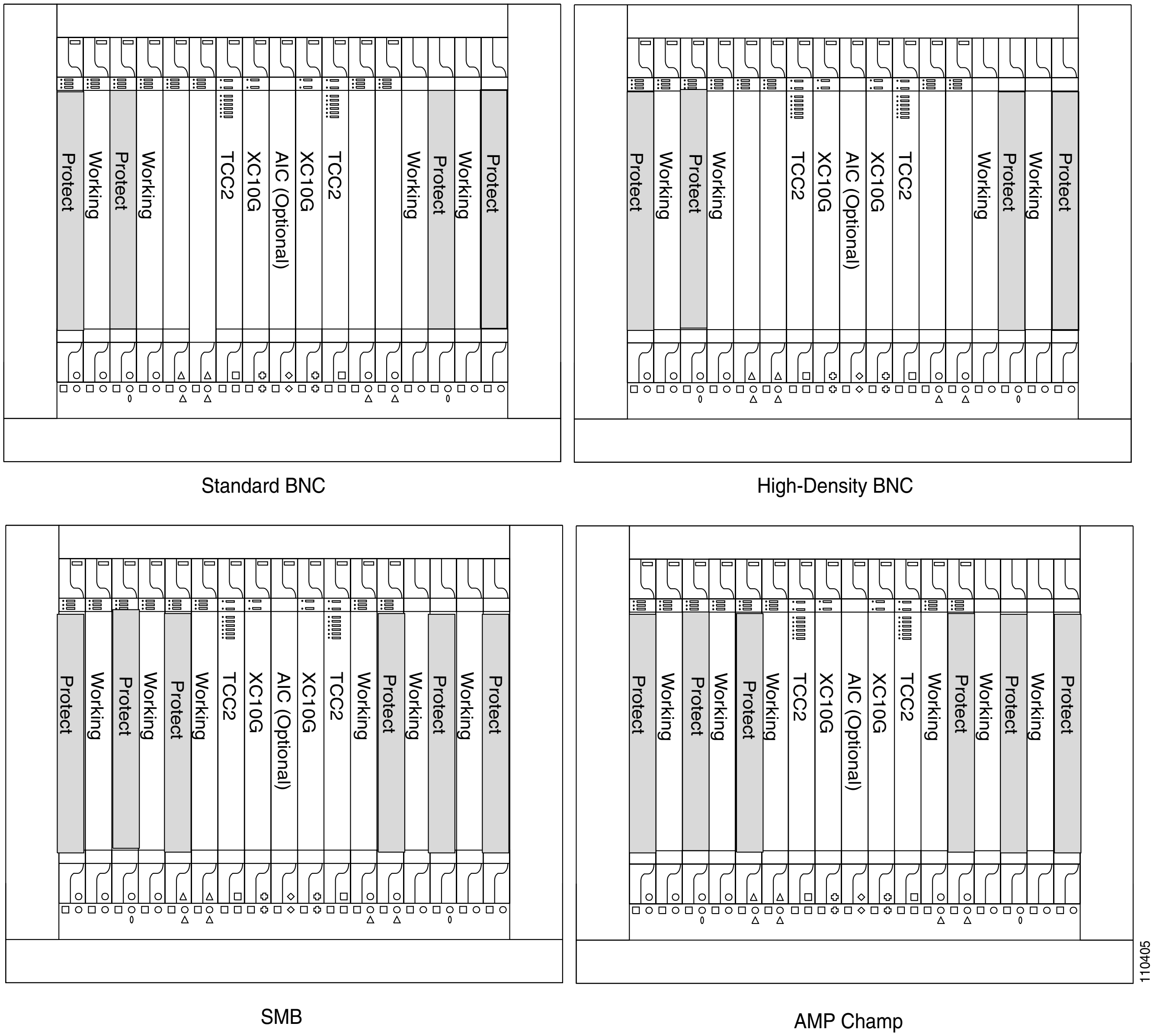
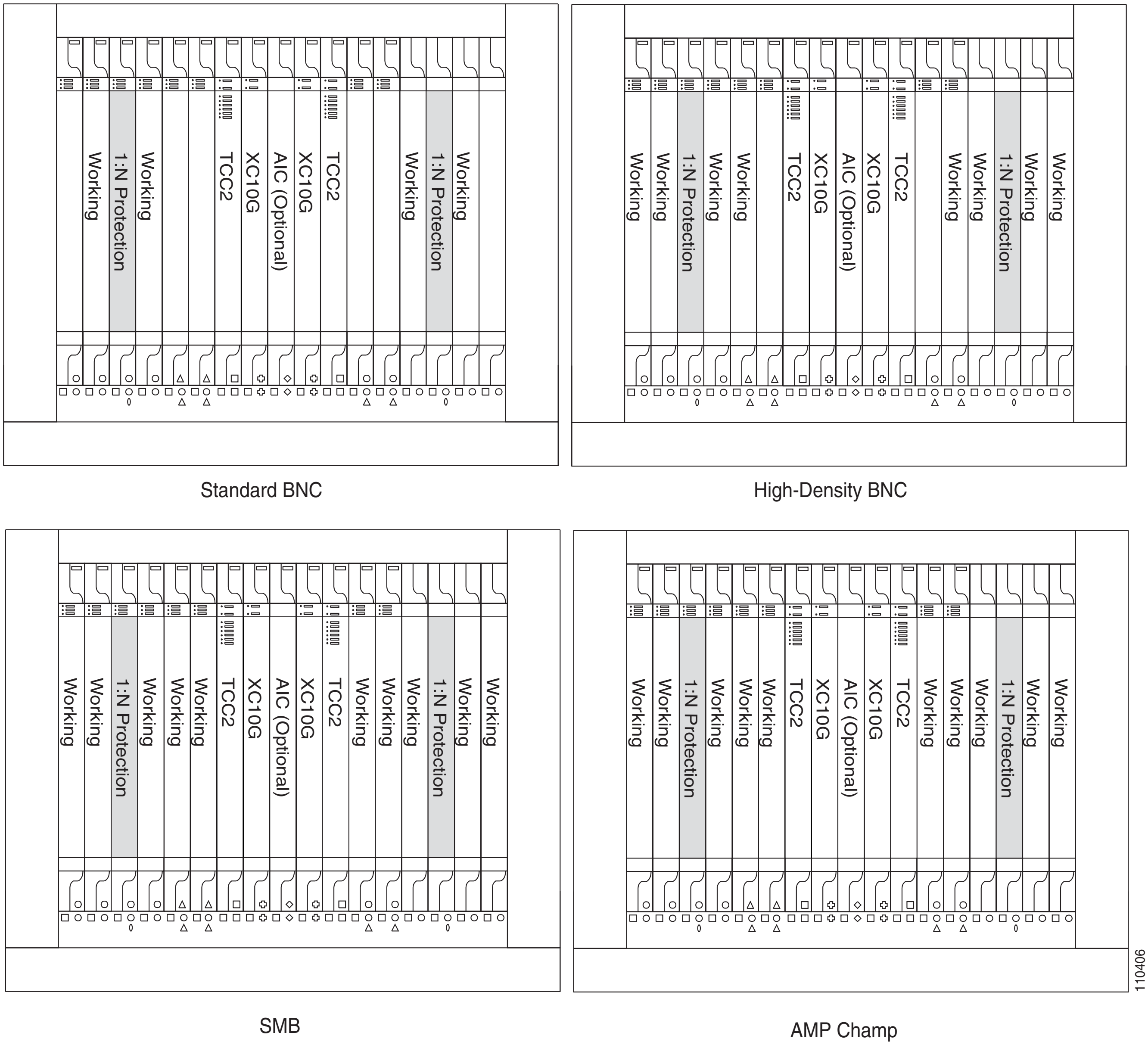


Figure 7-5 shows 1:N protection for DS-1 and DS-3 cards.

Figure 7-5 1:N Protection Schemes for DS-1 and DS-3 Cards with EIA Types



Note EC-1 cards do not support 1:N protection.

7.2.1 Standard BNC Protection

When you use BNC connectors, the ONS 15454 supports 1:1 protection or 1:N protection for a total of four working DS-3 electrical cards per shelf or 48 BNCs per shelf. If you are using EC-1 electrical cards with the BNC EIA, the ONS 15454 supports 1:1 protection and a total of four working cards. Slots 2, 4, 14, and 16 are designated working slots. These slots are mapped to a set of 12 BNC connectors on the EIA. These slots can be used without protection for unprotected DS-3 access.

With 1:N or 1:1 protection, Slots 1, 3, 15, and 17 are designated for protection when BNC connectors are used. With 1:N protection, Slots 3 and 15 are also designated for protection when BNC connectors are used. Slots 5, 6, 12, and 13 do not support DS3-12 cards when you use the regular BNC EIA.

7.2.2 High-Density BNC Protection

When you use the high-density BNC EIA, the ONS 15454 supports 1:1 protection or 1:N protection for eight total working DS-3 electrical cards per shelf or 96 BNCs. If you are using EC-1 electrical cards with the high-density BNC EIA, the ONS 15454 supports 1:1 protection and a total of eight working cards. Slots 1, 2, 4, 5, 13, 14, 16, and 17 are designated working slots.

These slots are mapped to a set of 12 BNC type connectors on the EIA. You can use these slots without protection for unprotected DS-3 or EC-1 access. Slots 3 and 15 are designated for 1:N protection slots when you use BNC connectors with the high-density BNC EIA. Slots 6 and 12 do not support DS-3 or EC-1 cards when you use the high-density BNC EIA.

7.2.3 SMB Protection

When you use SMB connectors, the ONS 15454 supports 1:1 or 1:N protection for the DS-1 and the DS-3 electrical cards. If you are using EC-1 cards with the SMB EIA, the ONS 15454 supports 1:1 protection. Working and protection electrical cards are defined by card slot pairs (the same card type is used for working and protect modules; the protection of the card is defined by the slot where it is housed). Each slot maps to a set of 12 or 14 SMB connectors on the EIA depending on the number of ports on the corresponding card. Any slot can be used without protection for unprotected DS-1, DS-3, or EC-1 access.

The DS1N-14 card can be a working or protect card in 1:1 or 1:N protection schemes. When used with 1:N protection, the DS1N-14 card can protect up to five DS1-14 plug-ins using the SMB connectors with the DS-1 electrical interface adapters (baluns).

7.2.4 AMP Champ Protection

When you use AMP Champ connectors, the ONS 15454 supports 1:1 or 1:N protection for the DS-1 cards. The DS1N-14 card can be a working or protect card in 1:1 or 1:N protection schemes. When used with 1:N protection, the DS1N-14 card can protect up to five DS1-14 plug-ins using the AMP Champ EIA.

7.3 OC-N Card Protection

With 1+1 port-to-port protection, any number of ports on the protect card can be assigned to protect the corresponding ports on the working card. The working and protect cards do not have to be placed side by side in the node. A working card must be paired with a protect card of the same type and number of ports. For example, a single-port OC-12 must be paired with another single-port OC-12, and a four-port OC-12 must be paired with another four-port OC-12. You cannot create a 1+1 protection group if one card is single-port and the other is multiport, even if the OC-N rates are the same. The protection takes place on the port level, and any number of ports on the protect card can be assigned to protect the corresponding ports on the working card.

For example, on a four-port card, you can assign one port as a protection port on the protect card (protecting the corresponding port on the working card) and leave three ports unprotected. Conversely, you can assign three ports as protection ports and leave one port unprotected. With 1:1 or 1:N protection (electrical cards), the protect card must protect an entire slot. In other words, all the ports on the protect card are used in the protection scheme.

1+1 span protection can be either revertive or nonrevertive. With nonrevertive 1+1 protection, when a failure occurs and the signal switches from the working card to the protect card, the signal stays switched to the protect card until it is manually switched back. Revertive 1+1 protection automatically switches the signal back to the working card when the working card comes back online. 1+1 protection is unidirectional and nonrevertive by default; revertive switching is easily provisioned using CTC.

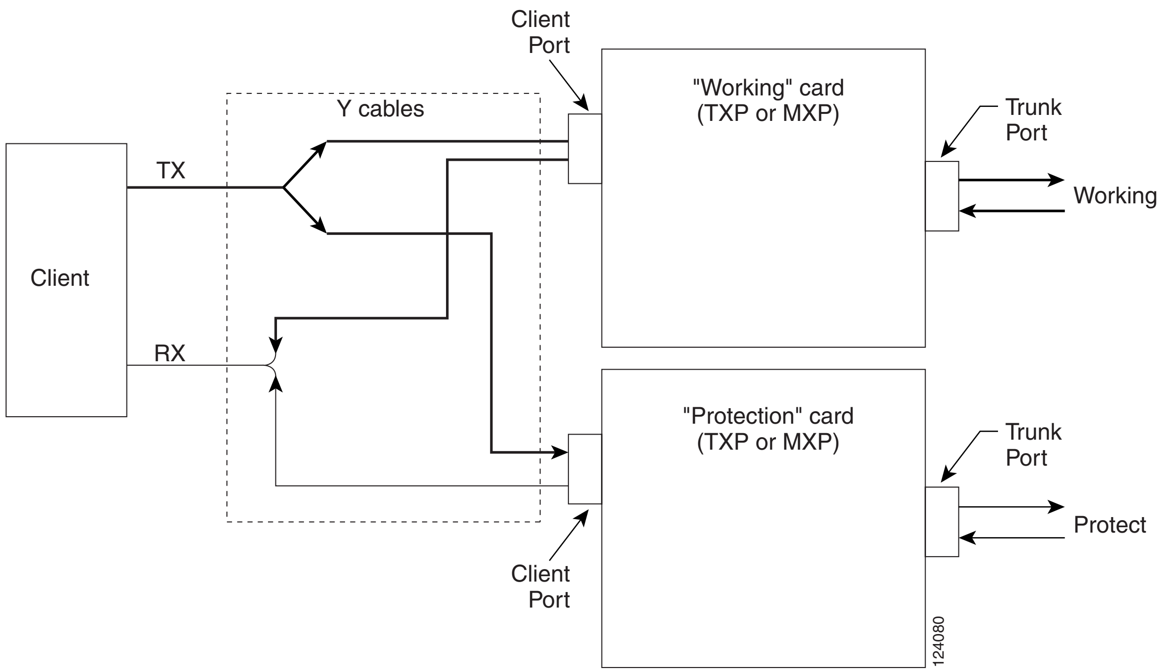
7.4 Transponder and Muxponder Protection

To create Y-cable protection, you create a Y-cable protection group for two TXP or MXP cards using the CTC software, then connect the client ports of the two cards physically with a Y-cable. The single client signal is sent into the Rx Y-cable and is split between the two TXP or MXP cards. The two Tx signals from the trunk side of the TXP or MXP cards are combined in the TX Y-cable into a single client signal. Only the active card signal passes through as the single TX client signal. The other card must have its laser turned off to avoid signal degradation where the Y-cable joins. Figure 7-6 shows the Y-cable signal flow. The Y-cable protection scheme always switches on the trunk side of the TXP or MXP cards. The client side does not switch.

The alarm severity of the client-side Loss of Signal (LOS) alarm is based on the protection status of the card; a critical (CR) alarm is raised for a working card and a minor (MN) alarm is raised for a standby card. If a working card has an active LOS alarm, the alarm severity is CR even though the circuit is protected.

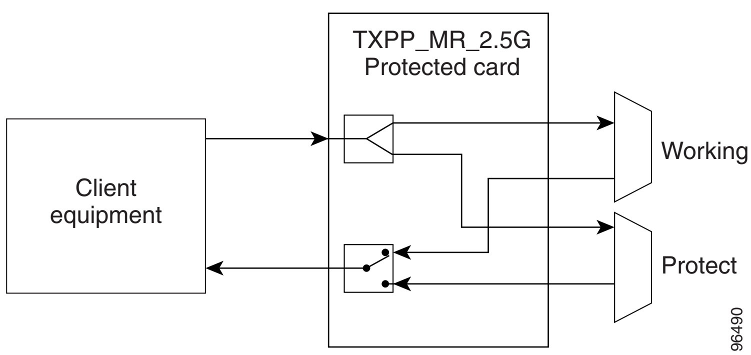
Note Loss of Signal–Payload (LOS-P), also called Incoming Payload Signal Absent, alarms can occur on a split signal if the ports are not in a Y-cable protection group.

Figure 7-6 Y-Cable Protection



Splitter protection, shown in Figure 7-7, is provided with the TXPP_MR_2.5G card. With splitter protection, the single client signal is split on the trunk side on two different paths. The TXPP card on the RX end chooses one of the two signals and switches to the other in case of failure. The trigger mechanisms for the protection switch are loss of signal (LOS), signal degrade (SD), signal failure (SF), and ITU-T G.709 loss of frame (LOF), LOM, and ODU-AIS.

Figure 7-7 Splitter Protection

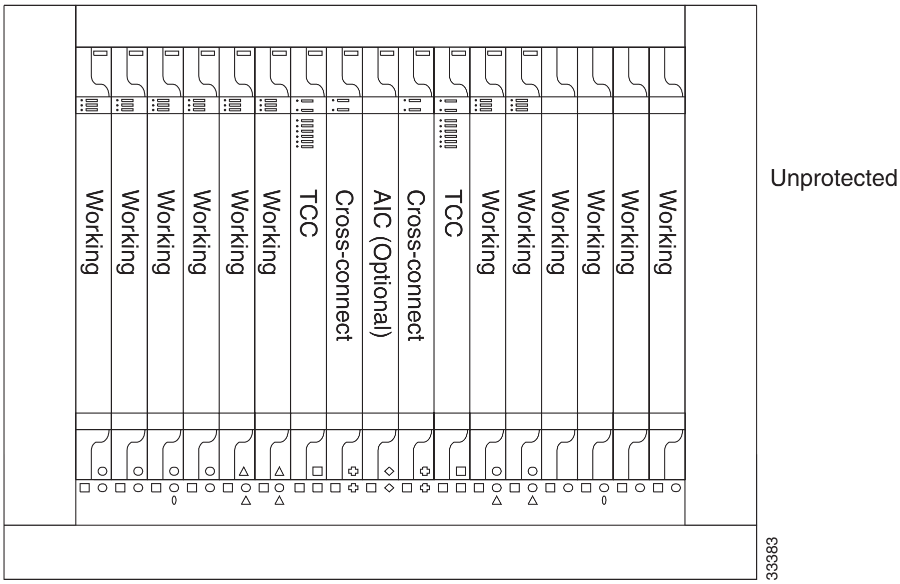


You create and modify protection schemes using CTC software. For more information, refer to the *Cisco ONS 15454 Procedure Guide*.

7.5 Unprotected Cards

Unprotected cards are not included in a protection scheme; therefore, a card failure or a signal error results in lost data. Because no bandwidth lies in reserve for protection, unprotected schemes maximize the available ONS 15454 bandwidth. Figure 7-8 shows the ONS 15454 in an unprotected configuration. All cards are in a working state.

Figure 7-8 ONS 15454 in an Unprotected Configuration



7.6 External Switching Commands

The external switching commands on the ONS 15454 are Manual, Force, and Lockout. If you choose a Manual switch, the command will switch traffic only if the path has an error rate less than the signal degrade bit error rate threshold. A Force switch will switch traffic even if the path has SD or SF conditions. A Force switch has a higher priority than a Manual switch. Lockouts can only be applied to protect cards (in1+1 configurations) and prevent traffic from switching to the protect port under any circumstance. Lockouts have the highest priority. In a 1+1 configuration you can also apply a lock on to the working port. A working port with a lock on applied cannot switch traffic to the protect port in the protection group (pair). In 1:1 protection groups, working or protect ports can have a lock on.

Note Force and Manual switches do not apply to 1:1 protection groups; these ports have a single switch command.

CHAPTER 8

Cisco Transport Controller Operation

This chapter describes Cisco Transport Controller (CTC), the software interface for the Cisco ONS 15454. For CTC set up and login information, refer to the *Cisco ONS 15454 Procedure Guide*.

Chapter topics include:

8.1 CTC Software Delivery Methods

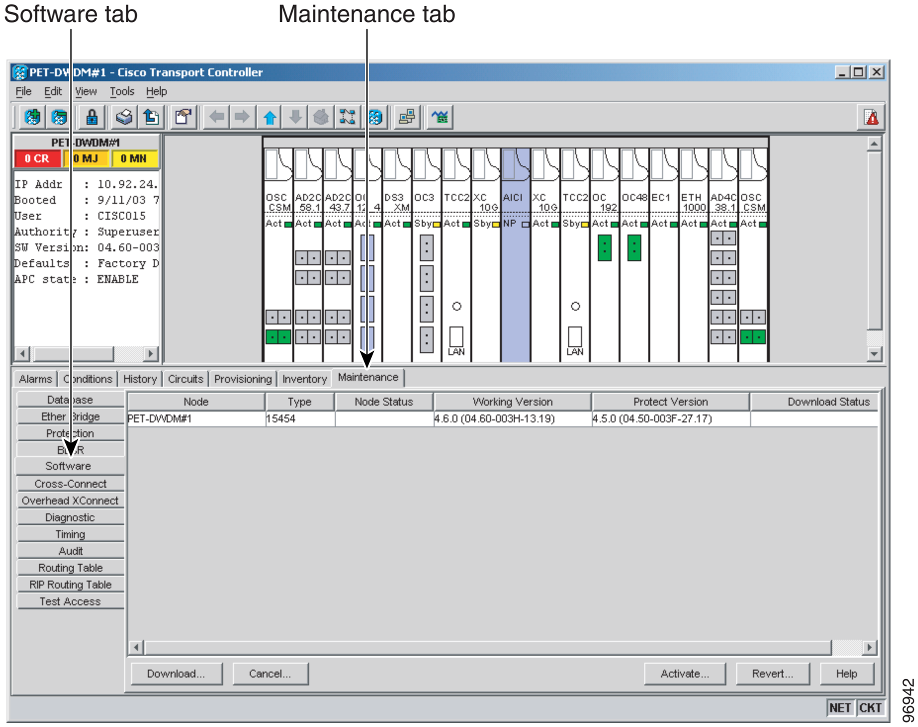
ONS 15454 provisioning and administration is performed using the CTC software. CTC is a Java application that is installed in two locations; CTC is stored on the TCC2 card, and it is downloaded to your workstation the first time you log into the ONS 15454 with a new software release.

8.1.1 CTC Software Installed on the TCC2 Card

CTC software is preloaded on the ONS 15454 TCC2 cards; therefore, you do not need to install software on the TCC2 cards. When a new CTC software version is released, use the *Cisco ONS 15454 Software Upgrade Guide* to upgrade the ONS 15454 software on the TCC2 cards.

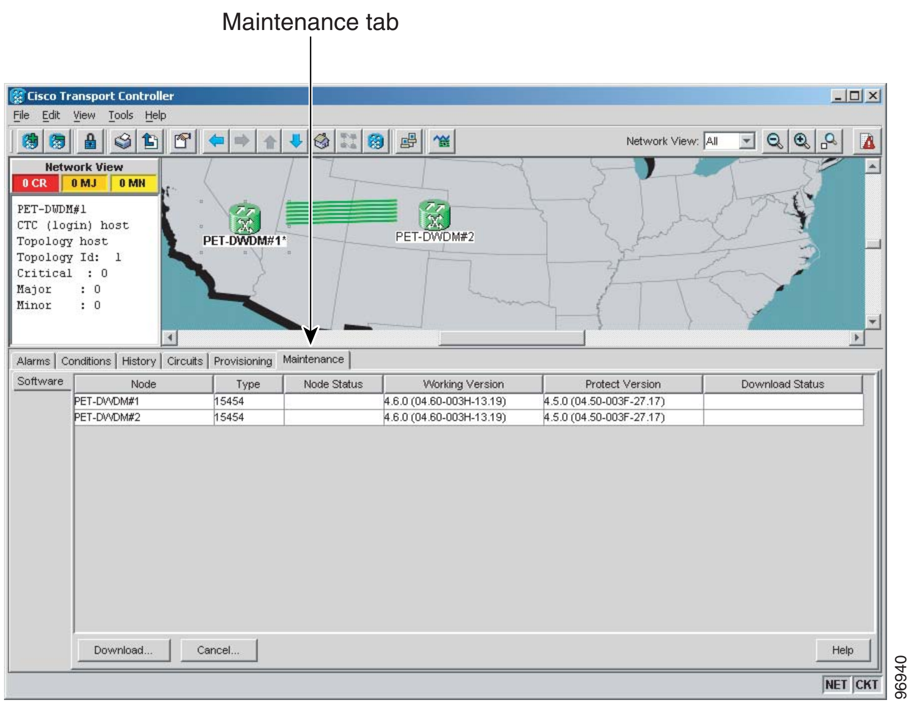
When you upgrade CTC software, the TCC2 cards store the new CTC version as the protect CTC version. When you activate the new CTC software, the TCC2 cards store the older CTC version as the protect CTC version, and the newer CTC release becomes the working version. You can view the software versions that are installed on an ONS 15454 by selecting the Maintenance > Software tabs in node view (Figure 8-1).

Figure 8-1 CTC Software Versions, Node View



Select the Maintenance > Software tabs in network view to display the software versions installed on all the network nodes (Figure 8-2).

Figure 8-2 CTC Software Versions, Network View



8.1.2 CTC Software Installed on the PC or UNIX Workstation

CTC software is downloaded from the TCC2 cards and installed on your computer automatically after you connect to the ONS 15454 with a new software release for the first time. Downloading the CTC software files automatically ensures that your computer is running the same CTC software version as the TCC2 cards you are accessing. The CTC files are stored in the temporary directory designated by your computer operating system. You can use the Delete CTC Cache button to remove files stored in the temporary directory. If the files are deleted, they download the next time you connect to an ONS 15454. Downloading the Java archive files, called “JAR” files, for CTC takes several minutes depending on the bandwidth of the connection between your workstation and the ONS 15454. For example, JAR files downloaded from a modem or a data communication channel (DCC) network link require more time than JAR files downloaded over a LAN connection.

8.2 CTC Installation Overview

To connect to an ONS 15454 using CTC, you enter the ONS 15454 IP address in the URL field of Netscape Navigator or Microsoft Internet Explorer. After connecting to an ONS 15454, the following occurs automatically:

1. A CTC launcher applet is downloaded from the TCC2 card to your computer.
2. The launcher determines whether your computer has a CTC release matching the release on the ONS 15454 TCC2 card.
3. If the computer does not have CTC installed, or if the installed release is older than the TCC2 card’s version, the launcher downloads the CTC program files from the TCC2 card.
4. The launcher starts CTC. The CTC session is separate from the web browser session, so the web browser is no longer needed. Always log into nodes having the latest software release. If you log into an ONS 15454 that is connected to ONS 15454s with older versions of CTC, or to Cisco ONS 15327s or Cisco ONS 15600s, CTC files are downloaded automatically to enable you to interact with those nodes. The CTC file download occurs only when necessary, such as during your first login. You cannot interact with nodes on the network that have a software version later than the node that you used to launch CTC.

Each ONS 15454 can handle up to five concurrent CTC sessions. CTC performance can vary, depending upon the volume of activity in each session, network bandwidth, and TCC2 card load.

Note You can also use TL1 commands to communicate with the Cisco ONS 15454 through VT100 terminals and VT100 emulation software, or you can telnet to an ONS 15454 using TL1 port 3083. Refer to the *Cisco ONS 15454 and Cisco ONS 15327 TL1 Command Guide* for a comprehensive list of TL1 commands.

8.3 PC and UNIX Workstation Requirements

To use CTC in the ONS 15454, your computer must have a web browser with the correct Java Runtime Environment (JRE) installed. The correct JRE for each CTC software release is included on the Cisco ONS 15454 software CD and the ONS 15454 documentation CD. If you are running multiple CTC software releases on a network, the JRE installed on the computer must be compatible with the different software releases.

You can change the JRE version on the Preferences dialog box JRE tab. When you change the JRE version on the JRE tab, you must exit and restart CTC for the new JRE version to take effect. Table 8-1 shows JRE compatibility with ONS software releases.

Table 8-1 JRE Compatibility

ONS Software Release	JRE 1.2.2 Compatible	JRE 1.3 Compatible	JRE 1.4 Compatible
ONS 15454 Release 2.2.1 and earlier	Yes	No	No
ONS 15454 Release 2.2.2	Yes	Yes	No
ONS 15454 Release 3.0	Yes	Yes	No
ONS 15454 Release 3.1	Yes	Yes	No
ONS 15454 Release 3.2	Yes	Yes	No
ONS 15454 Release 3.3	Yes	Yes	No
ONS 15454 Release 3.4	No	Yes	No
ONS 15454 Release 4.0 [1]	No	Yes	No
ONS 15454 Release 4.1	No	Yes	No
ONS 15454 Release 4.5	No	Yes	No
ONS 15454 Release 4.6	No	Yes	Yes

1. Software releases 4.0 and later notify you if an older version of the JRE is running on your PC or UNIX workstation.

Table 8-2 lists the requirements for PCs and UNIX workstations. In addition to the JRE, the Java plug-in and modified java.policy file are also included on the ONS 15454 software CD and the ONS 15454 documentation CD.

Table 8-2 Computer Requirements for CTC

Area	Requirements	Notes
Processor	Pentium III 700 MHz, UltraSPARC, or equivalent	700 MHz is the recommended processor speed. You can use computers with a lower processor speed; however, you may experience longer response times and slower performance.
RAM	256 MB	—
Hard drive	50 MB space must be available	—
Operating System	• PC: Windows 98, Windows NT 4.0 with Service Pack 6, Windows 2000, or Windows XP • Workstation: Solaris versions 8 or 9	—

Table 8-2 Computer Requirements for CTC (continued)

Area	Requirements	Notes
Java Runtime Environment	JRE 1.4.2 or 1.3.1_02	JRE 1.4.2 is installed by the CTC Installation Wizard included on the Cisco ONS 15454 software and documentation CDs. JRE 1.4.2 provides enhancements to CTC performance, especially for large networks with numerous circuits. Cisco recommends that you use JRE 1.4.2 for networks with Software R4.6 nodes. If CTC must be launched directly from nodes running software earlier than R4.6, Cisco recommends JRE 1.3.1_02.
Web browser	• PC: Netscape 4.76, Netscape 7.x, Internet Explorer 6.x • UNIX Workstation: Netscape 4.76, Netscape 7.x	For the PC, use JRE 1.4.2 or 1.3.1_02 with any supported web browser. For UNIX, use JRE 1.4.2 with Netscape 7.x or JRE 1.3.1_02 with Netscape 4.76. Netscape 4.76 or 7.x is available at the following site: http://channels.netscape.com/ns/browsers/default.jsp Internet Explorer 6.x is available at the following site: http://www.microsoft.com
Java.policy file	A java.policy file modified for CTC	The java.policy file is modified by the CTC Installation Wizard included on the Cisco ONS 15454 software and documentation CDs.
Cable	User-supplied Category 5 straight-through cable with RJ-45 connectors on each end to connect the computer to the ONS 15454 directly or through a LAN	—

8.4 ONS 15454 Connection

You can connect to the ONS 15454 in multiple ways. You can connect your PC directly the ONS 15454 (local craft connection) using the RJ-45 port on the TCC2 card or the LAN pins on the backplane, connect your PC to a hub or switch that is connected to the ONS 15454, connect to the ONS 15454 through a LAN or modem, or establish TL1 connections from a PC or TL1 terminal. Table 8-3 lists the ONS 15454 connection methods and requirements.

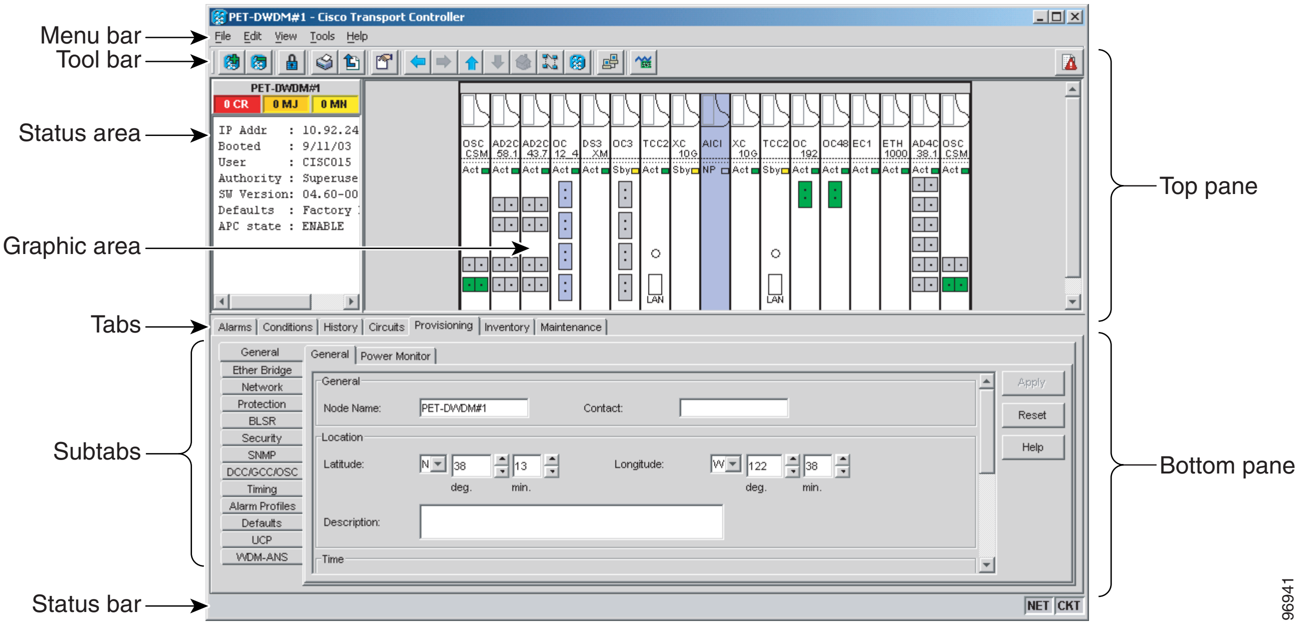
Table 8-3 ONS 15454 Connection Methods

Method	Description	Requirements
Local craft	Refers to onsite network connections between the CTC computer and the ONS 15454 using one of the following: • The RJ-45 (LAN) port on the TCC2 card • The LAN pins on the ONS 15454 backplane • A hub or switch to which the ONS 15454 is connected	If you do not use Dynamic Host Configuration Protocol (DHCP), you must change the computer IP address, subnet mask, and default router, or use automatic host detection.
Corporate LAN	Refers to a connection to the ONS 15454 through a corporate or network operations center (NOC) LAN.	• The ONS 15454 must be provisioned for LAN connectivity, including IP address, subnet mask, default gateway. • The ONS 15454 must be physically connected to the corporate LAN. • The CTC computer must be connected to the corporate LAN that has connectivity to the ONS 15454.
TL1	Refers to a connection to the ONS 15454 using TL1 rather than CTC. TL1 sessions can be started from CTC, or you can use a TL1 terminal. The physical connection can be a craft connection, corporate LAN, or a TL1 terminal.	Refer to the *Cisco ONS 15454 and Cisco ONS 15327 TL1 Command Guide*.
Remote	Refers to a connection made to the ONS 15454 using a modem.	• A modem must be connected to the ONS 15454. • The modem must be provisioned for the ONS 15454. To run CTC, the modem must be provisioned for Ethernet access.

8.5 CTC Window

The CTC window appears after you log into an ONS 15454 (Figure 8-3). The window includes a menu bar, toolbar, and a top and bottom pane. The top pane provides status information about the selected objects and a graphic of the current view. The bottom pane provides tabs and subtab to view ONS 15454 information and perform ONS 15454 provisioning and maintenance. From this window you can display three ONS 15454 views: network, node, and card.

Figure 8-3 Node View (Default Login View)



8.5.1 Node View

Node view, shown in Figure 8-3, is the first view that appears after you log into an ONS 15454. The login node is the first node shown, and it is the "home view" for the session. Node view allows you to manage one ONS 15454 node. The status area shows the node name; IP address; session boot date and time; number of Critical (CR), Major (MJ), and Minor (MN) alarms; the name of the current logged-in user; and the security level of the user; software version; and the network element default setup.

8.5.1.1 CTC Card Colors

The graphic area of the CTC window depicts the ONS 15454 shelf assembly. The colors of the cards in the graphic reflect the real-time status of the physical card and slot (Table 8-4).

Table 8-4 Node View Card Colors

Card Color	Status
Gray	Slot is not provisioned; no card is installed.
Violet	Slot is provisioned; no card is installed.
White	Slot is provisioned; a functioning card is installed.
Yellow	Slot is provisioned; a Minor alarm condition exists.
Orange	Slot is provisioned; a Major alarm condition exists.
Red	Slot is provisioned; a Critical alarm exists.

The wording on a card in node view shows the state of a card (Active, Standby, Loading, or Not Provisioned). Table 8-5 lists the card states.

Table 8-5 Node View Card States

Card State	Description
Sty	Card is in standby.
Act	Card is active.
NP	Card is not present.
Ldg	Card is resetting.

Ports can be assigned one of four states, OOS, IS, OOS-AINS, or OOS-MT. The color of the port in both card and node view indicates the port state. Table 8-6 lists the port colors and their states.

Table 8-6 Node View Card Port Colors

Port Color	State	Description
Gray	OOS	Port is out of service; no signal is transmitted. Loopbacks are not allowed in this state.
Violet	OOS-AINS	Port is in an out of service, auto-inservice state; alarm reporting is suppressed, but traffic is carried and loopbacks are allowed. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command. The AINS port will automatically transition to IS when a signal is received for the length of time provisioned in the soak field.
Cyan (blue)	OOS-MT	Port is in a maintenance state. The maintenance state does not interrupt traffic flow. Traffic is carried but loopbacks are allowed and alarm reporting is suppressed. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command. Use OOS-MT for testing or to suppress alarms temporarily. Change the state to IS, OOS, or OOS-AINS when testing is complete.
Green	IS	Port is in service. The port transmits a signal and displays alarms; loopbacks are not allowed.

8.5.1.2 Node View Card Shortcuts

If you move your mouse over cards in the graphic, popups display additional information about the card including the card type; the card status (active or standby); the type of alarm, such as Critical, Major, and Minor (if any); the alarm profile used by the card; and for TXP or MXP cards, the wavelength of the DWDM port. Right-click a card to reveal a shortcut menu, which you can use to open, reset, delete, or change a card. Right-click a slot to preprovision a card (that is, provision a slot before installing the card).

8.5.1.3 Node View Tabs

Table 8-7 lists the tabs and subtabs available in the node view.

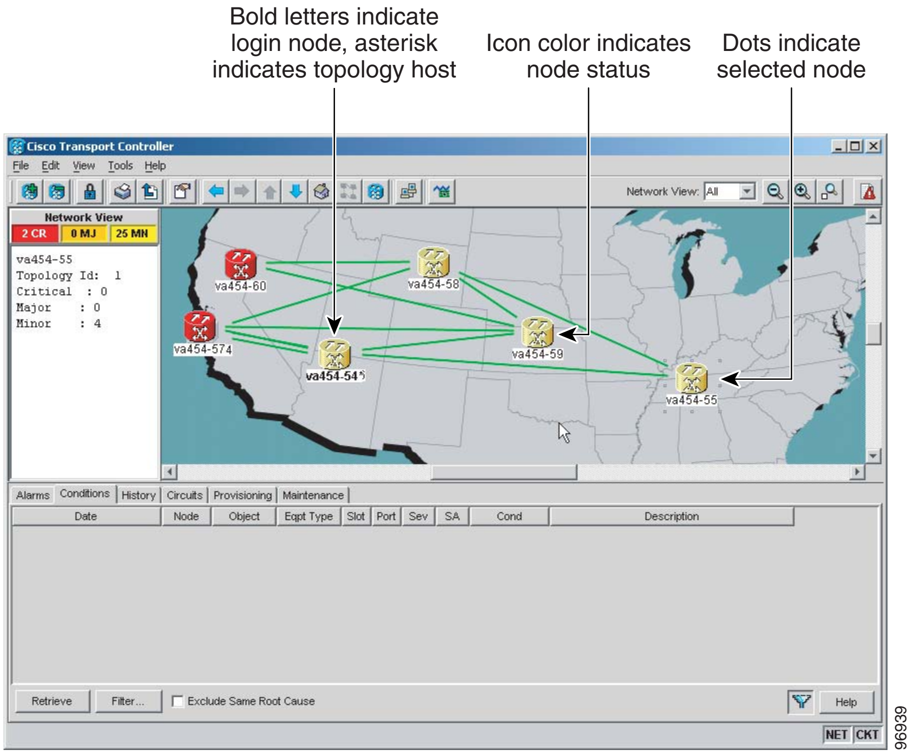
Table 8-7 Node View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the node and updates them in real time.	—
Conditions	Displays a list of standing conditions on the node.	—
History	Provides a history of node alarms including date, type, and severity of each alarm. The Session subtab displays alarms and events for the current session. The Node subtab displays alarms and events retrieved from a fixed-size log on the node.	Session, Node
Circuits	Creates, deletes, edits, and maps circuits.	—
Provisioning	Provisions the ONS 15454 node.	General, Ether Bridge, Network, Protection, BLSR, Security, SNMP, DCC/GCC/OSC, Timing, Alarm Profiles, Defaults, UCP, WDM-ANS
Inventory	Provides inventory information (part number, serial number, CLEI codes) for cards installed in the node. Allows you to delete and reset cards.	—
Maintenance	Performs maintenance tasks for the node.	Database, Ether Bridge, Protection, BLSR, Software, Cross-Connect, Overhead XConnect, Diagnostic, Timing, Audit, Routing Table, RIP Routing Table, Test Access

8.5.2 Network View

Network view allows you to view and manage ONS 15454s that have DCC connections to the node that you logged into and any login node groups you may have selected (Figure 8-4).

Figure 8-4 Network in CTC Network View



Note Nodes with DCC connections to the login node do not appear if you checked the Disable Network Discovery check box in the Login dialog box.

The graphic area displays a background image with colored ONS 15454 icons. A Superuser can set up the logical network view feature, which enables each user to see the same network view.

The lines show DCC connections between the nodes. DCC connections can be green (active) or gray (fail). The lines can also be solid (circuits can be routed through this link) or dashed (circuits cannot be routed through this link).

There are four possible combinations for the appearance of DCCs: green/solid, green/dashed, gray/solid, and gray/dashed. DCC appearance corresponds to the following states: active/routable, active/nonroutable, failed/routable, or failed/nonroutable. Circuit provisioning uses active/routable links. Selecting a node or span in the graphic area displays information about the node and span in the status area.

The color of a node in network view, shown in Table 8-8, indicates the node alarm status.

Table 8-8 Node Status Shown in Network View

Color	Alarm Status
Green	No alarms
Yellow	Minor alarms
Orange	Major alarms

Table 8-8 Node Status Shown in Network View (continued)

Color	Alarm Status
Red	Critical alarms
Gray with Unknown#	Node initializing for the first time (CTC displays Unknown# because CTC has not discovered the name of the node yet)

Table 8-9 lists the tabs and subtabs available in network view.

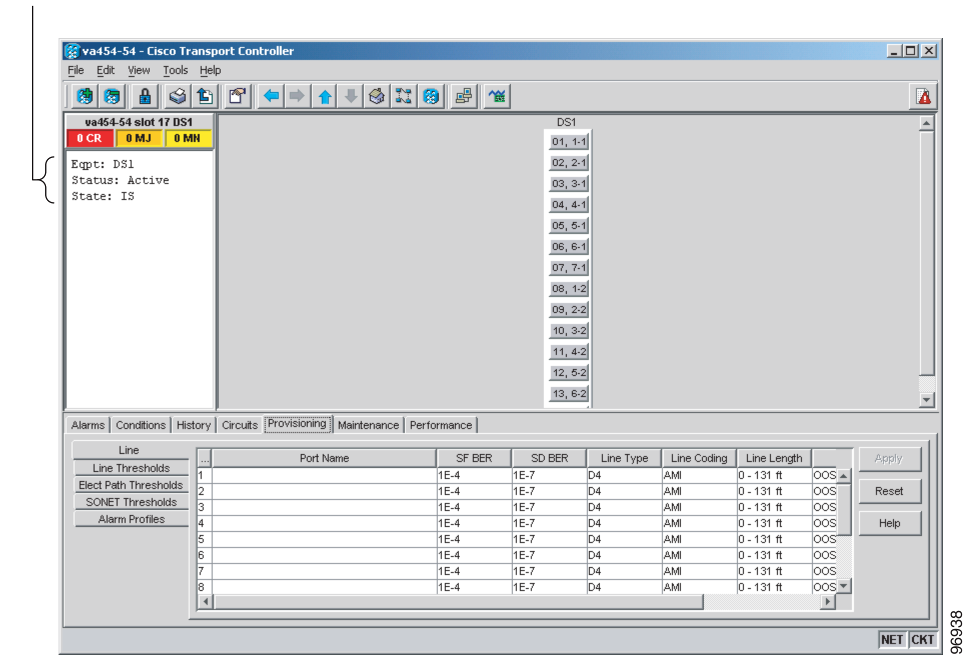
Table 8-9 Network View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the network and updates them in real time.	—
Conditions	Displays a list of standing conditions on the network.	—
History	Provides a history of network alarms including date, type, and severity of each alarm.	—
Circuits	Creates, deletes, edits, filters, and searches for network circuits.	—
Provisioning	Provisions security, alarm profiles, BLSRs, and overhead circuits.	Security, Alarm Profiles, BLSR, Overhead Circuits
Maintenance	Displays the type of equipment and the status of each node in the network; displays working and protect software versions; and allows software to be downloaded.	Software

8.5.3 Card View

Card view provides information about individual ONS 15454 cards. Use this window to perform card-specific maintenance and provisioning (Figure 8-5). A graphic showing the ports on the card is shown in the graphic area. The status area displays the node name, slot, number of alarms, card type, equipment type, and the card status (active or standby), card state (IS, OOS, OOS-AINS, or OOS-MT), or port state (IS, OOS, OOS-AINS, or OOS-MT). The information that appears and the actions you can perform depend on the card.

Figure 8-5 CTC Card View Showing a DS1 Card



> **Note** CTC provides a card view for all ONS 15454 cards except the TCC2, XC, XCVT, and XC10G cards. Provisioning for these common control cards occurs at the node view; therefore, no card view is necessary.

Use the card view tabs and subtabs, shown in Table 8-10, to provision and manage the ONS 15454. The subtabs, fields, and information shown under each tab depend on the card type selected. The Performance tab is not available for the AIC or AIC-I cards.

Table 8-10 Card View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the card and updates them in real time.	—
Conditions	Displays a list of standing conditions on the card.	—
History	Provides a history of card alarms including date, object, port, and severity of each alarm.	Session (displays alarms and events for the current session), Card (displays alarms and events retrieved from a fixed-size log on the card)
Circuits	Creates, deletes, edits, and search circuits.	Circuits

Table 8-10 Card View Tabs and Subtabs (continued)

Tab	Description	Subtabs
Provisioning	Provisions an ONS 15454 card.	DS-N and OC-N cards: Line, Line Thresholds (different threshold options are available for DS-N and OC-N cards), Elect Path Thresholds, SONET Thresholds, or SONET STS, and Alarm Profiles TXP and MXP cards: Card, Line, Line Thresholds (different threshold options are available for electrical and optical cards), Optics Thresholds, OTN, and Alarm Profiles DWDM cards (subtabs depend on card type): Optical Line, Optical Chn, Optical Amplifier, Parameters, Optics Thresholds
Maintenance	Performs maintenance tasks for the card.	Loopback, Info, Protection, J1 Path Trace, AINS Soak (options depend on the card type), Automatic Laser Shutdown (TXP and MXP cards only)
Performance	Performs performance monitoring for the card.	DS-N and OC-N cards: no subtabs TXP and MXP cards: Optics PM, Payload PM, OTN PM DWDM cards (subtabs depend on card type): Optical Line, Optical Chn, Optical Amplifier, Parameters, Optics Thresholds
Inventory	Displays an Inventory screen of the ports (TXP and MXP cards only).	—

8.6 TCC2 Card Reset

You can reset the ONS 15454 TCC2 card by using CTC (a soft reset) or by physically reseating a TCC2 card (a hard reset). A soft reset reboots the TCC2 card and reloads the operating system and the application software. Additionally, a hard reset temporarily removes power from the TCC2 card and clears all buffer memory.

You can apply a soft reset from CTC to either an active or standby TCC2 card without affecting traffic. If you need to perform a hard reset on an active TCC2 card, put the TCC2 card into standby mode first by performing a soft reset.

Note When a CTC reset is performed on an active TCC2 card, the AIC and AIC-I cards go through an initialization process and also resets because the AIC and AIC-I cards are controlled by the active TCC2.

8.7 TCC2 Card Database

When dual TCC2 cards are installed in the ONS 15454, each TCC2 card hosts a separate database; therefore, the protect card database is available if the database on the working TCC2 fails. You can also store a backup version of the database on the workstation running CTC. This operation should be part of a regular ONS 15454 maintenance program at approximately weekly intervals, and should also be completed when preparing an ONS 15454 for a pending natural disaster, such as a flood or fire.

Note The following parameters are not backed up and restored: node name, IP address, mask and gateway, and Internet Inter-ORB Protocol (IIOP) port. If you change the node name and then restore a backed up database with a different node name, the circuits map to the new node name. Cisco recommends keeping a record of the old and new node names.

8.8 Software Revert

When you click the Activate button after a software upgrade, the TCC2 copies the current working database and saves it in a reserved location in the TCC2 flash memory. If you later need to revert to the original working software load from the protect software load, the saved database installs automatically. You do not need to restore the database manually or recreate circuits.

Note The TCC2 card does not carry any software earlier than Software R4.0. You will not be able to revert to a software release earlier than Software R4.0 with TCC2 cards installed.

The revert feature is useful if a maintenance window closes while you are upgrading CTC software. You can revert to the protect software load without losing traffic. When the next maintenance window opens, complete the upgrade and activate the new software load.

Circuits created or provisioning done after a software load is activated (upgraded to a higher release) do not reinstate with a revert (for example, 4.0 to 3.4). The database configuration at the time of activation is reinstated after a revert. This does not apply to maintenance reverts (for example, 2.2.2 to 2.2.1), because maintenance releases use the same database.

CHAPTER 9

Security and Timing

This chapter provides information about Cisco ONS 15454 users and SONET timing. To provision security and timing, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

9.1 Users and Security

The CISCO15 ID is provided with the ONS 15454 system, but this user ID is not prompted when you sign into CTC. This ID can be used to set up other ONS 15454 users. (To do this, complete the “Create Users and Assign Security” procedure in the *Cisco ONS 15454 Procedure Guide*.)

You can have up to 500 user IDs on one ONS 15454. Each Cisco Transport Controller (CTC) or TL1 user can be assigned one of the following security levels:

- Retrieve—Users can retrieve and view CTC information but cannot set or modify parameters.
- Maintenance—Users can access only the ONS 15454 maintenance options.
- Provisioning—Users can access provisioning and maintenance options.
- Superusers—Users can perform all of the functions of the other security levels as well as set names, passwords, and security levels for other users.

By default, multiple concurrent user ID sessions are permitted on the node, that is, multiple users can log into a node using the same user ID. However, you can provision the node to allow only a single login per user and prevent concurrent logins for all users.

Note You must add the same user name and password to each node the user accesses.

9.1.1 Security Requirements

Table 9-1 shows the actions that each user privilege level can perform in node view.

Table 9-1 ONS 15454 Security Levels—Node View

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Alarms	—	Synchronize/Filter/Delete Cleared Alarms	X	X	X	X
Conditions	—	Retrieve/Filter	X	X	X	X
History	Session	Filter	X	X	X	X
	Node	Retrieve/Filter	X	X	X	X
Circuits	—	Create/Edit/Delete	—	Partial[1]	X	X
		Filter/Search	X	X	X	X
Provisioning	General	General: Edit	—	—	Partial[2]	X
		Power Monitor: Edit	—	—	X	X
	EtherBridge	Spanning trees: Edit	—	—	X	X
	Network	General: All	—	—	—	X
		Static Routing: Create/Edit/ Delete	—	—	X	X
		OSPF: Create/Edit/Delete	—	—	X	X
		RIP: Create/Edit/Delete	—	—	X	X
	Protection	Create/Delete/Edit	—	—	X	X
		View	X	X	X	X
	BLSR	All	—	—	X	X
	Security	Users: Create/Change/Delete	—	—	—	X
		Users: Change password	Same user	Same user	Same user	All users
		Active Logins: Logout	—	—	—	X
		Policy: Edit	—	—	—	X
		Access: Edit	—	—	—	X
		Legal Disclaimer: Edit	—	—	—	X
	SNMP	Create/Delete/Edit	—	—	X	X
		Browse trap destinations	X	X	X	X
	DCC/GCC/OSC	SDCC: Create/Edit/Delete	—	—	X	X
		LDCC: Create/Edit/Delete	—	—	X	X
		GCC: Create/Edit/Delete	—	—	X	X
		OSC: Create/Edit/Delete	—	—	X	X
	Timing	Edit	—	—	X	X
	Alarm Profiles	Alarm Profiles: Edit	—	—	X	X
		Alarm Profiles Editor: Load/Store/Compare	—	—	X	X

Table 9-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Provisioning (continued)	Defaults	Edit	—	—	—	X
	UCP	Node: Edit/Provision	—	—	X	X
		Neighbor: Create/Edit/Delete	—	—	X	X
		IPCC: Create/Edit/Delete	—	—	X	X
		Interface: Create/Edit/Delete	—	—	X	X
		Neighbor: Create/Edit/Delete	—	—	X	X
	WDM-ANS	Circuit: Create/Edit/Delete	—	—	X	X
		Connections: Create/Edit/Delete/Commit/ Calculate	—	—	X	X
		Services: Launch	—	—	X	X
		NE update: Edit/Reset/Import/Export	—	—	X	X
Inventory	—	Delete	—	—	X	X
		Reset	—	X	X	X
Maintenance	Database	Backup	—	X	X	X
		Restore	—	—	—	X
	EtherBridge	Spanning Trees: View	X	X	X	X
		MAC Table: Retrieve	X	X	X	X
		MAC Table: Clear/Clear All	—	X	X	X
		Trunk Utilization: Refresh	X	X	X	X
		Circuits: Refresh	X	X	X	X
	Protection	Switch/Lock out operations	—	X	X	X
	BLSR	Ring/Span Switches	—	—	X	X
	Software	Download	—	X	X	X
		Upgrade/Activate/Revert	—	—	—	X
	Cross-Connect	Protection Switches	—	X	X	X
	Overhead XConnect	Read only	—	—	—	—
	Diagnostic	Retrieve/Lamp Test	—	Partial	X	X
	Timing	Source: Edit	—	X	X	X
		Timing Report: View/Refresh	—	X	X	X
	Audit	Retrieve	—	—	—	X
	Routing Table	Read-only	—	—	—	—
	RIP Routing Table	Refresh	X	X	X	X

Table 9-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Maintenance (continued)	Test Access	Read-only	X	X	X	X

1. Maintenance user can edit path protection circuits.
2. Provisioner user cannot change node name, contact, daylight savings, or AIS-V insertion on STS-1 signal degrade (SD) parameters.

Table 9-2 shows the actions that each user privilege level can perform in network view.

Table 9-2 ONS 15454 Security Levels—Network View

CTC Tab	Subtab	[Subtab]: Actions	Retrieve	Maintenance	Provisioning	Superuser
Alarms	—	Synchronize/Filter/Delete cleared alarms	X	X	X	X
Conditions	—	Retrieve/Filter	X	X	X	X
History	—	Filter	X	X	X	X
Circuits	—	Create/Edit/Delete/Filter	—	Partial	X	X
		Search	X	X	X	X
Provisioning	Security	Users: Create/Change/Delete	—	—	—	X
		Active logins: Logout	—	—	—	X
		Policy: Change	—	—	—	X
	Alarm Profiles	Load/Store/Delete	—	—	X	X
		Compare/Available/Usage	—	X	X	X
	BLSR	Create/Delete/Edit/Upgrade	—	—	X	X
Overhead Circuits		Create/Delete/Edit/Merge	—	—	X	X
		Search	X	X	X	X

9.1.2 Security Policies

Users with Superuser security privilege can provision security policies on the ONS 15454. These security policies include idle user timeouts, password changes, password aging, and user lockout parameters. In addition, a Superuser can access the ONS 15454 through the TCC2 RJ-45 port, the backplane LAN connection, or both.

9.1.2.1 Idle User Timeout

Each ONS 15454 CTC or TL1 user can be idle during his or her login session for a specified amount of time before the CTC window is locked. The lockouts prevent unauthorized users from making changes. Higher-level users have shorter default idle periods and lower-level users have longer or unlimited default idle periods, as shown in Table 9-3. The user idle period can be modified by a Superuser; refer to the *Cisco ONS 15454 Procedure Guide* for instructions.

Table 9-3 ONS 15454 Default User Idle Times

Security Level	Idle Time
Superuser	15 minutes
Provisioning	30 minutes
Maintenance	60 minutes
Retrieve	Unlimited

9.1.2.2 User Password, Login, and Access Policies

Superusers can view real-time lists of users who are logged into CTC or TL1 user logins by node. Superusers can also provision the following password, login, and node access policies.

- Password expirations and reuse—Superusers can specify when users must change and when they can reuse their passwords.
- Locking out and disabling users—Superusers can provision the number of invalid logins that are allowed before locking out users and the length of time before inactive users are disabled.
- Node access and user sessions—Superusers can limit the number of CTC sessions one user can have, and they can prohibit access to the ONS 15454 using the LAN or TCC2 RJ-45 connections.

  In addition, a Superuser can select secure shell (SSH) instead of Telnet at the CTC Provisioning > Security > Access tabs. SSH is a terminal-remote host Internet protocol that uses encrypted links. It provides authentication and secure communication over unsecure channels. Port 22 is the default port and cannot be changed.

Note The superuser cannot modify the privilege level of an active user. The CTC displays a warning message when the superuser attempts to modify the privilege level of an active user.

9.1.2.3 Audit Trail

The ONS 15454 maintains a 640-entry, human-readable audit trail of user or system actions such as login, logout, circuit creation or deletion, and user- or system-generated actions. You can move the log to a local or network drive for later review. The ONS 15454 generates an event to indicate when the when the log is 80 percent full, and another event to indicate that the oldest log entries are being overwritten.

9.2 Node Timing

SONET timing parameters must be set for each ONS 15454. Each ONS 15454 independently accepts its timing reference from one of three sources:

- The building integrated timing supply (BITS) pins on the ONS 15454 backplane.
- An OC-N card installed in the ONS 15454. The card is connected to a node that receives timing through a BITS source.
- The internal ST3 clock on the TCC2 card.

You can set ONS 15454 timing to one of three modes: external, line, or mixed. If timing is coming from the BITS pins, set ONS 15454 timing to external. If the timing comes from an OC-N card, set the timing to line. In typical ONS 15454 networks:

- One node is set to external. The external node derives its timing from a BITS source wired to the BITS backplane pins. The BITS source, in turn, derives its timing from a primary reference source (PRS) such as a Stratum 1 clock or global positioning satellite (GPS) signal.
- The other nodes are set to line. The line nodes derive timing from the externally timed node through the OC-N trunk (span) cards.

You can set three timing references for each ONS 15454. The first two references are typically two BITS-level sources, or two line-level sources optically connected to a node with a BITS source. The third reference is usually assigned to the internal clock provided on every ONS 15454 TCC2 card. However, if you assign all three references to other timing sources, the internal clock is always available as a backup timing reference. The internal clock is a Stratum 3 (ST3), so if an ONS 15454 node becomes isolated, timing is maintained at the ST3 level.

The CTC Maintenance > Timing > Report tabs show current timing information for an ONS 15454, including the timing mode, clock state and status, switch type, and reference data.

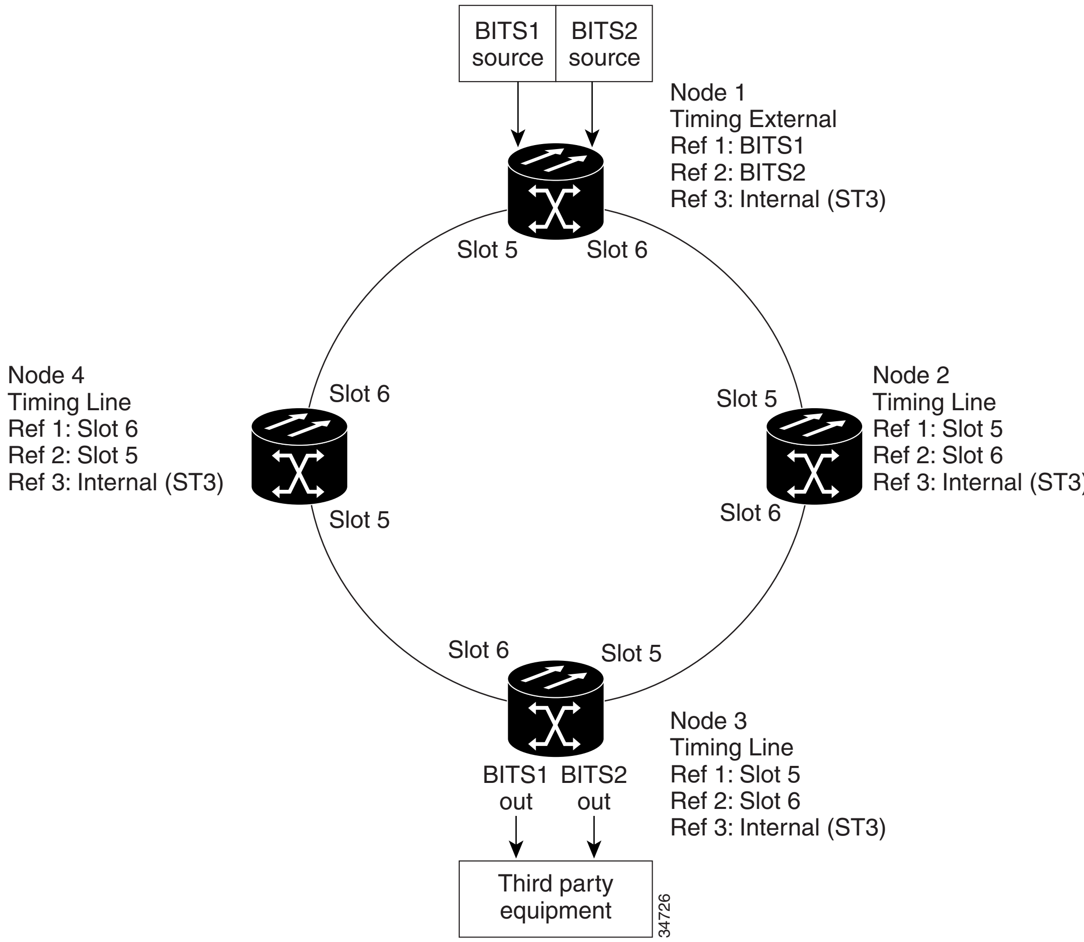
Caution Mixed timing allows you to select both external and line timing sources. However, Cisco does not recommend its use because it can create timing loops. Use this mode with caution.

9.2.1 Network Timing Example

Figure 9-1 shows an ONS 15454 network timing setup example. Node 1 is set to external timing. Two timing references are set to BITS. These are Stratum 1 timing sources wired to the BITS input pins on the Node 1 backplane. The third reference is set to internal clock. The BITS output pins on the backplane of Node 3 are used to provide timing to outside equipment, such as a digital access line access multiplexer.

In the example, Slots 5 and 6 contain the trunk (span) cards. Timing at Nodes 2, 3, and 4 is set to line, and the timing references are set to the trunk cards based on distance from the BITS source. Reference 1 is set to the trunk card closest to the BITS source. At Node 2, Reference 1 is Slot 5 because it is connected to Node 1. At Node 4, Reference 1 is set to Slot 6 because it is connected to Node 1. At Node 3, Reference 1 could be either trunk card because they are equal distance from Node 1.

Figure 9-1 ONS 15454 Timing Example



9.2.2 Synchronization Status Messaging

Synchronization status messaging (SSM) is a SONET protocol that communicates information about the quality of the timing source. SSM messages are carried on the S1 byte of the SONET Line layer. They enable SONET devices to automatically select the highest quality timing reference and to avoid timing loops.

SSM messages are either Generation 1 or Generation 2. Generation 1 is the first and most widely deployed SSM message set. Generation 2 is a newer version. If you enable SSM for the ONS 15454, consult your timing reference documentation to determine which message set to use. Table 9-4 and Table 9-5 on page 9-8 show the Generation 1 and Generation 2 message sets.

Table 9-4 SSM Generation 1 Message Set

Message	Quality	Description
PRS	1	Primary reference source—Stratum 1
STU	2	Synchronization traceability unknown
ST2	3	Stratum 2

Table 9-4 SSM Generation 1 Message Set (continued)

Message	Quality	Description
ST3	4	Stratum 3
SMC	5	SONET minimum clock
ST4	6	Stratum 4
DUS	7	Do not use for timing synchronization
RES		Reserved; quality level set by user

Table 9-5 SSM Generation 2 Message Set

Message	Quality	Description
PRS	1	Primary reference source—Stratum 1
STU	2	Synchronization traceability unknown
ST2	3	Stratum 2
TNC	4	Transit node clock
ST3E	5	Stratum 3E
ST3	6	Stratum 3
SMC	7	SONET minimum clock
ST4	8	Stratum 4
DUS	9	Do not use for timing synchronization
RES		Reserved; quality level set by user

CHAPTER 10

Circuits and Tunnels

This chapter explains Cisco ONS 15454 STS, virtual tributary (VT), and virtual concatenated (VCAT) circuits and VT, data communications channel (DCC), and IP-encapsulated tunnels. To provision circuits and tunnels, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

10.1 Overview

On an ONS 15454, you can create unidirectional and bidirectional circuits. For path protection circuits, you can create revertive or nonrevertive circuits. Circuits are routed automatically or you can manually route them. With the autorange feature, you do not need to individually build multiple circuits of the same type; CTC can create additional sequential circuits if you specify the number of circuits you need and build the first circuit.

You can provision circuits at any of the following points:

- Before cards are installed. The ONS 15454 allows you to provision slots and circuits before installing the traffic cards. (To provision an empty slot, right-click it and choose a card from the shortcut menu.) However, circuits cannot carry traffic until you install the cards and place their ports in service. For card installation procedures and ring-related procedures, refer to the *Cisco ONS 15454 Procedure Guide.*
- After cards are installed, but before their ports are in service (enabled). You must place the ports in service before circuits can carry traffic.
- After cards are installed and their ports are in service. Circuits carry traffic as soon as the signal is received.

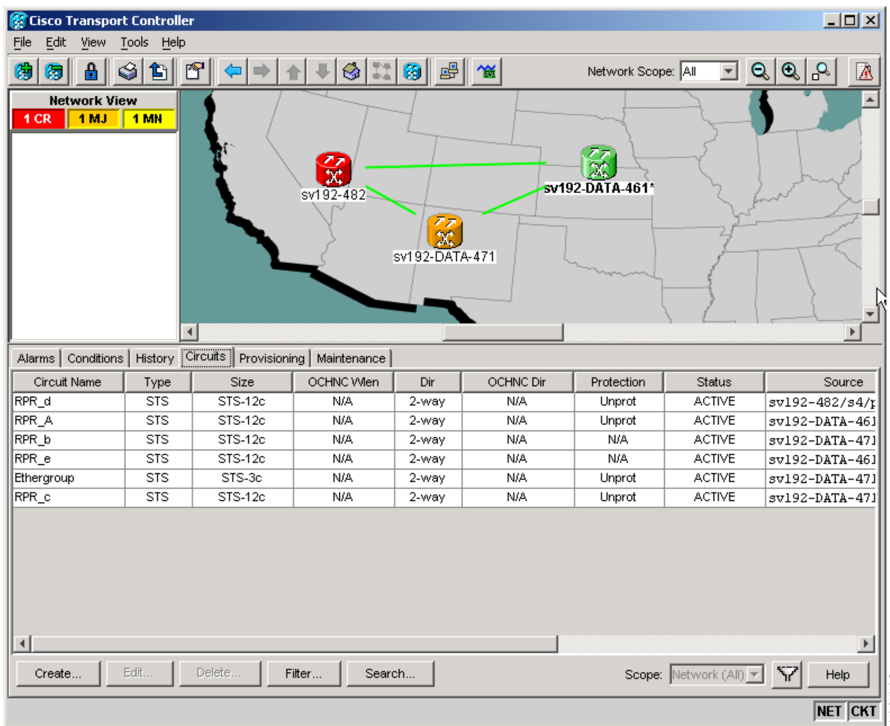
10.2 Circuit Properties

The ONS 15454 Circuits window, which appears in network, node, and card view, is where you can view information about circuits. The Circuits window (Figure 10-1) displays the following information:

- Name—The name of the circuit. The circuit name can be manually assigned or automatically generated.
- Type—The circuit types are STS (STS circuit), VT (VT circuit), VTT (VT tunnel), VAP (VT aggregation point), OCHNC (dense wavelength division multiplexing [DWDM] optical channel network connection), or STS-V (STS virtual concatenated [VCAT] circuit).
- Size—The circuit size. VT circuits are 1.5. STS circuit sizes are 1, 3c, 6c, 9c, 12c, 24c, 36c, 48c, 192c. OCHNC sizes are Equipped non specific, Multi-rate, 2.5 Gbps No FEC (forward error correction), 2.5 Gbps FEC, 10 Gbps No FEC, and 10 Gbps FEC. VCAT circuits are STS-1-2v, STS-3c-2v, and STS-12c-2v.
- OCHNC Wlen—For OCHNCs, the wavelength provisioned for the optical channel network connection.
- Direction—The circuit direction, either two-way or one-way.
- OCHNC Dir—For OCHNCs, the direction of the optical channel network connection, either east to west or west to east.
- Protection—The type of circuit protection. See the "10.2.3 Circuit Protection Types" section on page 10-6 for a list of protection types.
- Status—The circuit status. See the "10.2.1 Circuit Status" section on page 10-3.
- Source—The circuit source in the format: node/slot/port "port name"/STS/VT. (The port name appears in quotes.) Node and slot always appear; port "port name"/STS/VT might appear, depending on the source card, circuit type, and whether a name is assigned to the port. If the circuit size is a concatenated size (3c, 6c, 12c, etc.), STSs used in the circuit are indicated by an ellipsis, for example, S7..9, (STSs 7, 8, and 9) or S10..12 (STS 10, 11, and 12).

- Destination—The circuit destination in same format (node/slot/port “port name”/STS/VT) as the circuit source.
- # of VLANS—The number of VLANS used by an Ethernet circuit.
- # of Spans—The number of inter-node links that constitute the circuit. Right-clicking the column displays a shortcut menu from which you can choose to show or hide circuit span detail.
- State—The circuit state. See the “10.2.2 Circuit States” section on page 10-5.

Figure 10-1 ONS 15454 Circuit Window in Network View



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10.2.1 Circuit Status

The circuit statuses that appear in the Circuit window Status column are generated by CTC based on conditions along the circuit path. Table 10-1 shows the statuses that can appear in the Status column.

Table 10-1 ONS 15454 Circuit Status

Status	Definition/Activity
CREATING	CTC is creating a circuit.
ACTIVE	CTC created a circuit. All components are in place and a complete path exists from circuit source to destination.
DELETING	CTC is deleting a circuit.

Table 10-1 ONS 15454 Circuit Status (continued)

Status	Definition/Activity
INCOMPLETE	A CTC-created circuit is missing a cross-connect or network span, a complete path from source to destination(s) does not exist, or an Alarm Interface Panel (AIP) change occurred on one of the circuit nodes and the circuit is in need of repair. (AIPs store the node MAC address.) In CTC, circuits are represented using cross-connects and network spans. If a network span is missing from a circuit, the circuit status is INCOMPLETE. However, an INCOMPLETE status does not necessarily mean a circuit traffic failure has occurred, because traffic may flow on a protect path. Network spans are in one of two states: up or down. On CTC circuit and network maps, up spans appear as green lines, and down spans appear as gray lines. If a failure occurs on a network span during a CTC session, the span remains on the network map but its color changes to gray to indicate that the span is down. If you restart your CTC session while the failure is active, the new CTC session cannot discover the span and its span line does not appear on the network map. Subsequently, circuits routed on a network span that goes down appear as ACTIVE during the current CTC session, but appear as INCOMPLETE to users who log in after the span failure. INCOMPLETE status does not apply to OCHNC circuit types.
UPGRADABLE	A TL1-created circuit or a TL1-like, CTC-created circuit is complete and has upgradable cross-connects. A complete path from source to destination(s) exists. The circuit can be upgraded. This status does not apply to OCHNC circuit types.
INCOMPLETE_UPGRADABLE	A TL1-created circuit or a TL1-like, CTC-created circuit with upgradable cross-connects is missing a cross-connect or circuit span (network link), and a complete path from source to destination(s) does not exist. The circuit cannot be upgraded until missing components are in place. This status does not apply to OCHNC circuit types.
NOT_UPGRADABLE	A TL1-created circuit or a TL1-like, CTC-created circuit is complete but has at least one non-upgradable cross-connect. UPSR_HEAD, UPSR_EN, UPSR_DC, and UPSR_DROP connections are not upgradable, so all path protection circuits created with TL1 are not upgradable. This status does not apply to OCHNC circuit types.
INCOMPLETE_NOT_UPGRADABLE	A TL1-created circuit or a TL1-like CTC-created circuit with one or more nonupgradable cross-connects is missing a cross-connect or circuit span (network link); a complete path from source to destination(s) does not exist. This status does not apply to OCHNC circuit types.

10.2.2 Circuit States

State is a user-assigned designation that indicates whether the circuit should be in service or out of service. Table 10-2 lists the states that you can assign to circuits. To carry traffic, circuits must have a status of Active and a state of IS, OOS-AINS, or OOS-MT. The circuit source port and destination port must also be IS, OOS-AINS, or OOS-MT.

Note OOS-AINS and OOS-MT allow a signal to be carried, although alarm reporting is suppressed.

You can assign a state to circuits at two points:

- During circuit creation, you can assign a state to the circuit on the Create Circuit wizard.
- After circuit creation, you can change a circuit state on the Edit Circuit window or from the Tools > Circuits > Set Circuit State menu.

Table 10-2 Circuit States

State	Definition
IS	In Service; able to carry traffic.
OOS	Out of Service; unable to carry traffic. This state does not apply to OCHNC circuit types.
OOS-AINS	Out of Service, Auto In Service; alarm reporting is suppressed, but traffic is carried and loopbacks are allowed. Raised fault conditions, whether their alarms are reported or not, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command. VT circuits in OOS-AINS generally switch to IS when source and destination ports are IS, OOS-AINS, or OOS-MT regardless of whether a physical signal is present. STS circuits in OOS-AINS switch to IS when a signal is received. This state does not apply to OCHNC circuit types.
OOS-MT	Out of Service, Maintenance; alarm reporting is suppressed, but traffic is carried and loopbacks are allowed. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command. This state does not apply to OCHNC circuit types.

PARTIAL is appended to a circuit state whenever all circuit cross-connects are not in the same state. Table 10-3 shows the partial circuit states that can appear. Partial circuit states do not apply to OCHNC circuit types.

Table 10-3 Partial Circuit States

State	Definition
OOS-PARTIAL	At least one connection is OOS and at least one other is in a different state.
OOS-AINS-PARTIAL	At least one connection is OOS-AINS and at least one other is in IS state.
OOS-MT-PARTIAL	At least one connection is OOS-MT and at least one other is a different state (other than OOS).

PARTIAL states can occur during automatic or manual transitions between states. OOS-AINS-PARTIAL appears if you assign OOS-AINS to a circuit with DS-1 or DS3XM cards as the source or destination. Some cross-connects transition to IS, while others are OOS-AINS. PARTIAL can appear during a manual transition caused by an abnormal event such as a CTC crash or communication error, or if one of the cross-connects could not be changed. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for troubleshooting procedures.

Circuits do not use the soak timer for transitional states, but ports do. The soak period is the amount of time that the port remains in the OOS-AINS state after a signal is continuously received. When provisioned as OOS-AINS, the ONS 15454 monitors a circuit's cross-connects for an error-free signal. It changes the state of the circuit from OOS-AINS to IS or to AINS-partial as each cross-connect assigned to the circuit path is completed. This allows you to provision a circuit using TL1, verify its path continuity, and prepare the port to go into service when it receives an error-free signal for the time specified in the port soak timer. Two common examples of state changes you see when provisioning DS-1 and DS-3 circuits using CTC are:

- When provisioning VT1.5 circuits and VT tunnels as OOS-AINS, the circuit state transitions to IS shortly after the circuits are created when the circuit source and destination ports are IS, OOS-AINS, or OOS-MT. The source and destination ports on the VT1.5 circuits remain in the OOS-AINS state until an alarm-free signal is received for the duration of the soak timer. When the soak timer expires, the VT1.5 source port and destination port states change to IS.
- When provisioning STS circuits as OOS-AINS, the circuit source and destination ports are OOS-AINS. As soon as an alarm-free signal is received the circuit state changes to IS and the source and destination ports remain OOS-AINS for the duration of the soak timer. After the port soak timer expires, STS source and destination ports change to IS.

To find the remaining port OOS-AINS soak time, choose the Maintenance > AINS Soak tabs in card view and click the Retrieve button. If the port is in the OOS-AINS state and has a good signal, the Time Until IS column shows the soak count down status. If the port is OOS-AINS and has a bad signal, the Time Until IS column indicates that the signal is bad. You must click the Retrieve button to obtain the latest time value.

10.2.3 Circuit Protection Types

The Protection column on the Circuit window shows the card (line) and SONET topology (path) protection used for the entire circuit path. Table 10-4 shows the protection type indicators that appear in this column.

Table 10-4 Circuit Protection Types

Protection Type	Description
—	Circuit protection is not applicable.
2F BLSR	The circuit is protected by a two-fiber bidirectional line switched ring (BLSR).
4F BLSR	The circuit is protected by a four-fiber BLSR.
BLSR	The circuit is protected by a both a two-fiber and a four-fiber BLSR.
Path Protection	The circuit is protected by a path protection.
Path Protection-DRI	The circuit is protected by a path protection dual ring interconnection
1+1	The circuit is protected by a 1+1 protection group.
Y-Cable	The circuit is protected by a transponder or muxponder card Y-cable protection group.
Protected	The circuit is protected by diverse SONET topologies, for example, a BLSR and a path protection, or a path protection and 1+1.

Table 10-4 Circuit Protection Types (continued)

Protection Type	Description
2F-PCA	The circuit is routed on a protection channel access (PCA) path on a two-fiber BLSR. PCA circuits are unprotected.
4F-PCA	The circuit is routed on a protection channel access path on a four-fiber BLSR. PCA circuits are unprotected.
PCA	The circuit is routed on a protection channel access path on both two-fiber and four-fiber BLSRs. PCA circuits are unprotected.
Unprot (black)	The circuit is not protected.
Unprot (red)	A circuit created as a fully-protected circuit is no longer protected due to a system change, such as a traffic switch.
Unknown	The circuit protection types appear in the Protection column only when all circuit components are known, that is, when the circuit status is ACTIVE or UPGRADABLE. If the circuit is in some other status, the protection type appears as "unknown."

10.2.4 Circuit Information in the Edit Circuit Window

The detailed circuit map on the Edit Circuit window allows you to view information about ONS 15454 circuits. Routing information that appears includes:

- Circuit direction (unidirectional/bidirectional)
- The nodes, STSs, and VTs through which a circuit passes, including slots and port numbers
- The circuit source and destination points
- OSPF Area IDs
- Link protection (path protection, unprotected, BLSR, 1+1) and bandwidth (OC-N)

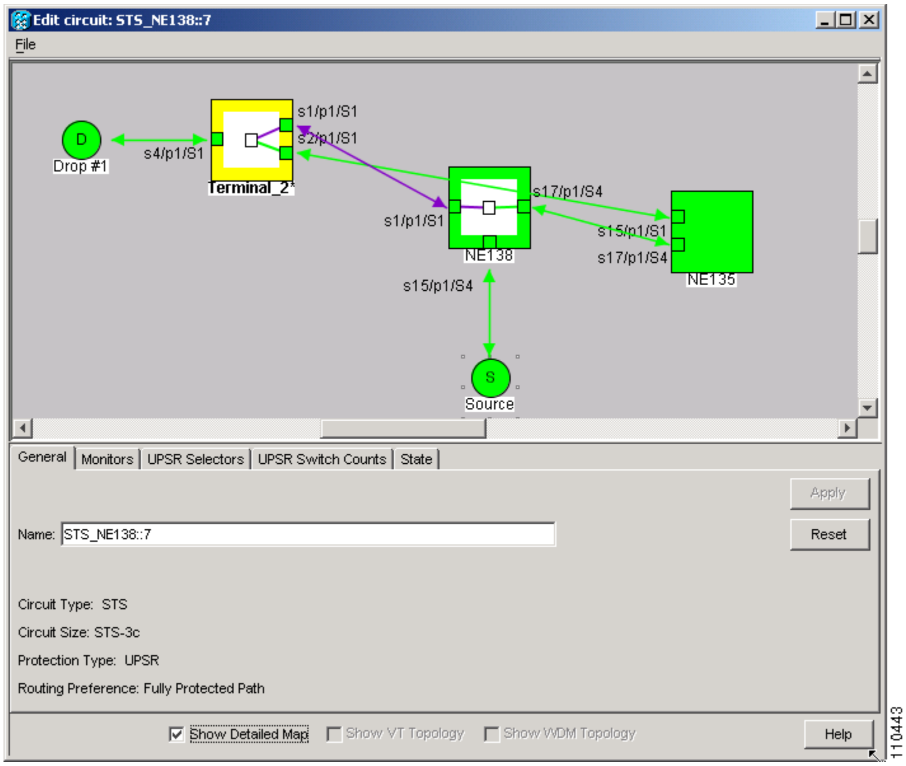
For BLSRs, the detailed map shows the number of BLSR fibers and the BLSR ring ID. For path protections, the map shows the active and standby paths from circuit source to destination, and it also shows the working and protect paths. For VCAT circuits, the detailed map is not available for an entire VCAT circuit. However, you can view the detailed map to view the circuit route for each individual member.

You can also view alarms and states on the circuit map, including:

- Alarm states of nodes on the circuit route
- Number of alarms on each node organized by severity
- Port service states on the circuit route
- Alarm state/color of most severe alarm on port
- Loopbacks
- Path trace states
- Path selector states

Figure 10-2 shows a bidirectional STS circuit routed on a path protection.

Figure 10-2 Path Protection Circuit Displayed on the Detailed Circuit Map



By default, the working path is indicated by a green, bidirectional arrow, and the protect path is indicated by a purple, bidirectional arrow. Source and destination ports are shown as circles with an S and D. Port states are indicated by colors, shown in Table 10-5.

Table 10-5 Port State Color Indicators

Port Color	State
Green	IS
Gray	OOS
Purple	OOS-AINS
Cyan (Blue)	OOS-MT

A notation within or by the squares in detailed view indicates switches and loopbacks, including:

- F = Force switch
- M = Manual switch
- L = Lockout switch
- T = Terminal loopback
- Arrow = Facility loopback

Move the mouse cursor over nodes, ports, and spans to see tooltips with information including the number of alarms on a node (organized by severity), a port's state of service (IS, OOS, etc.), and the protection topology.

Right-click a node, port, or span on the detailed circuit map to initiate certain circuit actions:

- Right-click a unidirectional circuit destination node to add a drop to the circuit.
- Right-click a port containing a path-trace-capable card to initiate the path trace.
- Right-click a path protection span to change the state of the path selectors in the path protection circuit.

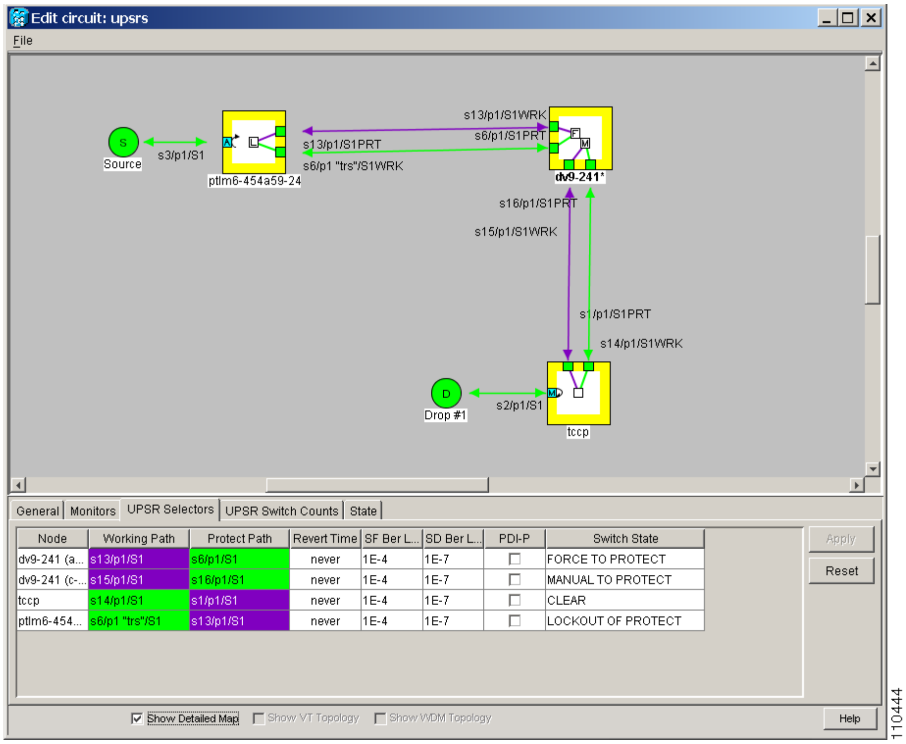
Figure 10-3 on page 10-10 shows an example of the information that can appear. From this example, you can determine:

- The circuit has one source and one destination.
- The circuit has three nodes in its route; the state of the most severe alarm can be determined by the color of the node icons. For example, yellow indicates that the most severe alarm is minor in severity.
- The STSs and ports that the circuit passes through from source to destination.
- The port states and severity of the most severe alarm on each port.
- A facility loopback exists on the port at one end of the circuit; a terminal loopback exists at the other end port.
- An automatic path trace exists on one STS end of the circuit; a manual path trace exists at the other STS end.
- The circuit is path protection-protected (by path selectors). One path selector has a Lockout, one has a Force switch, one has a Manual switch, and the others are free of external switching commands.
- The working path (green) flows from ptlm6-454a59-24/s6/p1/S1 to dv9-241/s6/p1/S1, and from dv9-241/s16/p1/S1 to tccp/s14/p1/vc3-3. The protect path (purple) is also visible.
- On ptlm6-454a59-24 and tccp, the working path is active; on dv9-241, the protect path is active.

From the example, you could:

- Display any port or node view.
- Edit the path trace states of any port that supports path trace.
- Change the path selector state of any path protection path selector.

Figure 10-3 Detailed Circuit Map Showing a Terminal Loopback



Node	Working Path	Protect Path	Revert Time	SF Ber L...	SD Ber L...	PDI-P	Switch State
dv9-241 (a...	s13/p1/S1	s6/p1/S1	never	1E-4	1E-7	☐	FORCE TO PROTECT
dv9-241 (c-...	s15/p1/S1	s16/p1/S1	never	1E-4	1E-7	☐	MANUAL TO PROTECT
tccp	s14/p1/S1	s1/p1/S1	never	1E-4	1E-7	☐	CLEAR
ptlm6-454...	s6/p1 "trs"/S1	s13/p1/S1	never	1E-4	1E-7	☐	LOCKOUT OF PROTECT

10.3 Cross-Connect Card Bandwidth

The ONS 15454 XC, XCVT, and XC10G cross-connect cards perform port-to-port, time-division multiplexing (TDM). XC cards perform STS multiplexing only. XCVT and XC10G cards perform STS and VT1.5 multiplexing.

The STS matrix on the XC and XCVT cross-connect cards has a capacity for 288 STS terminations, and the XC10G has a capacity for 1152 STS terminations. Because each STS circuit requires a minimum of two terminations, one for ingress and one for egress, the XC and XCVT have a capacity for 144 STS circuits, and the XC10G has a capacity for 576 STS circuits. However, this capacity is reduced at path protection and 1+1 nodes because three STS terminations are required at circuit source and destination nodes and four terminations are required at 1+1 circuit pass-through nodes. Path Protection pass-through nodes only require two STS terminations.

The XCVT and XC10G cards perform VT1.5 multiplexing through 24 logical STS ports on the XCVT or XC10G VT matrix. Each logical STS port can carry 28 VT1.5s. Subsequently, the VT matrix has capacity for 672 VT1.5s terminations, or 336 VT1.5 circuits, because every circuit requires two terminations, one for ingress and one for egress. However, this capacity is only achievable if:

- Every STS port on the VT matrix carries 28 VT1.5s.
- The node is in a BLSR.

For example, if you create a VT1.5 circuit from STS-1 on a drop card and a second VT1.5 circuit from STS-2, two VT matrix STS ports are used, as shown in Figure 10-4. If you create a second VT1.5 circuit from the same STS port on the drop card, no additional logical STS ports are used on the VT matrix. However, if the next VT1.5 circuit originates on a different STS, a second STS port on the VT matrix is used, as shown in Figure 10-5. If you continued to create VT1.5 circuits on a different EC-1 STSs and mapped each to an unused outbound STS, the VT matrix capacity would be reached after you created 12 VT1.5 circuits.

Figure 10-4 One VT1.5 Circuit on One STS

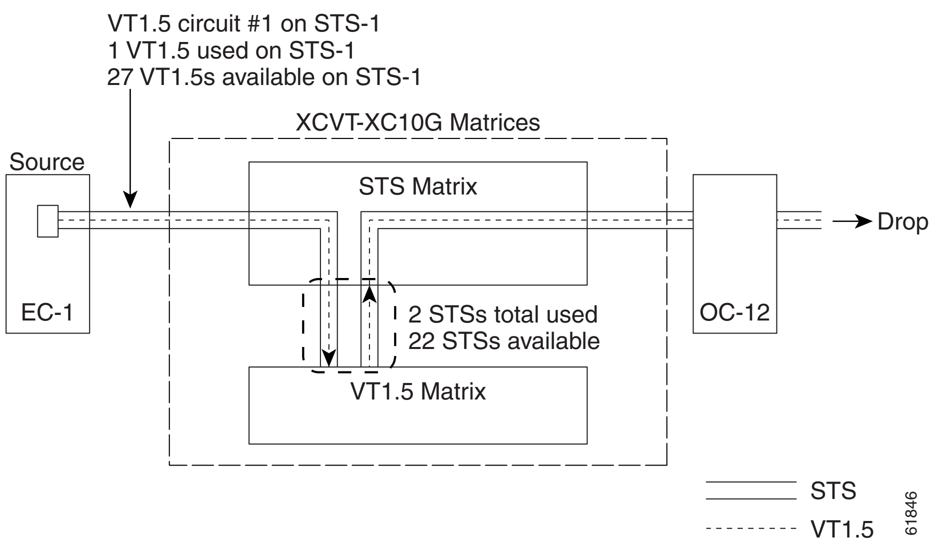
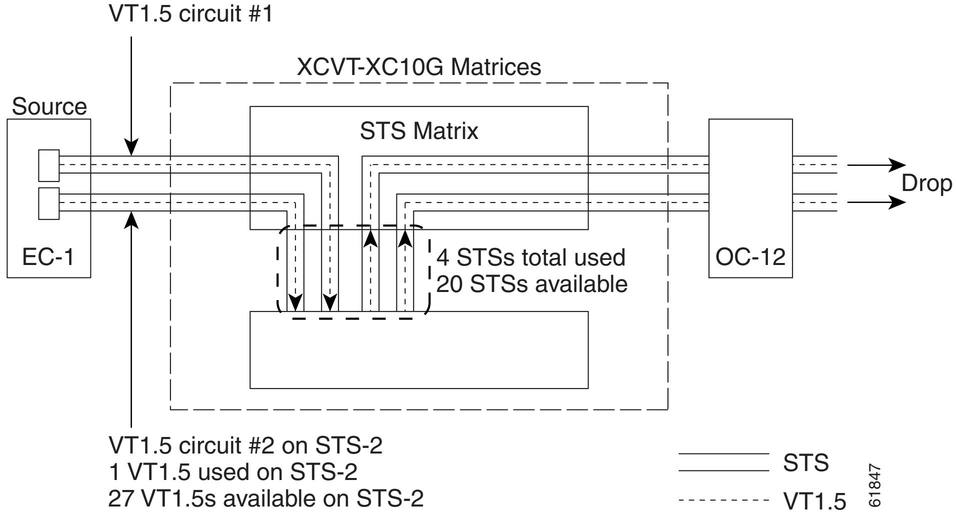


Figure 10-5 Two VT1.5 Circuits in a BLSR



Note Circuits with DS1-14 and DS1N-14 circuit sources or destinations use one STS port on the VT matrix. Because you can only create 14 VT1.5 circuits from the DS-1 cards, 14 VT1.4s are unused on the VT matrix.

VT matrix capacity is also affected by SONET protection topology and node position within the circuit path. Matrix usage is slightly higher for path protection and 1+1 nodes than BLSR nodes. Circuits use two VT matrix ports at pass-through nodes if VT tunnels and aggregation points are not used. If the circuit is routed on a VT tunnel or an aggregation point, no VT matrix resources are used. Table 10-6 shows basic STS port usage rates for VT 1.5 circuits.

Table 10-6 VT Matrix Port Usage for One VT1.5 Circuit

Node Type	No Protection	BLSR	Path Protection	1+1
Circuit source or destination node	2	2	3	3
Circuit pass-through node without VT tunnel	2	2	2	4
Circuit pass-through node with VT tunnel	0	0	0	0

Cross-connect card resources can be viewed on the Maintenance > Cross-Connect > Resource Usage tabs. This tab shows:

- STS-1 Matrix—The percent of STS matrix resources that are used. 288 STSs are available on XC and XCVT cards; 1152 are available on XC10G cards.
- VT Matrix Ports—The percent of the VT matrix ports (logical STS ports) that are used. No ports are available on XC cards; 24 are available on XCVT and XC10G cards. The VT Port Matrix Detail shows the percent of each VT matrix port that is used.
- VT Matrix—The percent of the total VT matrix terminations that are used. There are 672 terminations, which is the number of logical STS VT matrix ports (24) multiplied by the number of VT1.5s per port (28).

To maximize resources on the cross-connect card VT matrix, keep the following points in mind as you provision circuits:

- Use all 28 VT1.5s on a given port or STS before moving to the next port or STS.
- Try to use EC-1, DS3XM, or OC-N cards as the VT1.5 circuit source and destination. VT1.5 circuits with DS-1-14 or DS1N-14 sources or destinations use a full port on the VT matrix even though only 14 VT1.5 circuits can be created.
- Use VT tunnels and VT aggregation points to reduce VT matrix utilization. VT tunnels allow VT1.5 circuits to bypass the VT matrix on pass-through nodes. They are cross-connected as an STS and only go through the STS matrix. VT aggregation points allow multiple VT1.5 circuits to be aggregated onto a single STS to bypass the VT matrix at the aggregation node.

10.4 DCC Tunnels

SONET provides four DCCs for network element operations, administration, maintenance, and provisioning: one on the SONET Section layer (DCC1) and three on the SONET Line layer (DCC2, DCC3, and DCC4). The ONS 15454 uses the section DCC for ONS 15454 management and provisioning. A section DCC (SDCC) and line DCC (LDCC) each provide 192 Kbps of bandwidth per channel. The aggregate bandwidth of the three LDCCs is 576 Kbps. When multiple DCC channels exist between two neighboring nodes, the ONS 15454 balances traffic over the existing DCC channels using a load balancing algorithm. This algorithm chooses a DCC for packet transport by considering packet size and DCC utilization.

You can tunnel third-party SONET equipment across ONS 15454 networks using one of two tunneling methods, a traditional DCC tunnel or an IP-encapsulated tunnel.

10.4.1 Traditional DCC Tunnels

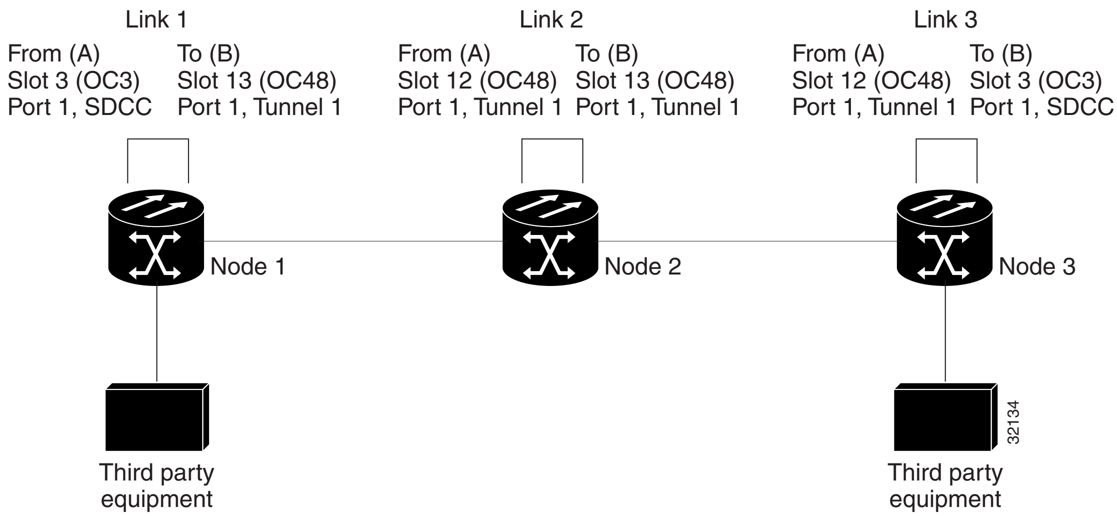
In traditional DCC tunnels, you can use the three line DCCs and the section DCC (when not used for ONS 15454 DCC terminations). A traditional DCC tunnel endpoint is defined by slot, port, and DCC, where DCC can be either the section DCC or one of the line DCCs. You can link line DCCs to line DCCs and link section DCCs to section DCCs. You can also link a section DCC to an line DCC, and a line DCC to a section DCC. To create a DCC tunnel, you connect the tunnel endpoints from one ONS 15454 optical port to another. Cisco recommends a maximum of 84 DCC tunnel connections for an ONS 15454. Table 10-7 shows the DCC tunnels that you can create using different OC-N cards.

Table 10-7 DCC Tunnels

Card	DCC	SONET Layer	SONET Bytes
OC3 IR 4/STM1 SH 1310	DCC1	Section	D1 - D3
OC3 IR/STM1 SH 1310-8; All OC-12, OC-48, OC-192 Cards	DCC1	Section	D1 - D3
	DCC2	Line	D4 - D6
	DCC3	Line	D7 - D9
	DCC4	Line	D10 - D12

Figure 10-6 shows a DCC tunnel example. Third-party equipment is connected to OC-3 cards at Node 1/Slot 3/Port 1 and Node 3/Slot 3/Port 1. Each ONS 15454 node is connected by OC-48 trunk (span) cards. In the example, three tunnel connections are created, one at Node 1 (OC-3 to OC-48), one at Node 2 (OC-48 to OC-48), and one at Node 3 (OC-48 to OC-3).

Figure 10-6 Traditional DCC Tunnel



When you create DCC tunnels, keep the following guidelines in mind:

- Each ONS 15454 can have up to 84 DCC tunnel connections.
- Each ONS 15454 can have up to 84 Section DCC terminations.
- A section DCC that is terminated cannot be used as a DCC tunnel endpoint.
- A section DCC that is used as an DCC tunnel endpoint cannot be terminated.
- All DCC tunnel connections are bidirectional.

10.4.2 IP-Encapsulated Tunnels

An IP-encapsulated tunnel puts a section DCC in an IP packet at a source node and dynamically routes the packet to a destination node. To compare traditional DCC tunnels with IP-encapsulated tunnels, a traditional DCC tunnel is configured as one dedicated path across a network and does not provide a failure recovery mechanism if the path is down. An IP-encapsulated tunnel is a virtual path, which adds protection when traffic travels between different networks.

IP-encapsulated tunneling has the potential of flooding the DCC network with traffic resulting in a degradation of performance for CTC. The data originating from an IP tunnel can be throttled to a user-specified rate, which is a percentage of the total SDCC bandwidth.

Each ONS 15454 supports up to ten IP-encapsulated tunnels. You can convert a traditional DCC tunnel to an IP-encapsulated tunnel or an IP-encapsulated tunnel to a traditional DCC tunnel. Only tunnels in the Active state can be converted.

Caution Converting from one tunnel type to the other is service-affecting.

10.5 Multiple Destinations for Unidirectional Circuits

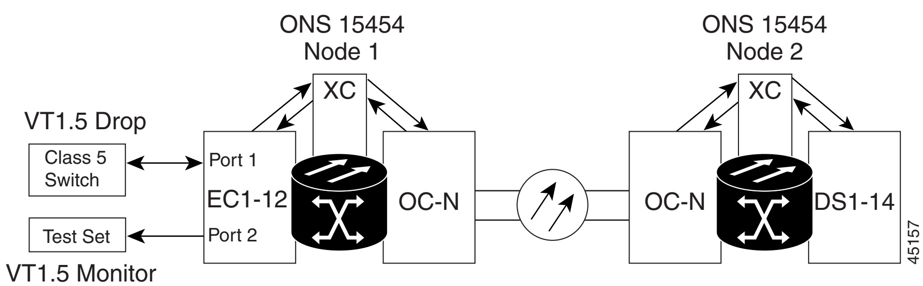
Unidirectional circuits can have multiple destinations for use in broadcast circuit schemes. In broadcast scenarios, one source transmits traffic to multiple destinations, but traffic is not returned to the source.

When you create a unidirectional circuit, the card that does not have its backplane receive (Rx) input terminated with a valid input signal generates a loss of signal (LOS) alarm. To mask the alarm, create an alarm profile suppressing the LOS alarm and apply the profile to the port that does not have its Rx input terminated.

10.6 Monitor Circuits

Monitor circuits are secondary circuits that monitor traffic on primary bidirectional circuits. Figure 10-7 shows an example of a monitor circuit. At Node 1, a VT1.5 is dropped from Port 1 of an EC1-12 card. To monitor the VT1.5 traffic, plug test equipment into Port 2 of the EC1-12 card and provision a monitor circuit to Port 2. Circuit monitors are one-way. The monitor circuit in Figure 10-7 monitors VT1.5 traffic received by Port 1 of the EC1-12 card.

Figure 10-7 VT1.5 Monitor Circuit Received at an EC1-12 Port



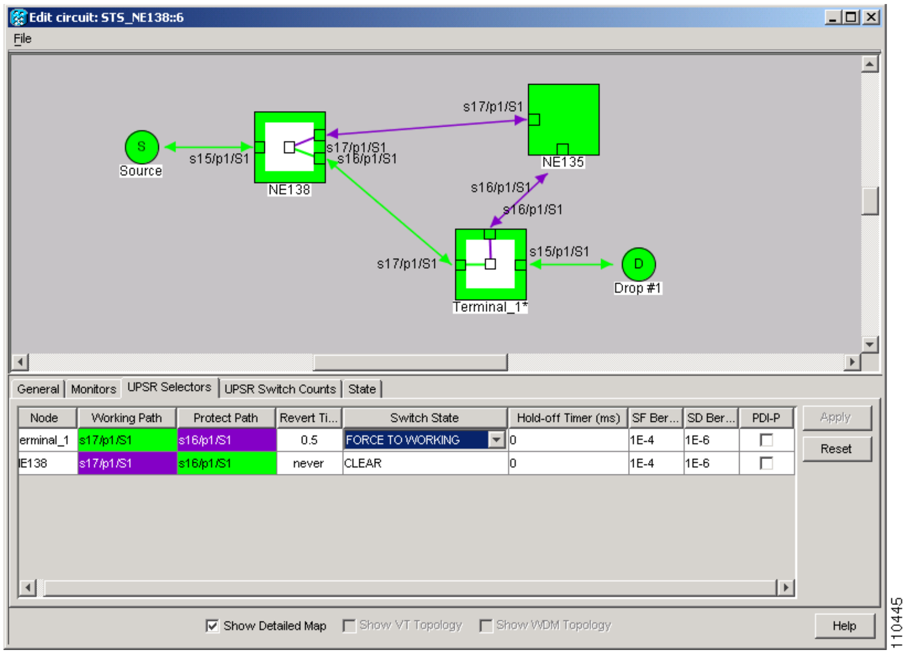
Note Monitor circuits cannot be used with Ethernet circuits.

10.7 Path Protection Circuits

Use the Edit Circuits window to change path protection selectors and switch protection paths (Figure 10-8). In this window, you can:

- View the path protection circuit's working and protection paths.
- Edit the reversion time.
- Edit the Signal Fail/Signal Degrade thresholds.
- Change PDI-P settings.
- Perform maintenance switches on the circuit selector.
- View switch counts for the selectors.

Figure 10-8 Editing Path Protection Selectors



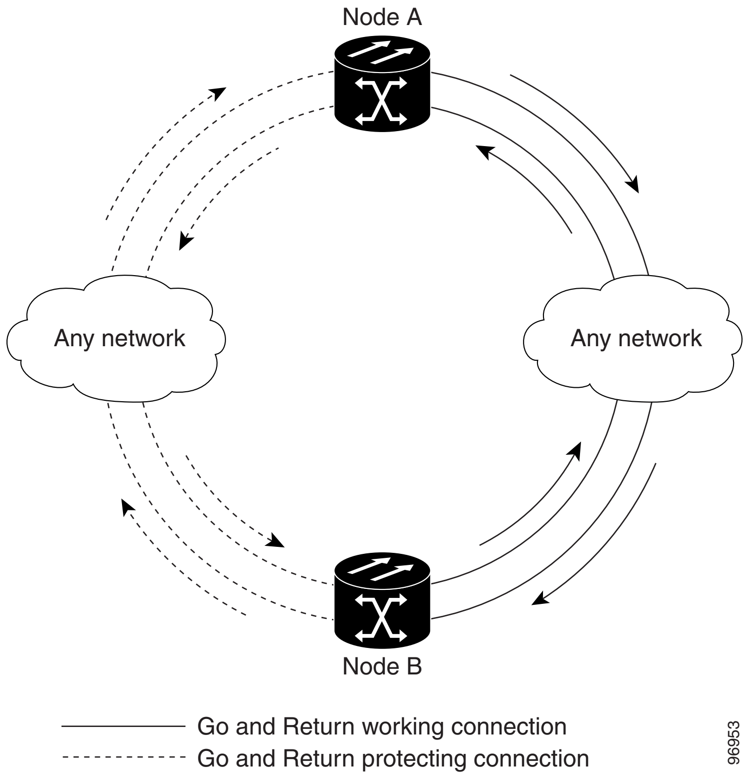
10.7.1 Open-Ended Path Protection Circuits

If ONS 15454s are connected to a third-party network, you can create an open-ended path protection circuit to route a circuit through it. To do this, you create three circuits. One circuit is created on the source ONS 15454 network. This circuit has one source and two destinations, one at each ONS 15454 that is connected to the third-party network. The second circuit is created on the third-party network so that the circuit travels across the network on two paths to the ONS 15454s. That circuit routes the two circuit signals across the network to ONS 15454s that are connected to the network on other side. At the destination node network, the third circuit is created with two sources, one at each node connected to the third-party network. A selector at the destination node chooses between the two signals that arrive at the node, similar to a regular path protection circuit.

10.7.2 Go-and-Return Path Protection Routing

The go-and-return path protection routing option allows you to route the path protection working path on one fiber pair and the protect path on a separate fiber pair (Figure 10-9). The working path will always be the shortest path. If a fault occurs, both the working and protection fibers are not affected. This feature only applies to bidirectional path protection circuits. The go-and-return option appears on the Circuit Attributes panel of the Circuit Creation wizard.

Figure 10-9 Path Protection Go-and-Return Routing



10.8 BLSR Protection Channel Access Circuits

You can provision circuits to carry traffic on BLSR protection channels when conditions are fault-free. Traffic routed on BLSR PCA circuits, called extra traffic, has lower priority than the traffic on the working channels and has no means for protection. During ring or span switches, PCA circuits are preempted and squelched. For example, in a two-fiber OC-48 BLSR, STSs 25-48 can carry extra traffic when no ring switches are active, but PCA circuits on these STSs are preempted when a ring switch occurs. When the conditions that caused the ring switch are remedied and the ring switch is removed, PCA circuits are restored. If the BLSR is provisioned as revertive, this occurs automatically after the fault conditions are cleared and the reversion timer has expired.

Traffic provisioning on BLSR protection channels is performed during circuit provisioning. The Protection Channel Access check box appears whenever Fully Protected Path is unchecked on the circuit creation wizard. Refer to the *Cisco ONS 15454 Procedure Guide* for more information. When provisioning PCA circuits, two considerations are important to keep in mind:

- If BLSRs are provisioned as nonrevertive, PCA circuits are not restored automatically after a ring or span switch. You must switch the BLSR manually.
- PCA circuits are routed on working channels when you upgrade a BLSR from a two-fiber to a four-fiber or from one optical speed to a higher optical speed. For example, if you upgrade a two-fiber OC-48 BLSR to an OC-192, STSs 25-48 on the OC-48 BLSR become working channels on the OC-192 BLSR.

10.9 Path Trace

The SONET J1 Path Trace is a repeated, fixed-length string comprised of 64 consecutive J1 bytes. You can use the string to monitor interruptions or changes to circuit traffic. Table 10-8 shows the ONS 15454 cards that support path trace. DS-1 and DS-3 cards can transmit and receive the J1 field, while the EC-1, OC-3, OC-48AS, and OC-192 can only receive the J1 bytes. Cards that are not listed in the table do not support the J1 byte.

Table 10-8 ONS 15454 Cards Capable of Path Trace

J1 Function	Cards
Transmit and Receive	DS1-14 DS1N-14 DS3-12E DS3i-N-12 DS3N-12E DS3XM-6 G-Series ML-Series
Receive Only	EC1-12 OC3 IR 4 1310 OC12/STM4-4 OC48 IR/STM16 SH AS 1310 OC48 LR/STM16 LH AS 1550 OC192 LR/STM64 LH 1550

The J1 path trace transmits a repeated, fixed-length string. If the string received at a circuit drop port does not match the string the port expects to receive, an alarm is raised. Two path trace modes are available:

- Automatic—The receiving port assumes that the first J1 string it receives is the baseline J1 string.
- Manual—The receiving port uses a string that you manually enter as the baseline J1 string.

10.10 Path Signal Label, C2 Byte

One of the overhead bytes in the SONET frame is the C2 Byte. The SONET standard defines the C2 byte as the path signal label. The purpose of this byte is to communicate the payload type being encapsulated by the STS path overhead (POH). The C2 byte functions similarly to EtherType and Logical Link Control (LLC)/Subnetwork Access Protocol (SNAP) header fields on an Ethernet network; it allows a single interface to transport multiple payload types simultaneously. C2 byte hex values are provided in Table 10-9.

Table 10-9 STS Path Signal Label Assignments for Signals

Hex Code	Content of the STS SPE
0x00	Unequipped
0x01	Equipped - nonspecific payload
0x02	Virtual Tributary (VT) structured STS-1 (DS-1)
0x03	Locked VT mode
0x04	Asynchronous mapping for DS-3
0x12	Asynchronous mapping for DS4NA
0x13	Mapping for Asynchronous Transfer Mode (ATM)
0x14	Mapping for distributed queue dual bus (DQDB)
0x15	Asynchronous mapping for fiber distributed data interface (FDDI)
0x16	High level data link control (HDLC) over SONET mapping
0xFD	Reserved
0xFE	0.181 Test signal (TSS1 to TSS3) mapping SDH network
0xFF	Alarm indication signal, path (AIS-P)

If a circuit is provisioned using a terminating card, the terminating card provides the C2 byte. A VT circuit is terminated at the XCVT or XC-10G card, which generates the C2 byte (0x02) downstream to the STS terminating cards. The XCVT or XC10G card generates the C2 value (0x02) to the DS1 or DS3XM terminating card. If an optical circuit is created with no terminating cards, the test equipment must supply the path overhead in terminating mode. If the test equipment is in "pass through mode," the C2 values usually change rapidly between 0x00 and 0xFF. Adding a terminating card to an optical circuit usually fixes a circuit having C2 byte problems. Table 10-10 lists label assignments for signals with payload defects.

Table 10-10 STS Path Signal Label Assignments for Signals with Payload Defects

Hex Code	Content of the STS SPE
0xE1	VT-structured STS-1 SPE with 1 VTx payload defect (STS-1 with 1 VTx PD)
0xE2	STS-1 with 2 VTx PDs
0xE3	STS-1 with 3 VTx PDs
0xE4	STS-1 with 4 VTx PDs
0xE5	STS-1 with 5 VTx PDs
0xE6	STS-1 with 6 VTx PDs

Table 10-10 STS Path Signal Label Assignments for Signals with Payload Defects (continued)

Hex Code	Content of the STS SPE
0xE7	STS-1 with 7 VTx PDs
0xE8	STS-1 with 8 VTx PDs
0xE9	STS-1 with 9 VTx PDs
0xEA	STS-1 with 10 VTx PDs
0xEB	STS-1 with 11 VTx PDs
0xEC	STS-1 with 12 VTx PDs
0xED	STS-1 with 13 VTx PDs
0xEE	STS-1 with 14 VTx PDs
0xEF	STS-1 with 15 VTx PDs
0xF0	STS-1 with 16 VTx PDs
0xF1	STS-1 with 17 VTx PDs
0xF2	STS-1 with 18 VTx PDs
0xF3	STS-1 with 19 VTx PDs
0xF4	STS-1 with 20 VTx PDs
0xF5	STS-1 with 21 VTx PDs
0xF6	STS-1 with 22 VTx PDs
0xF7	STS-1 with 23 VTx PDs
0xF8	STS-1 with 24 VTx PDs
0xF9	STS-1 with 25 VTx PDs
0xFA	STS-1 with 26 VTx PDs
0xFB	STS-1 with 27 VTx PDs
0xFC	VT-structured STS-1 SPE with 28 VT1.5 (Payload defects or a non-VT-structured STS-1 or STS-Nc SPE with a payload defect.)
0xFF	Reserved

10.11 Automatic Circuit Routing

If you select automatic routing during circuit creation, CTC routes the circuit by dividing the entire circuit route into segments based on protection domains. For unprotected segments of circuits provisioned as fully protected, CTC finds an alternate route to protect the segment, creating a virtual path protection. Each segment of a circuit path is a separate protection domain. Each protection domain is protected in a specific protection scheme including card protection (1+1, 1:1, etc.) or SONET topology (path protection, BLSR, etc.).

The following list provides principles and characteristics of automatic circuit routing:

- Circuit routing tries to use the shortest path within the user-specified or network-specified constraints. VT tunnels are preferable for VT circuits because VT tunnels are considered shortcuts when CTC calculates a circuit path in path-protected mesh networks.

- If you do not choose fully path protected during circuit creation, circuits can still contain protected segments. Because circuit routing always selects the shortest path, one or more links and/or segments can have some protection. CTC does not look at link protection while computing a path for unprotected circuits.
- Circuit routing does not use links that are down. If you want all links to be considered for routing, do not create circuits when a link is down.
- Circuit routing computes the shortest path when you add a new drop to an existing circuit. It tries to find the shortest path from the new drop to any nodes on the existing circuit.
- If the network has a mixture of VT-capable nodes and VT-incapable nodes, CTC may automatically create a VT tunnel. Otherwise, CTC asks you whether a VT tunnel is needed.
- You cannot create protected VT circuits between path protection configurations and BLSRs if an XC card is installed on the node shared by the two topologies. To create protected circuits between topologies, install an XCVT or XC10G cross-connect card on the shared node.

10.11.1 Bandwidth Allocation and Routing

Within a given network, CTC routes circuits on the shortest possible path between source and destination based on the circuit attributes, such as protection and type. CTC considers using a link for the circuit only if the link meets the following requirements:

- The link has sufficient bandwidth to support the circuit.
- The link does not change the protection characteristics of the path.
- The link has the required time slots to enforce the same time slot restrictions for BLSR.

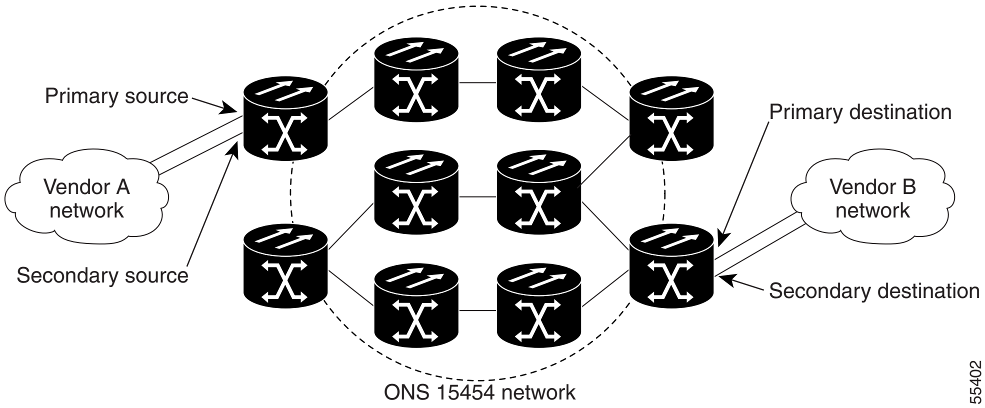
If CTC cannot find a link that meets these requirements, an error appears.

The same logic applies to VT circuits on VT tunnels. Circuit routing typically favors VT tunnels because VT tunnels are shortcuts between a given source and destination. If the VT tunnel in the route is full (no more bandwidth), CTC asks whether you want to create an additional VT tunnel.

10.11.2 Secondary Sources and Destination

CTC supports secondary circuit sources and destinations (drops). Secondary sources and destinations can be created to connect two third-party networks, as shown in Figure 10-10. Traffic is protected while it goes through a network of ONS 15454s.

Figure 10-10 Secondary Sources and Destinations



Several rules apply to secondary sources and destinations:

- CTC does not allow a secondary destination for unidirectional circuits because you can always specify additional destinations after you create the circuit.
- The sources and destinations cannot be DS-3, DS3XM, or DS-1-based STS-1s or VT1.5s.
- Secondary sources and destinations are permitted only for regular STS/VT1.5 connections (not for VT tunnels and multicard EtherSwitch circuits).
- For point-to-point (straight) Ethernet circuits, only SONET STS endpoints can be specified as multiple sources or destinations.

For bidirectional circuits, CTC creates a path protection connection at the source node that allows traffic to be selected from one of the two sources on the ONS 15454 network. If you check the Fully Path Protected option during circuit creation, traffic is protected within the ONS 15454 network. At the destination, another path protection connection is created to bridge traffic from the ONS 15454 network to the two destinations. A similar but opposite path exists for the reverse traffic flowing from the destinations to the sources.

For unidirectional circuits, a path protection drop-and-continue connection is created at the source node.

10.12 Manual Circuit Routing

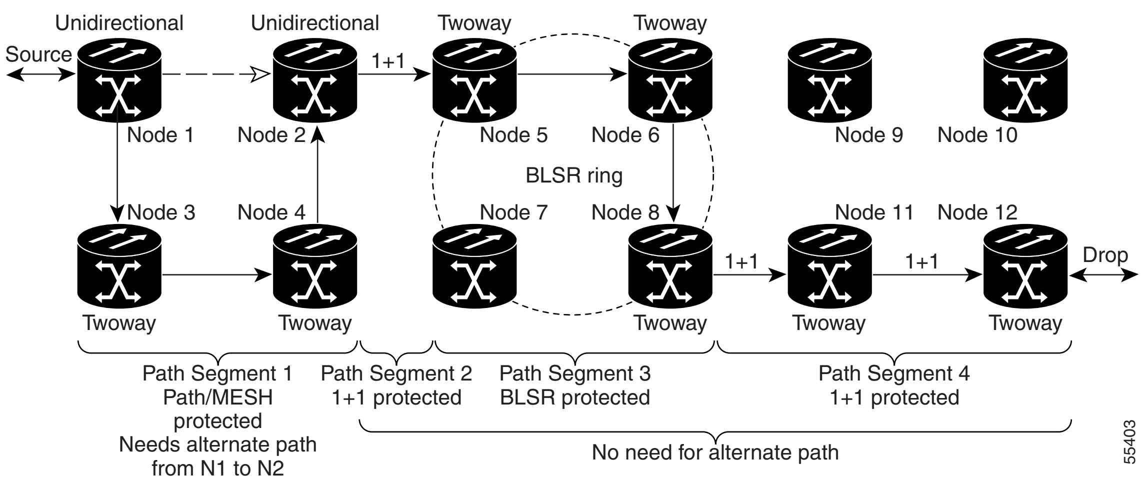
Routing circuits manually allows you to:

- Choose a specific path, not necessarily the shortest path.
- Choose a specific STS/VT1.5 on each link along the route.
- Create a shared packet ring for multicard EtherSwitch circuits.
- Choose a protected path for multicard EtherSwitch circuits, allowing virtual path protection segments.

CTC imposes the following rules on manual routes:

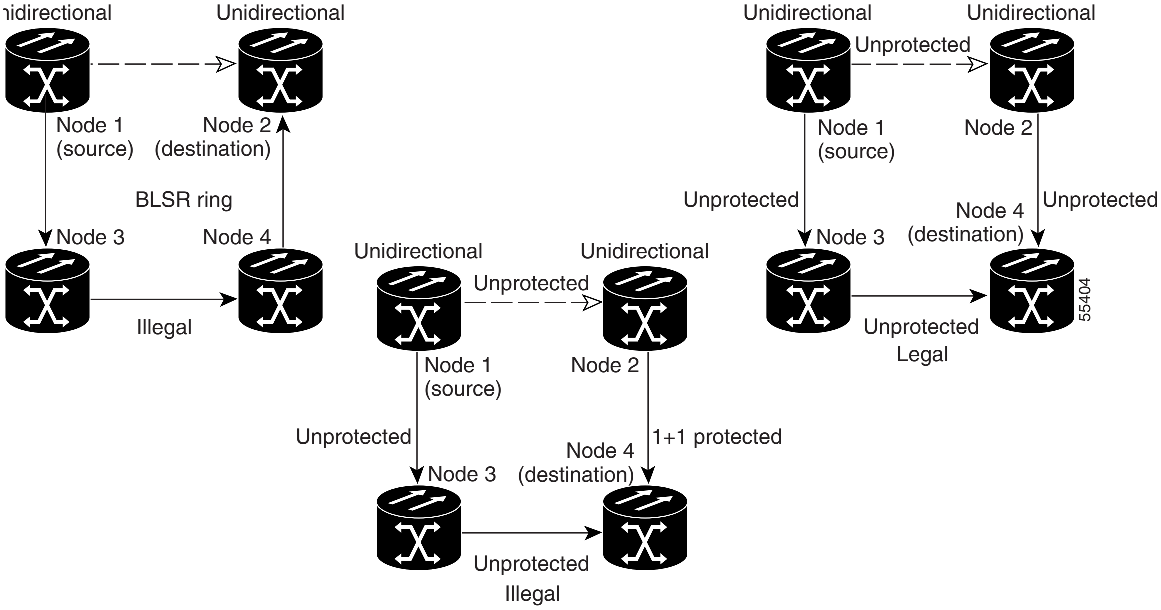
- All circuits, except multicard EtherSwitch circuits in a shared packet ring, should have links with a direction that flows from source to destination. This is true for multicard EtherSwitch circuits that are not in a shared packet ring.
- If you enabled fully path protected, choose a diverse protect (alternate) path for every unprotected segment (Figure 10-11).

Figure 10-11 Alternate Paths for Virtual Path Protection Segments



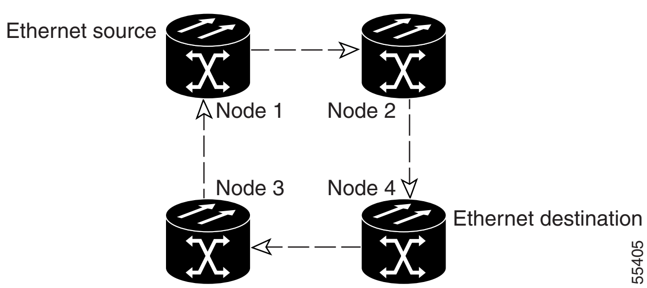
- For multicard EtherSwitch circuits, the fully path protected option is ignored.
- For a node that has a path protection selector based on the links chosen, the input links to the path protection selectors cannot be 1+1 or BLSR protected (Figure 10-12). The same rule applies at the path protection bridge.

Figure 10-12 Mixing 1+1 or BLSR Protected Links With a Path Protection



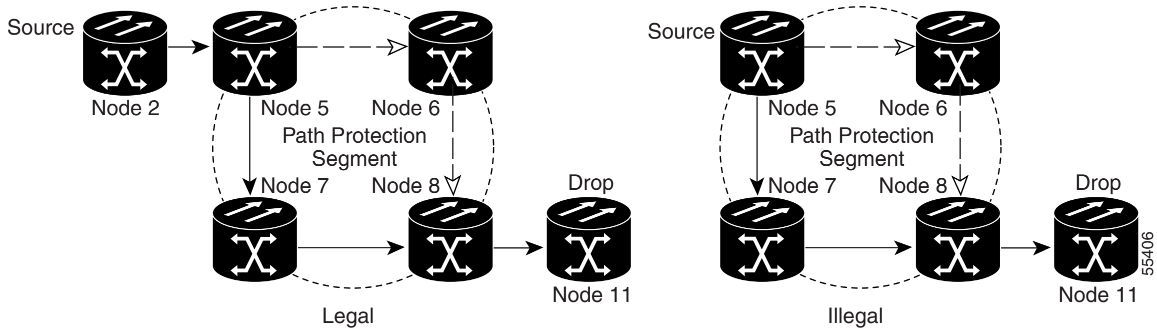
- Choose the links of multicard EtherSwitch circuits in a shared packet ring to route from source to destination back to source (Figure 10-13). Otherwise, a route (set of links) chosen with loops is invalid.

Figure 10-13 Ethernet Shared Packet Ring Routing



- Multicard EtherSwitch circuits can have virtual path protection segments if the source or destination is not in the path protection domain. This restriction also applies after circuit creation; therefore, if you create a circuit with path protection segments, Ethernet destinations cannot exist anywhere on the path protection segment (Figure 10-14).

Figure 10-14 Ethernet and Path Protection



- VT tunnels cannot be the endpoint of a path protection segment. A path protection segment endpoint is where the path protection selector resides.

If you provision full path protection, CTC verifies that the route selection is protected at all segments. A route can have multiple protection domains with each domain protected by a different scheme.

Table 10-11 through Table 10-14 on page 10-26 summarize the available node connections. Any other combination is invalid and generates an error.

Table 10-11 Bidirectional STS/VT/Regular Multicard EtherSwitch/Point-to-Point (Straight) Ethernet Circuits

Connection Type	Number of Inbound Links	Number of Outbound Links	Number of Sources	Number of Destinations
Path Protection	—	2	1	—
Path Protection	2	—	—	1
Path Protection	2	1	—	—
Path Protection	1	2	—	—
Path Protection	1	—	—	2
Path Protection	—	1	2	—
Double path protection	2	2	—	—
Double path protection	2	—	—	2
Double path protection	—	2	2	—
Two way	1	1	—	—
Ethernet	0 or 1	0 or 1	Ethernet node source	—
Ethernet	0 or 1	0 or 1	—	Ethernet node drop

Table 10-12 Unidirectional STS/VT Circuit

Connection Type	Number of Inbound Links	Number of Outbound Links	Number of Sources	Number of Destinations
One way	1	1	—	—
Path Protection headend	1	2	—	—
Path Protection headend	—	2	1	—
Path Protection drop and continue	2	—	—	1+

Table 10-13 Multicard Group Ethernet Shared Packet Ring Circuit

Connection Type	Number of Inbound Links	Number of Outbound Links	Number of Sources	Number of Destinations
At intermediate nodes only				
Double path protection	2	2	—	—
Two way	1	1	—	—
At source or destination nodes only				
Ethernet	1	1	—	—

Table 10-14 Bidirectional VT Tunnels

Connection Type	Number of Inbound Links	Number of Outbound Links	Number of Sources	Number of Destinations
At intermediate nodes only				
Path Protection	2	1	—	—
Path Protection	1	2	—	—
Double path protection	2	2	—	—
Two way	1	1	—	—
At source nodes only				
VT tunnel endpoint	—	1	—	—
At destination nodes only				
VT tunnel endpoint	1	—	—	—

Although virtual path protection segments are possible in VT tunnels, VT tunnels are still considered unprotected. If you need to protect VT circuits use two independent VT tunnels that are diversely routed or use a VT tunnel that is routed over 1+1, BLSR, or a mixture of 1+1 and BLSR links.

10.13 Constraint-Based Circuit Routing

When you create circuits, you can choose Fully Protected Path to protect the circuit from source to destination. The protection mechanism used depends on the path CTC calculates for the circuit. If the network is composed entirely of BLSR or 1+1 links, or the path between source and destination can be entirely protected using 1+1 or BLSR links, no path-protected mesh network (PPMN), or virtual path protection, is used.

If PPMN protection is needed to protect the path, set the level of node diversity for the PPMN portions of the complete path on the Circuit Routing Preferences area of the Circuit Creation dialog box:

- Nodal Diversity Required—Ensures that the primary and alternate paths of each PPMN domain in the complete path have a diverse set of nodes.
- Nodal Diversity Desired—CTC looks for a node diverse path; if a node-diverse path is not available, CTC finds a link-diverse path for each PPMN domain in the complete path.
- Link Diversity Only—Creates only a link-diverse path for each PPMN domain.

When you choose automatic circuit routing during circuit creation, you have the option to require or exclude nodes and links in the calculated route. You can use this option to:

- Simplify manual routing, especially if the network is large and selecting every span is tedious. You can select a general route from source to destination and allow CTC to fill in the route details.
- Balance network traffic; by default CTC chooses the shortest path, which can load traffic on certain links while other links have most of their bandwidth available. By selecting a required node and/or a link, you force the CTC to use (or not use) an element, resulting in more efficient use of network resources.

CTC considers required nodes and links to be an ordered set of elements. CTC treats the source nodes of every required link as required nodes. When CTC calculates the path, it makes sure the computed path traverses the required set of nodes and links and does not traverse excluded nodes and links.

The required nodes and links constraint is only used during the primary path computation and only for PPMN domains/segments. The alternate path is computed normally; CTC uses excluded nodes/links when finding all primary and alternate paths on PPMNs.

10.14 Virtual Concatenated Circuits

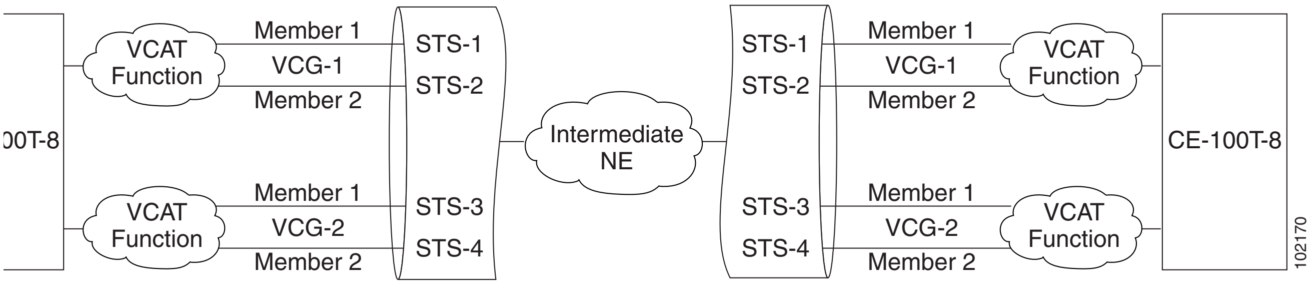
Virtual concatenated (VCAT) circuits, also called VCAT groups (VCGs), transport traffic using noncontiguous time division multiplexing (TDM) timeslots, avoiding the bandwidth fragmentation problem that exists with contiguous concatenated circuits. In a VCAT circuit, circuit bandwidth is divided into smaller circuits called VCAT members. The individual members act as independent TDM circuits.

Intermediate nodes treat the VCAT members as normal circuits that are independently routed and protected by the SONET network. At the terminating nodes, these member circuits are multiplexed into a contiguous stream of data. All VCAT members should be the same size and must originate/terminate at the same end points. Each member can be line protected, unprotected, or use PCA. If a member is unprotected, all members must be unprotected. Path protection is not supported.

Note Software Release 4.6 supports two members in VCAT circuits created using ML-Series cards and eight members in VCAT circuits created using the FC_MR-4 card.

The automatic and manual routing selection applies to the entire VCAT circuit, that is, all members are manually or automatically routed. In Software R4.6, bidirectional VCAT circuits are symmetric, which means that the same number of members travel in each direction. Software R4.6 supports common fiber routing, where all VCAT members travel on the same fibers, thus eliminating delay between members. Figure 10-15 shows an example of common fiber routing.

Figure 10-15 VCAT on Common Fiber



The Software–Link Capacity Adjustment Scheme (Sw-LCAS) uses legacy SONET failure indicators like the AIS-P and RDI-P to detect member failure. Sw-LCAS removes the failed member from the VCAT circuit for the duration of the failure, leaving the remaining members to carry the traffic. When the failure clears, the member circuit is added back into the VCAT circuit. Sw-LCAS cannot autonomously remove members that have defects in the H4/Z7 byte. Sw-LCAS is only available for legacy SONET defects such as AIS-P, LOP-P, etc. Sw-LCAS is optional. You can select Sw-LCAS during VCAT circuit creation.

Note Sw-LCAS allows circuit pairing for ML-Series cards over two-fiber BLSRs. With circuit pairing, a VCAT circuit is set up between two ML-Series cards; one is a protected circuit (line protection) and the other is PCA. For four-fiber BLSR, member protection cannot be mixed.

SONET Topologies

This chapter explains Cisco ONS 15454 SONET topologies. For information about dense wavelength division multiplexing (DWDM) SONET topologies, refer to Chapter 12, “DWDM Topologies.”

To provision topologies, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

11.1 SONET Rings and TCC2 Cards

Table 11-1 shows the SONET rings that can be created on each ONS 15454 node using redundant TCC2 cards.

Table 11-1 ONS 15454 Rings with Redundant TCC2 Cards

Ring Type	Maximum Rings per Node
BLSRs	5
2-Fiber BLSR	5
4-Fiber BLSR	1
Path Protection with SDCC	34[1, 2]

Table 11-1 ONS 15454 Rings with Redundant TCC2 Cards (continued)

Ring Type	Maximum Rings per Node
Path Protection with LDCC	14[3] [4]
Path Protection with LDCC and SDCC	26[5]

1. Total SDCC usage must be equal to or less than 68 SDCCs.
2. See the "11.3 Unidirectional Path Switched Rings" section on page 11-13.
3. Total LDCC usage must be equal to or less than 28 LDCCs.
4. See the "11.3 Unidirectional Path Switched Rings" section on page 11-13.
5. Total LDCC and SDCC usage must be equal to or less than 73. When LDCC is provisioned, an SDCC termination is allowed on the same port, but is not recommended. Using SDCC and LDCC on the same port is only needed during a software upgrade if the other end of the link does not support LDCC. You can provision SDCCs and LDCCs on different ports in the same node.

11.2 Bidirectional Line Switched Rings

The ONS 15454 can support five concurrent bidirectional line switch rings (BLSRs) in one of the following configurations:

- Five two-fiber BLSRs
- Four two-fiber and one four-fiber BLSR

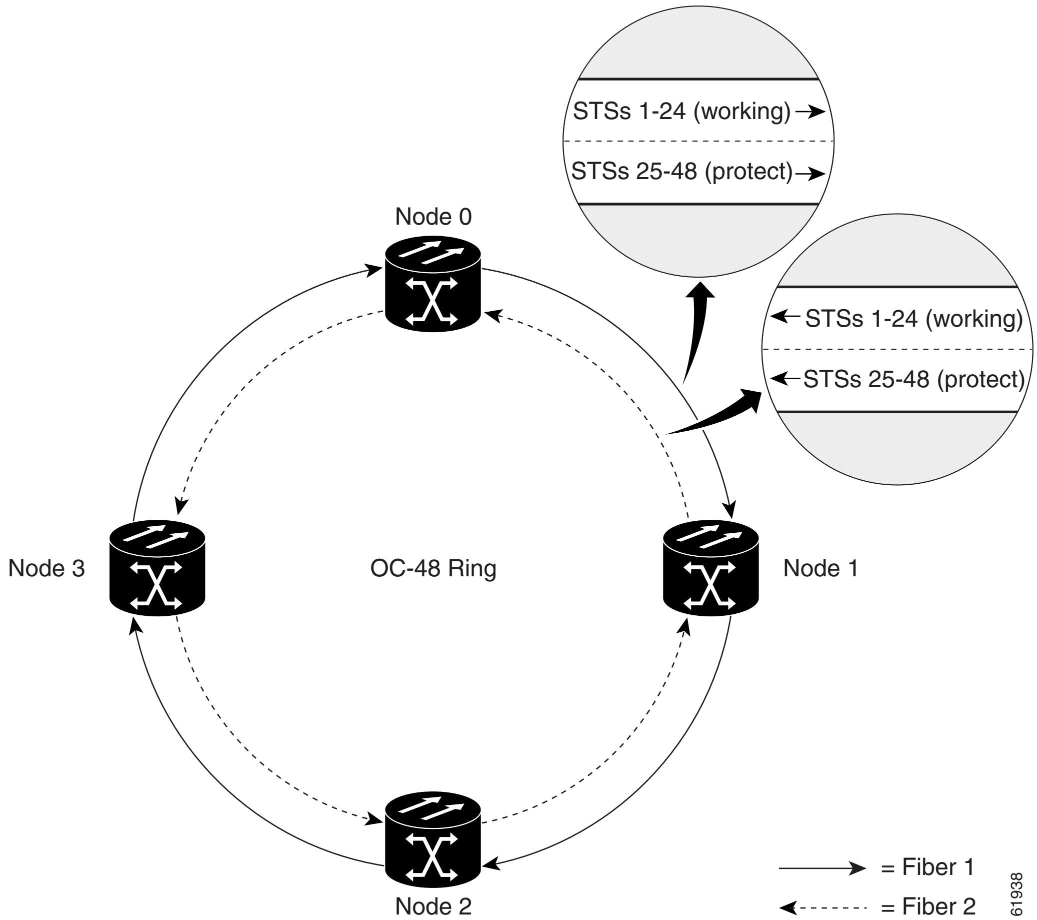
Each BLSR can have up to 32 ONS 15454s. Because the working and protect bandwidths must be equal, you can create only OC-12 (two-fiber only), OC-48, or OC-192 BLSRs. For information about BLSR protection channels, see the "10.8 BLSR Protection Channel Access Circuits" section on page 10-17.

Note For best performance, BLSRs should have one LAN connection for every ten nodes in the BLSR.

11.2.1 Two-Fiber BLSRs

In two-fiber BLSRs, each fiber is divided into working and protect bandwidths. For example, in an OC-48 BLSR (Figure 11-1), STSs 1 to 24 carry the working traffic, and STSs 25 to 48 are reserved for protection. Working traffic (STSs 1 to 24) travels in one direction on one fiber and in the opposite direction on the second fiber. The Cisco Transport Controller (CTC) circuit routing routines calculate the shortest path for circuits based on many factors, including user requirements, traffic patterns, and distance. For example, in Figure 11-1, circuits going from Node 0 to Node 1 typically travel on Fiber 1, unless that fiber is full, in which case circuits are routed on Fiber 2 through Node 3 and Node 2. Traffic from Node 0 to Node 2 (or Node 1 to Node 3) can be routed on either fiber, depending on circuit provisioning requirements and traffic loads.

Figure 11-1 Four-Node, Two-Fiber BLSR



The SONET K1, K2, and K3 bytes carry the information that governs BLSR protection switches. Each BLSR node monitors the K bytes to determine when to switch the SONET signal to an alternate physical path. The K bytes communicate failure conditions and actions taken between nodes in the ring.

If a break occurs on one fiber, working traffic targeted for a node beyond the break switches to the protect bandwidth on the second fiber. The traffic travels in a reverse direction on the protect bandwidth until it reaches its destination node. At that point, traffic is switched back to the working bandwidth.

Figure 11-2 shows a traffic pattern sample on a four-node, two-fiber BLSR.

Figure 11-2 Four-Node, Two-Fiber BLSR Traffic Pattern Sample

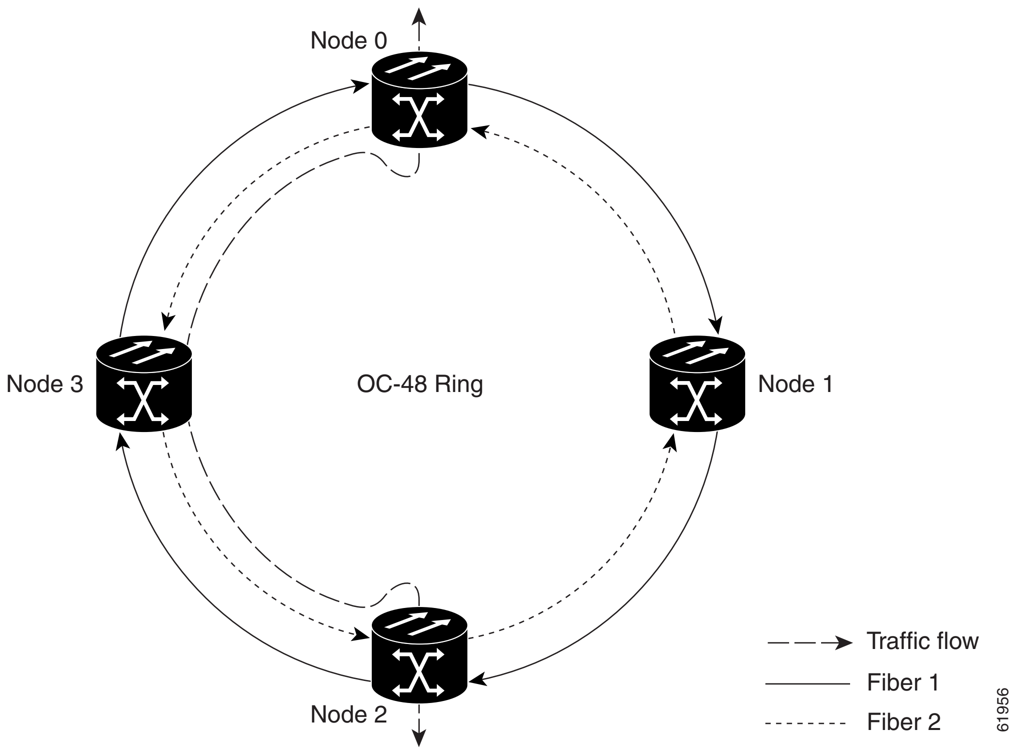
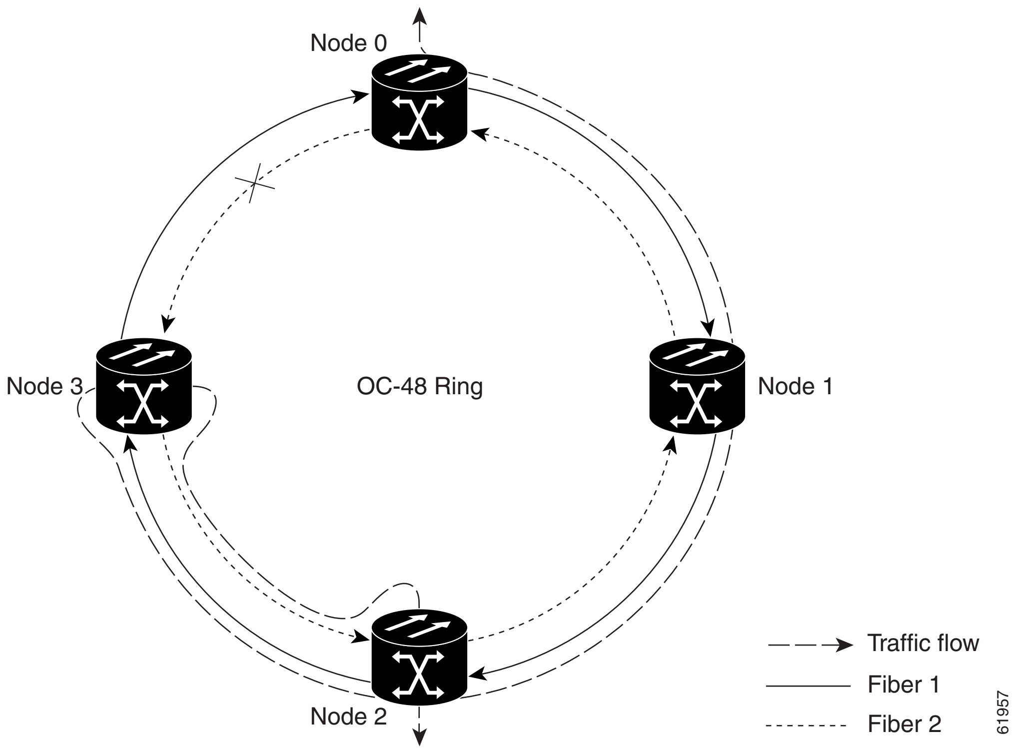


Figure 11-3 shows how traffic is rerouted following a line break between Node 0 and Node 3.

- All circuits originating on Node 0 carried traffic to Node 2 on Fiber 2 are switched to the protect bandwidth of Fiber 1. For example, a circuit carrying traffic on STS-1 on Fiber 2 is switched to STS-25 on Fiber 1. A circuit carried on STS-2 on Fiber 2 is switched to STS-26 on Fiber 1. Fiber 1 carries the circuit to Node 3 (the original routing destination). Node 3 switches the circuit back to STS-1 on Fiber 2 where it is routed to Node 2 on STS-1.
- Circuits originating on Node 2 that normally carried traffic to Node 0 on Fiber 1 are switched to the protect bandwidth of Fiber 2 at Node 3. For example, a circuit carrying traffic on STS-2 on Fiber 1 is switched to STS-26 on Fiber 2. Fiber 2 carries the circuit to Node 0 where the circuit is switched back to STS-2 on Fiber 1 and then dropped to its destination.

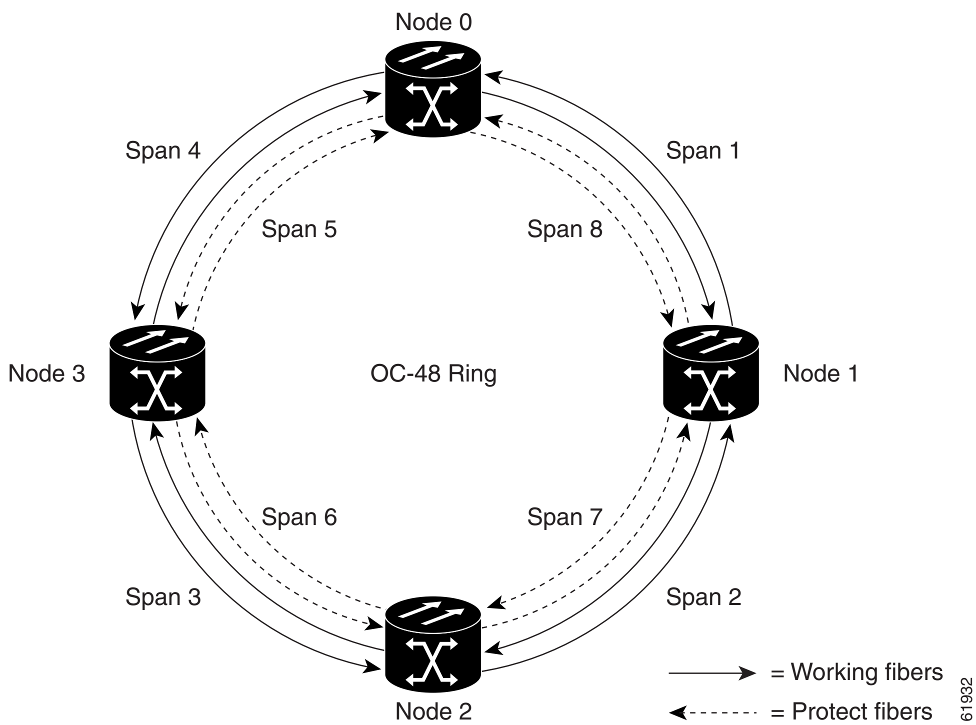
Figure 11-3 Four-Node, Two-Fiber BLSR Traffic Pattern Following Line Break



11.2.2 Four-Fiber BLSRs

Four-fiber BLSRs double the bandwidth of two-fiber BLSRs. Because they allow span switching as well as ring switching, four-fiber BLSRs increase the reliability and flexibility of traffic protection. Two fibers are allocated for working traffic and two fibers for protection, as shown in Figure 11-4. To implement a four-fiber BLSR, you must install four OC-48, OC-48 AS, or OC-192 cards at each BLSR node.

Figure 11-4 Four-Node, Four-Fiber BLSR



Four-fiber BLSRs provide span and ring switching:

- Span switching (Figure 11-5 on page 11-7) occurs when a working span fails. Traffic switches to the protect fibers between the nodes (Node 0 and Node 1 in the example in Figure 11-5) and then returns to the working fibers. Multiple span switches can occur at the same time.
- Ring switching (Figure 11-6 on page 11-7) occurs when a span switch cannot recover traffic, such as when both the working and protect fibers fail on the same span. In a ring switch, traffic is routed to the protect fibers throughout the full ring.

Figure 11-5 Four-Fiber BLSR Span Switch

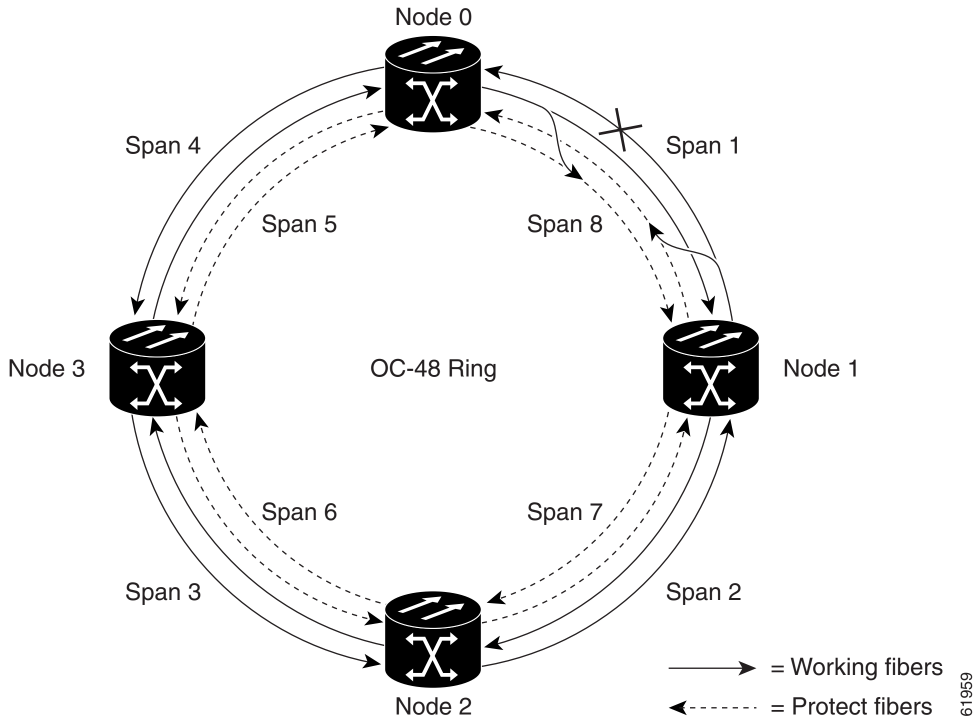
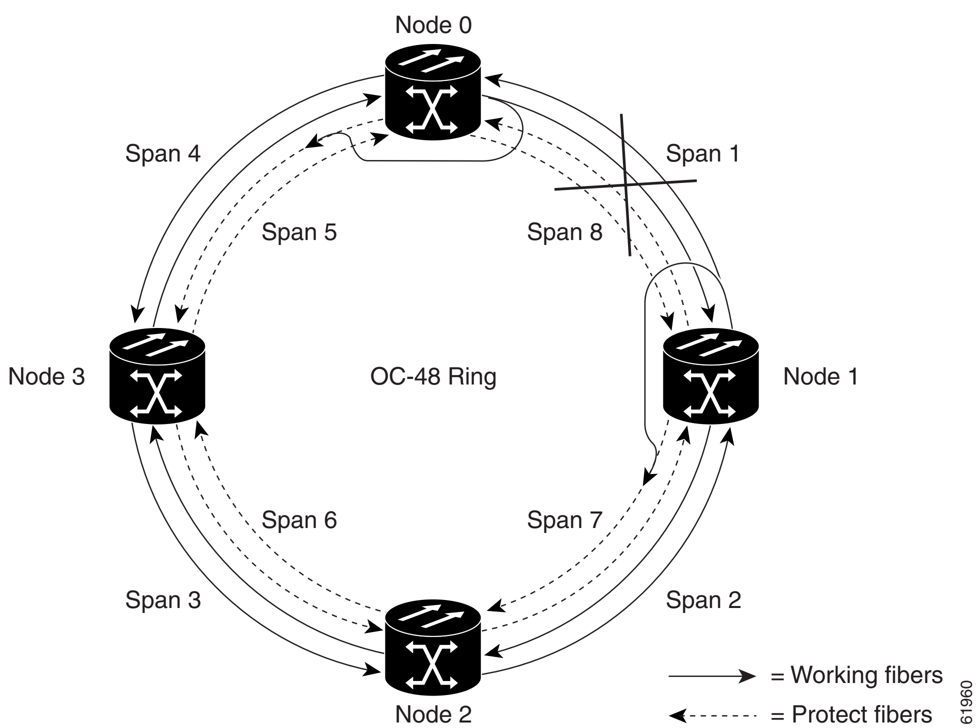


Figure 11-6 Four-Fiber BLSR Ring Switch



11.2.3 BLSR Bandwidth

BLSR nodes can terminate traffic coming from either side of the ring. Therefore, BLSRs are suited for distributed node-to-node traffic applications such as interoffice networks and access networks.

BLSRs allow bandwidth to be reused around the ring and can carry more traffic than a network with traffic flowing through one central hub. BLSRs can also carry more traffic than a path protection operating at the same OC-N rate. Table 11-2 shows the bidirectional bandwidth capacities of two-fiber BLSRs. The capacity is the OC-N rate divided by two, multiplied by the number of nodes in the ring minus the number of pass-through STS-1 circuits. Table 11-3 shows the bidirectional bandwidth capacities of four-fiber BLSRs.

Table 11-2 Two-Fiber BLSR Capacity

OC Rate	Working Bandwidth	Protection Bandwidth	Ring Capacity
OC-12	STS1-6	STS 7-12	6 x N[1] – PT[2]
OC-48	STS 1-24	STS 25-48	24 x N – PT
OC-192	STS 1-96	STS 97-192	96 x N – PT

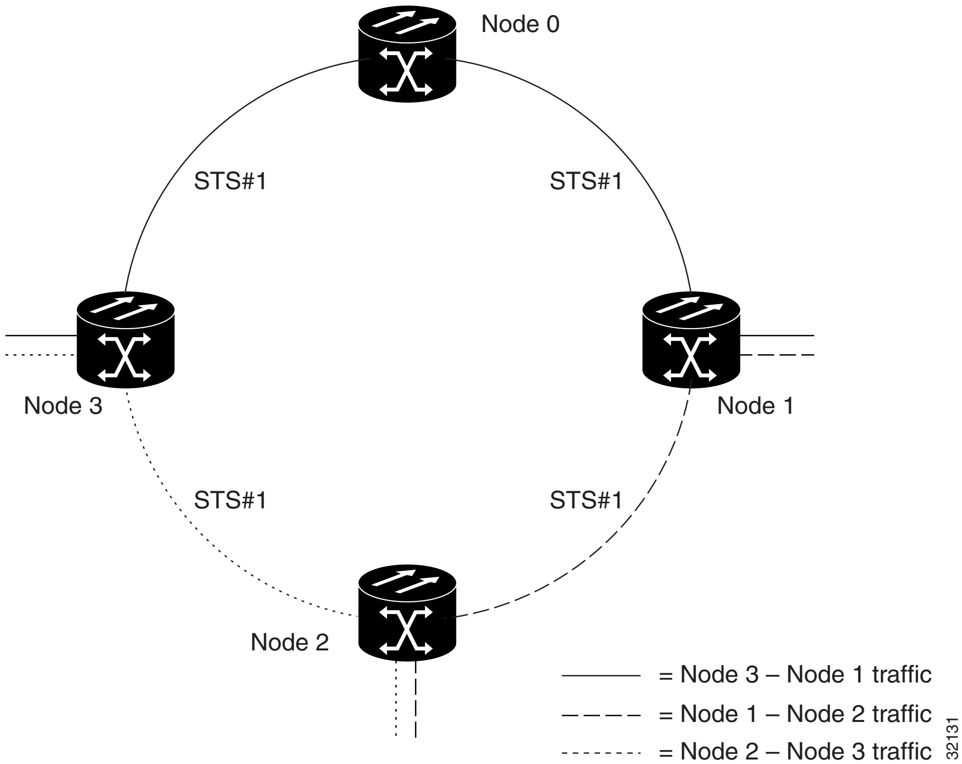
1. N equals the number of ONS 15454 nodes configured as BLSR nodes.
2. PT equals the number of STS-1 circuits passed through ONS 15454 nodes in the ring (capacity can vary depending on the traffic pattern).

Table 11-3 Four-Fiber BLSR Capacity

OC Rate	Working Bandwidth	Protection Bandwidth	Ring Capacity
OC-48	STS 1-48 (Fiber 1)	STS 1-48 (Fiber 2)	48 x N – PT
OC-192	STS 1-192 (Fiber 1)	STS 1-192 (Fiber 2)	192 x N – PT

Figure 11-7 shows an example of BLSR bandwidth reuse. The same STS carries three different traffic sets simultaneously on different spans around the ring: one set from Node 3 to Node 1, another set from Node 1 to Node 2, and another set from Node 2 to Node 3.

Figure 11-7 BLSR Bandwidth Reuse



11.2.4 BLSR Application Example

Figure 11-8 shows a two-fiber BLSR implementation example with five nodes. A regional long-distance network connects to other carriers at Node 0. Traffic is delivered to the service provider's major hubs.

- Carrier 1 delivers six DS-3s over two OC-3 spans to Node 0. Carrier 2 provides twelve DS-3s directly. Node 0 receives the signals and delivers them around the ring to the appropriate node.
- The ring also brings 14 DS-1s back from each remote site to Node 0. Intermediate nodes serve these shorter regional connections.
- The ONS 15454 OC-3 card supports a total of four OC-3 ports so that two additional OC-3 spans can be added at little cost.

Figure 11-8 Five-Node Two-Fiber BLSR

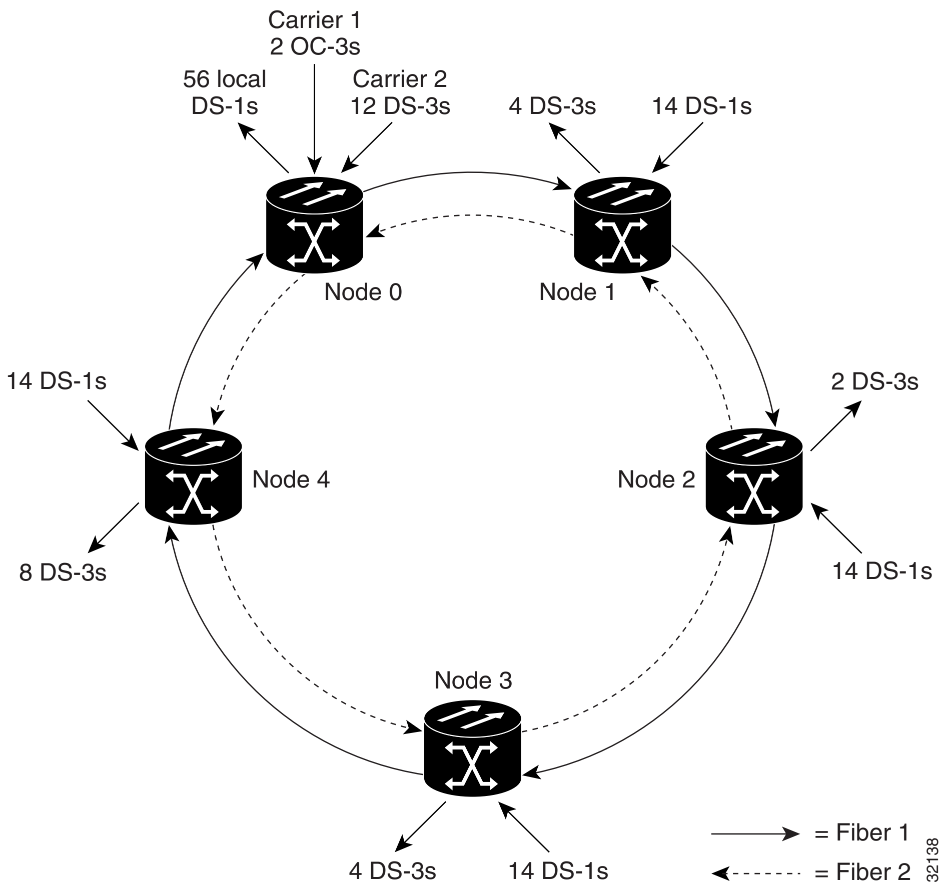


Figure 11-9 shows the shelf assembly layout for Node 0, which has one free slot. Figure 11-10 shows the shelf assembly layout for the remaining sites in the ring. In this BLSR configuration, an additional eight DS-3s at Node IDs 1 and 3 can be activated. An additional four DS-3s can be added at Node 4, and ten DS-3s can be added at Node 2. Each site has free slots for future traffic needs.

Figure 11-9 Shelf Assembly Layout for Node 0 in Figure 11-8

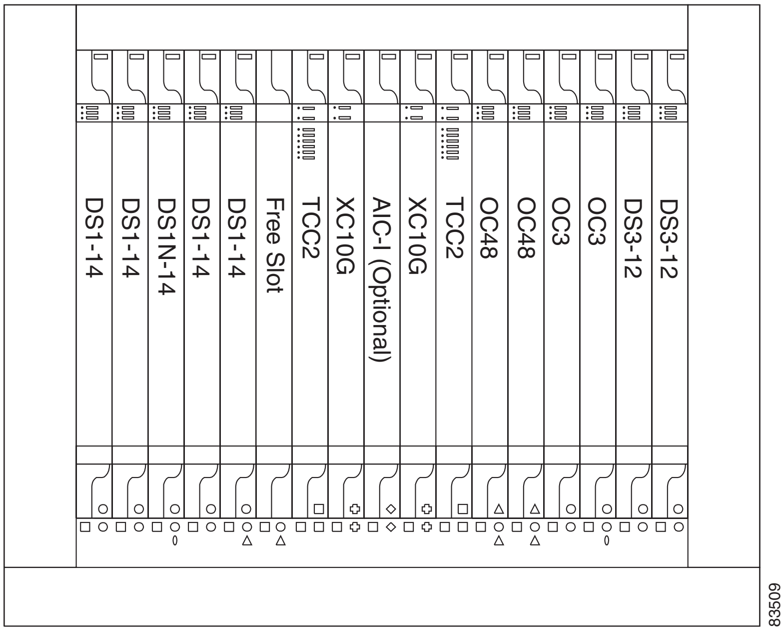
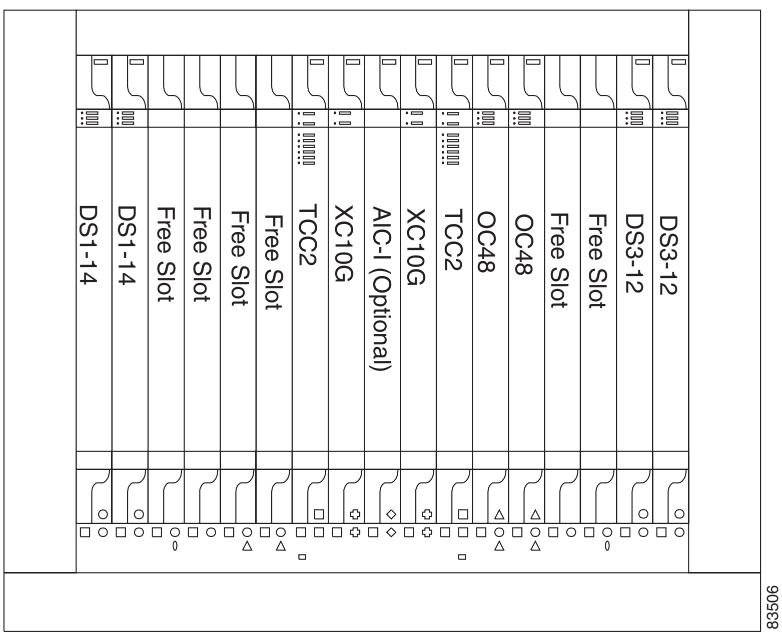


Figure 11-10 Shelf Assembly Layout for Nodes 1 to 4 in Figure 11-8



11.2.5 BLSR Fiber Connections

Plan your fiber connections and use the same plan for all BLSR nodes. For example, make the east port the farthest slot to the right and the west port the farthest slot to the left. Plug fiber connected to an east port at one node into the west port on an adjacent node. Figure 11-11 shows fiber connections for a two-fiber BLSR with trunk cards in Slot 5 (west) and Slot 12 (east). Refer to the *Cisco ONS 15454 Procedure Guide* for fiber connection procedures.

Note Always plug the transmit (Tx) connector of an OC-N card at one node into the receive (Rx) connector of an OC-N card at the adjacent node. Cards display an SF LED when Tx and Rx connections are mismatched.

For four-fiber BLSRs, use the same east-west connection pattern for the working and protect fibers. Do not mix working and protect card connections. The BLSR does not function if working and protect cards are interconnected. Figure 11-12 shows fiber connections for a four-fiber BLSR. Slot 5 (west) and Slot 12 (east) carry the working traffic. Slot 6 (west) and Slot 13 (east) carry the protect traffic.

Figure 11-11 Connecting Fiber to a Four-Node, Two-Fiber BLSR

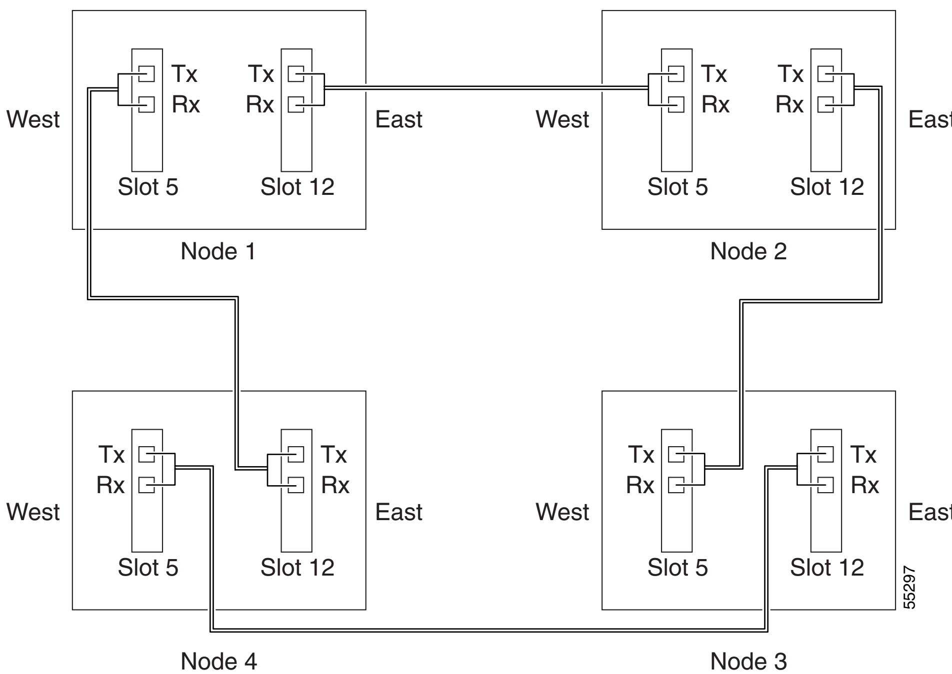
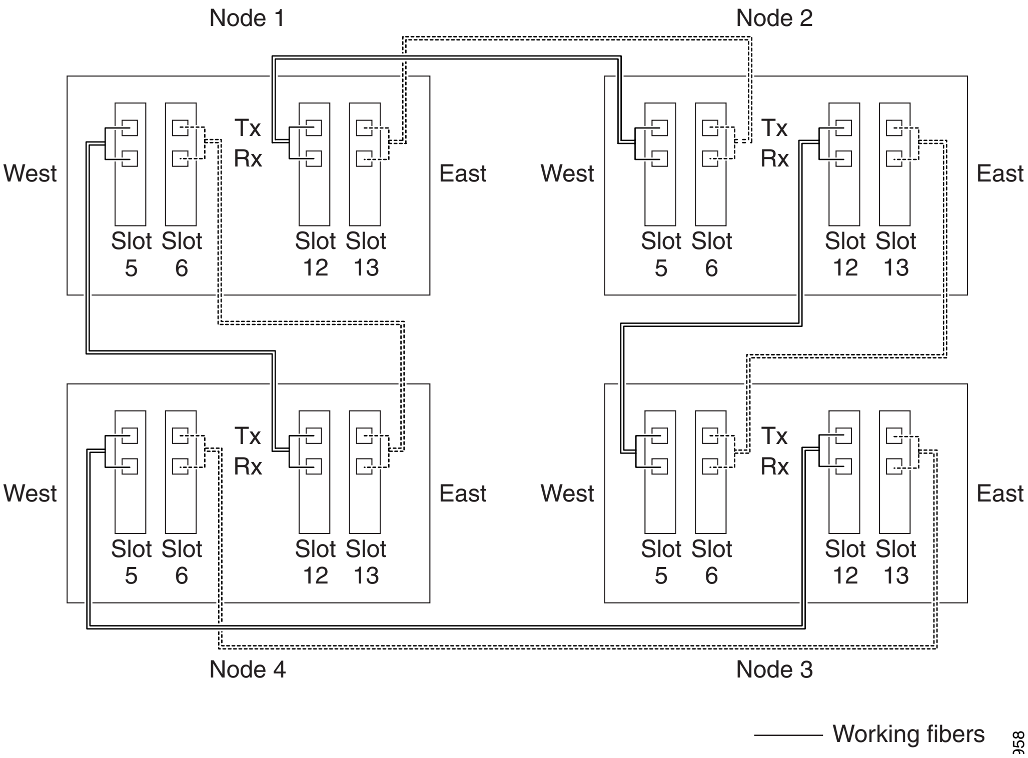


Figure 11-12 Connecting Fiber to a Four-Node, Four-Fiber BLSR



11.2.6 Two-Fiber BLSR to Four-Fiber BLSR Conversion

Two-fiber OC-48 or OC-192 BLSRs can be converted to four-fiber BLSRs. To convert the BLSR, install two OC-48 or OC-192 cards at each two-fiber BLSR node, then log into CTC and convert each node from two-fiber to four-fiber. The fibers that were divided into working and protect bandwidths for the two-fiber BLSR are now fully allocated for working BLSR traffic. Refer to the *Cisco ONS 15454 Procedure Guide* for BLSR conversion procedures.

11.3 Unidirectional Path Switched Rings

Path Protection configurations provide duplicate fiber paths around the ring. Working traffic flows in one direction and protection traffic flows in the opposite direction. If a problem occurs with the working traffic path, the receiving node switches to the path coming from the opposite direction.

CTC automates ring configuration. path protection traffic is defined within the ONS 15454 on a circuit-by-circuit basis. If a path-protected circuit is not defined within a 1+1 or BLSR line protection scheme and path protection is available and specified, CTC uses path protection as the default.

A path protection circuit requires two DCC-provisioned optical spans per node. path protection circuits can be created across these spans until their bandwidth is consumed.

Note If a path protection circuit is created manually by TL1, data communication channels (DCCs) are not needed; therefore, path protection circuits are limited by the cross-connection bandwidth, or the span bandwidth, but not by the number of DCCs.

The span bandwidth consumed by a path protection circuit is two times the circuit bandwidth, because the circuit is duplicated. The cross-connection bandwidth consumed by a path protection circuit is three times the circuit bandwidth at the source and destination nodes only. The cross-connection bandwidth consumed by an intermediate node has a factor of one.

The path protection circuit limit is the sum of the optical bandwidth containing 68 section data communication channels (SDCCs) or 28 line data communication channels (LDCCs), divided by two if you are using redundant TCC2 cards. The spans can be of any bandwidth from OC-3 to OC-192. The circuits can be of any size from VT1.5 to 192c.

Figure 11-13 shows a basic four-node path protection configuration. If Node ID 0 sends a signal to Node ID 2, the working signal travels on the working traffic path through Node ID 1. The same signal is also sent on the protect traffic path through Node ID 3. If a fiber break occurs (Figure 11-14), Node ID 2 switches its active receiver to the protect signal coming through Node ID 3.

Because each traffic path is transported around the entire ring, path protections are best suited for networks where traffic concentrates at one or two locations and is not widely distributed. path protection capacity is equal to its bit rate. Services can originate and terminate on the same path protection, or they can be passed to an adjacent access or interoffice ring for transport to the service-terminating location.

Figure 11-13 Basic Four-Node Path Protection

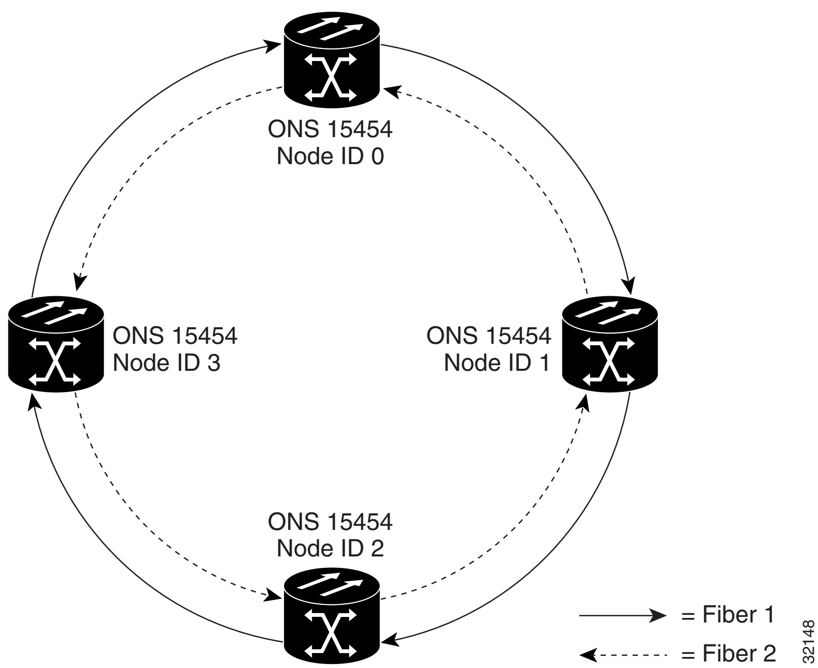


Figure 11-14 Path Protection with a Fiber Break

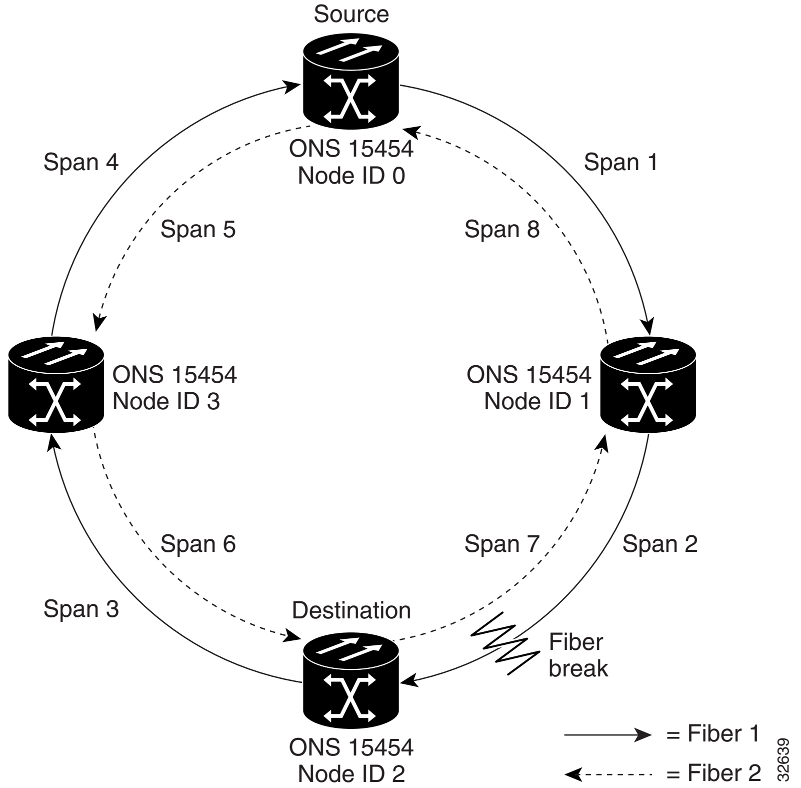
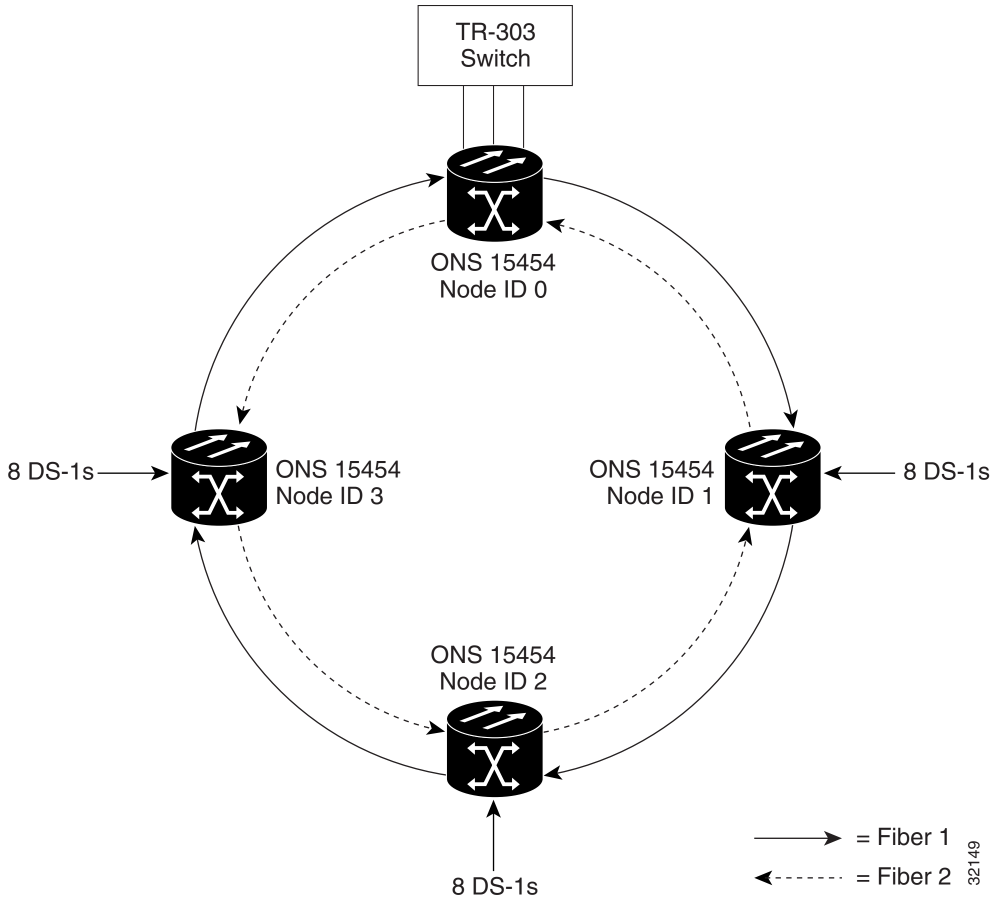


Figure 11-15 shows a common path protection application. OC-3 optics provide remote switch connectivity to a host Telcordia TR-303 switch. In the example, each remote switch requires eight DS-1s to return to the host switch. Figure 11-16 on page 11-17 and Figure 11-17 on page 11-17 show the shelf layout for each site.

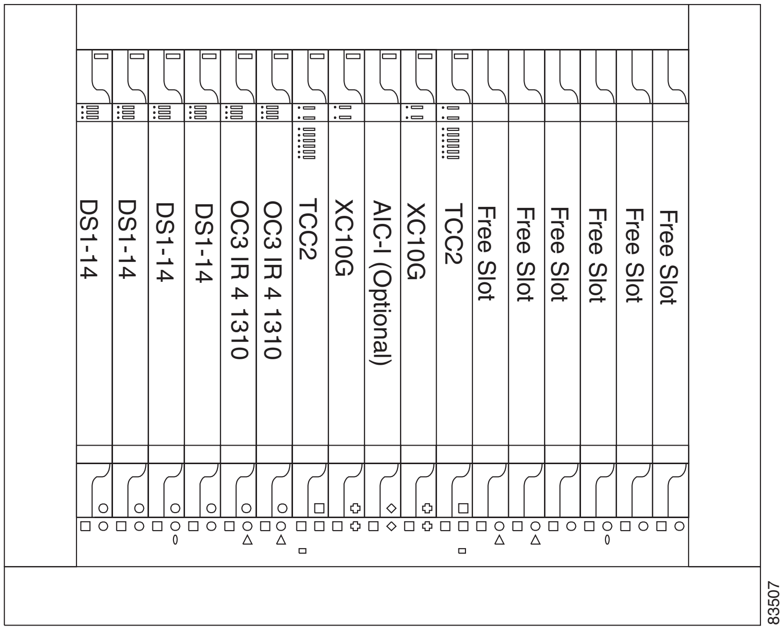
Figure 11-15 Four-Port, OC-3 Path Protection



Node ID 0 has four DS1-14 cards to provide 56 active DS-1 ports. The other sites only require two DS1-14 cards to handle the eight DS-1s to and from the remote switch. You can use the other half of each ONS 15454 shelf assembly to provide support for a second or third ring to other existing or planned remote sites.

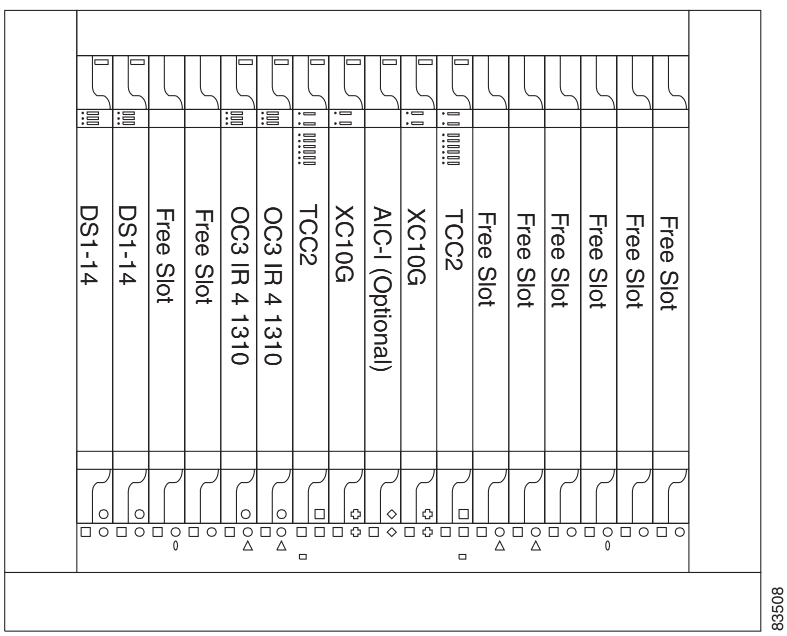
In the OC-3 path protection sample, Node ID 0 contains four DS1-14 cards and two OC3 IR 4 1310 cards. Six free slots can be provisioned with cards or left empty. Figure 11-16 shows the shelf setup for these cards.

Figure 11-16 Layout of Node ID 0 in the OC-3 Path Protection Example in Figure 11-15



In the Figure 11-15 on page 11-16 example, Nodes IDs 1 to 3 each contain two DS1-14 cards and two OC3 IR 4 1310 cards. Eight free slots exist. They can be provisioned with other cards or left empty. Figure 11-17 shows the shelf assembly setup for this configuration example.

Figure 11-17 Layout of Node IDs 1 to 3 in the OC-3 Path Protection Example in Figure 11-15

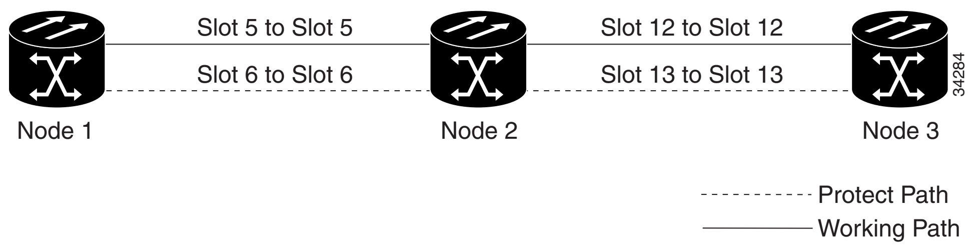


11.4 Linear ADM Configurations

You can configure ONS 15454s as a line of add/drop multiplexers (ADMs) by configuring one set of OC-N cards as the working path and a second set as the protect path. Unlike rings, linear (point-to-point) ADMs require that the OC-N cards at each node be in 1+1 protection to ensure that a break to the working line is automatically routed to the protect line.

Figure 11-18 shows three ONS 15454s in a linear ADM configuration. Working traffic flows from Slot 5/Node 1 to Slot 5/Node 2, and from Slot 12/Node 2 to Slot 12/Node 3. You create the protect path by placing Slot 6 in 1+1 protection with Slot 5 at Nodes 1 and 2, and Slot 12 in 1+1 protection with Slot 13 at Nodes 2 and 3.

Figure 11-18 Linear (Point-to-Point) ADM Configuration



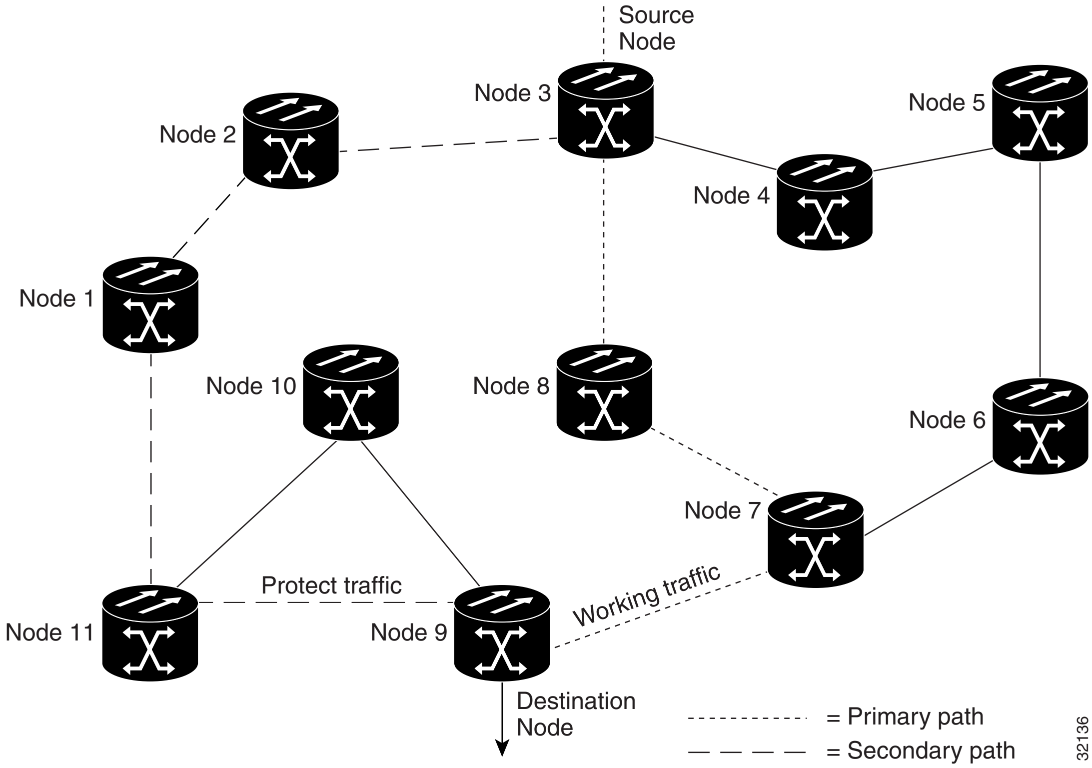
11.5 Path-Protected Mesh Networks

In addition to single BLSRs, path protection configurations, and ADMs, you can extend ONS 15454 traffic protection by creating path-protected mesh networks (PPMNs). PPMNs include multiple ONS 15454 SONET topologies and extend the protection provided by a single path protection to the meshed architecture of several interconnecting rings. In a PPMN, circuits travel diverse paths through a network of single or multiple meshed rings. When you create circuits, you can have CTC automatically route circuits across the PPMN, or you can manually route them. You can also choose levels of circuit protection. For example, if you choose full protection, CTC creates an alternate route for the circuit in addition to the main route. The second route follows a unique path through the network between the source and destination and sets up a second set of cross-connections.

For example, in Figure 11-19 a circuit is created from Node 3 to Node 9. CTC determines that the shortest route between the two nodes passes through Node 8 and Node 7, shown by the dotted line, and automatically creates cross-connections at Nodes 3, 8, 7, and 9 to provide the primary circuit path.

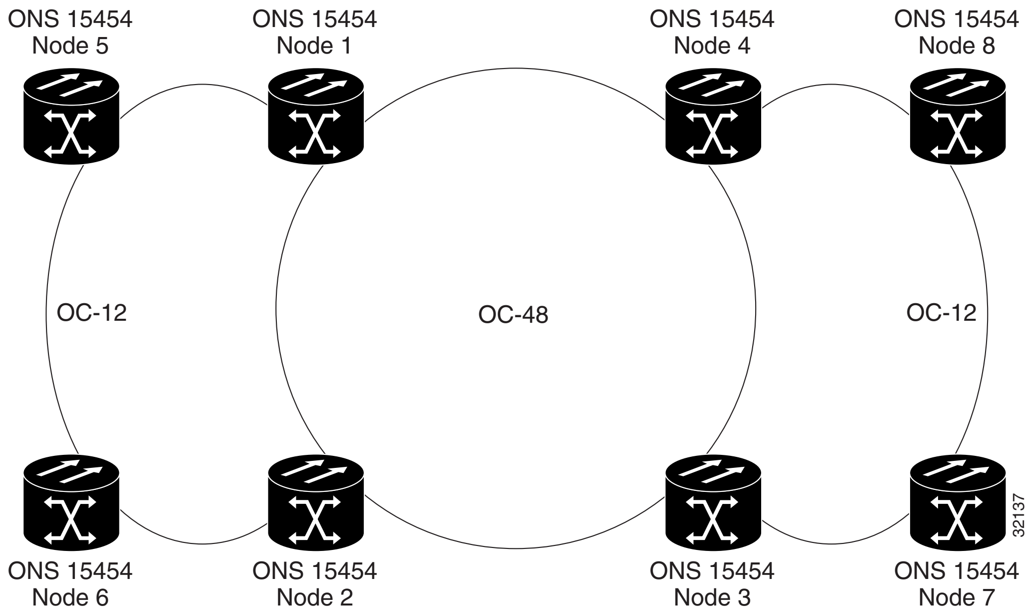
If full protection is selected, CTC creates a second unique route between Nodes 3 and 9 which, in this example, passes through Nodes 2, 1, and 11. Cross-connections are automatically created at Nodes 3, 2, 1, 11, and 9, shown by the dashed line. If a failure occurs on the primary path, traffic switches to the second circuit path. In this example, Node 9 switches from the traffic coming in from Node 7 to the traffic coming in from Node 11 and service resumes. The switch occurs within 50 ms.

Figure 11-19 Path-Protected Mesh Network



PPMN also allows spans with different SONET speeds to be mixed together in "virtual rings." Figure 11-20 shows Nodes 1, 2, 3, and 4 in a standard OC-48 ring. Nodes 5, 6, 7, and 8 link to the backbone ring through OC-12 fiber. The "virtual ring" formed by Nodes 5, 6, 7, and 8 uses both OC-48 and OC-12 cards.

Figure 11-20 PPMN Virtual Ring

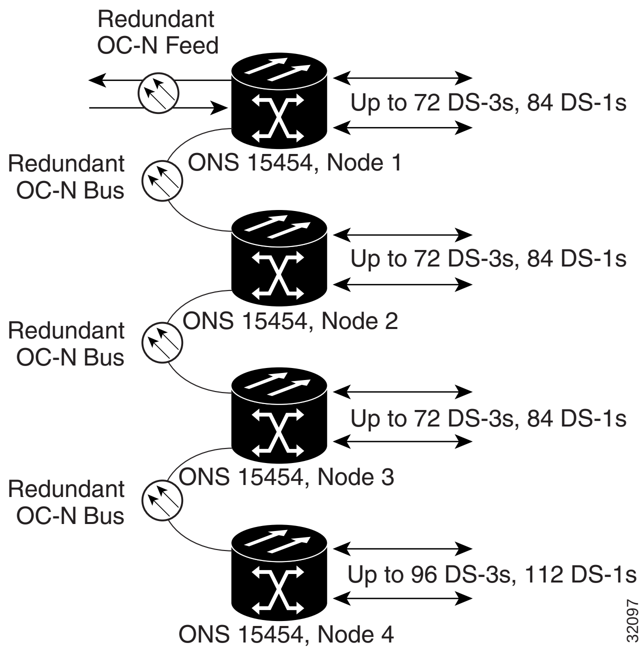


11.6 Four-Shelf Node Configurations

You can link multiple ONS 15454s using their OC-N cards (that is, create a fiber-optic bus) to accommodate more access traffic than a single ONS 15454 can support. Refer to the *Cisco ONS 15454 Procedure Guide*. For example, to drop more than 112 DS-1s or 96 DS-3s (the maximum that can be aggregated in a single node), you can link the nodes but not merge multiple nodes into a single ONS 15454. You can link nodes with OC-12 or OC-48 fiber spans as you would link any other two network nodes. The nodes can be grouped in one facility to aggregate more local traffic.

Figure 11-21 on page 11-21 shows a four-shelf node setup. Each shelf assembly is recognized as a separate node in the ONS 15454 software interface and traffic is mapped using CTC cross-connect options. In Figure 11-21, each node uses redundant fiber-optic cards. Node 1 uses redundant OC-N transport and OC-N bus (connecting) cards for a total of four cards, with eight free slots remaining. Nodes 2 and 3 each use two redundant OC-N bus cards for a total of four cards, with eight free slots remaining. Node 4 uses redundant OC-12 bus cards for a total of two cards, with ten free slots remaining. The four-shelf node example presented here is one of many ways to set up a multiple-node configuration.

Figure 11-21 Four-Shelf Node Configuration



11.7 OC-N Speed Upgrades

A span is the optical fiber connection between two ONS 15454 nodes. In a span (optical speed) upgrade, the transmission rate of a span is upgraded from a lower to a higher OC-N signal but all other span configuration attributes remain unchanged. With multiple nodes, a span upgrade is a coordinated series of upgrades on all nodes in the ring or protection group. You can perform in-service span upgrades for the following ONS 15454 cards:

- Single-port OC-12 to OC-48
- Single-port OC-12 to OC-192
- OC-48 to OC-192

You can also perform in-service card upgrades for the following ONS 15454 cards:

- Four-port OC-3 to eight-port OC-3
- Single-port OC-12 to four-port OC-12

Note Since the four-port OC-3 to eight-port OC-3 cards and the single-port OC-12 to four-port OC-12 cards are the same speed, they are not considered span upgrades.

Use the XC10G card, the TCC2 card, Software R4.0 or later, and the 15454-SA-ANSI shelf assembly to enable the OC48AS and the OC192 cards.

To perform a span upgrade, the higher-rate OC-N card must replace the lower-rate card in the same slot. If the upgrade is conducted on spans residing in a BLSR, all spans in the ring must be upgraded. The protection configuration of the original lower-rate OC-N card (two-fiber BLSR, four-fiber BLSR, path protection, and 1+1) is retained for the higher-rate OC-N card.

When performing span upgrades on a large number of nodes, we recommend that you upgrade all spans in a ring consecutively and in the same maintenance window. Until all spans are upgraded, mismatched card types are present.

We recommend using the Span Upgrade Wizard to perform span upgrades. Although you can also use the manual span upgrade procedures, the manual procedures are mainly provided as error recovery for the wizard. The Span Upgrade Wizard and the Manual Span Upgrade procedures require at least two technicians (one at each end of the span) who can communicate with each other during the upgrade. Upgrading a span is non-service affecting and causes no more than three switches, each of which is less than 50 ms in duration.

Note Span upgrades do not upgrade SONET topologies, for example, a 1+1 group to a two-fiber BLSR. Refer to the *Cisco ONS 15454 Procedure Guide* for topology upgrade procedures.

11.7.1 Span Upgrade Wizard

The Span Upgrade Wizard automates all steps in the manual span upgrade procedure (BLSR, path protection, and 1+1). The wizard can upgrade both lines on one side of a four-fiber BLSR or both lines of a 1+1 group; the wizard upgrades path protection configurations and two-fiber BLSRs one line at a time. The Span Upgrade Wizard requires that spans have DCCs enabled.

The Span Upgrade Wizard provides no way to back out of an upgrade. In the case of an error, you must exit the wizard and initiate the manual procedure to either continue with the upgrade or back out of it. To continue with the manual procedure, examine the standing conditions and alarms to identify the stage in which the wizard failure occurred.

11.7.2 Manual Span Upgrades

Manual span upgrades are mainly provided as error recovery for the Span Upgrade Wizard, but they can be used to perform span upgrades. Downgrading can be performed to back out of a span upgrade. The procedure for downgrading is the same as upgrading except that you choose a lower-rate card type. You cannot downgrade if circuits exist on the STSs that will be removed (the higher STSs).

Procedures for manual span upgrades can be found in the "Upgrade Cards and Spans" chapter in the *ONS 15454 SDH Procedure Guide.* Five manual span upgrade options are available:

- Upgrade on a two-fiber BLSR
- Upgrade on a four-fiber BLSR
- Upgrade on a path protection
- Upgrade on a 1+1 protection group
- Upgrade on an unprotected span

DWDM Topologies

This chapter explains Cisco ONS 15454 dense wavelength division multiplexing (DWDM) topologies.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

There are two main DWDM network types, metro core, where the channel power is equalized and dispersion compensation is applied, and metro access, where the channels are not equalized and dispersion compensation is not applied. Metro Core networks often include multiple spans and amplifiers, thus making optical signal-to-noise ratio (OSNR) the limiting factor for channel performance. Metro Access networks often include a few spans with very low span loss; therefore, the signal link budget is the limiting factor for performance. The DWDM network topologies supported are: hubbed rings, multihubbed rings, meshed rings, linear configurations, and single-span links.

The DWDM node types supported are: hub, terminal, optical add/drop multiplexing (OADM), anti-amplified spontaneous emissions (ASE), and line amplifier. The hybrid node types supported are: 1+1 protected flexible terminal, scalable terminal, hybrid terminal, hybrid OADM, hybrid line amplifier, and amplified time-division multiplexing (TDM).

Note For information about DWDM cards, see Chapter 6, "DWDM Cards." For DWDM and hybrid node turn up and network turn up procedures, refer to the "DWDM Node Turn Up" chapter and the "DWDM Network Turn Up" chapter in the *Cisco ONS 15454 Procedure Guide*.

Chapter topics include:

12.1 DWDM Rings and TCC2 Cards

Table 12-1 shows the DWDM rings that can be created on each ONS 15454 node using redundant TCC2 cards.

Table 12-1 ONS 15454 Rings with Redundant TCC2 Cards

Ring Type	Maximum Rings per Node
Hubbed rings	1
Multihubbed rings	1
Meshed rings	1
Linear configurations	1
Single-span link	1
Hybrid rings	1 DWDM ring[1]

1. The number of TDM bidirectional line switch rings (BLSRs) and path protection configurations depends on slot availability. See Table 11-1ONS 15454 Rings with Redundant TCC2 Cards, page 1 for more information about TDM ring capacity.

12.2 DWDM Node Types

The node type in a network configuration is determined by the type of amplifier and filter cards that are installed in an ONS 15454 DWDM node. The ONS 15454 supports the following DWDM node types: hub, terminal, OADM, anti-ASE, and line amplifier.

Note The MetroPlanner tool creates a plan for amplifier placement and proper node equipment.

12.2.1 Hub Node

A hub node is a single ONS 15454 node equipped with at least two 32-channel multiplexer (32 MUX-O) cards, two 32-channel demultiplexer (32 DMX-O) cards, and two TCC2 cards. A dispersion compensation unit (DCU) can also be added, if necessary. The hub node does not support both DWDM and TDM applications since the DWDM slot requirements do not leave room for TDM cards. Figure 12-1 shows a typical hub node configuration.

Note The OADM AD-xC-xx.x or AD-xB-xx.x cards are not part of a hub node because the 32 MUX-O and 32 DMX-O cards drop and add all 32 channels; therefore, no other cards are necessary.

Figure 12-1 Hub Node Configuration Example

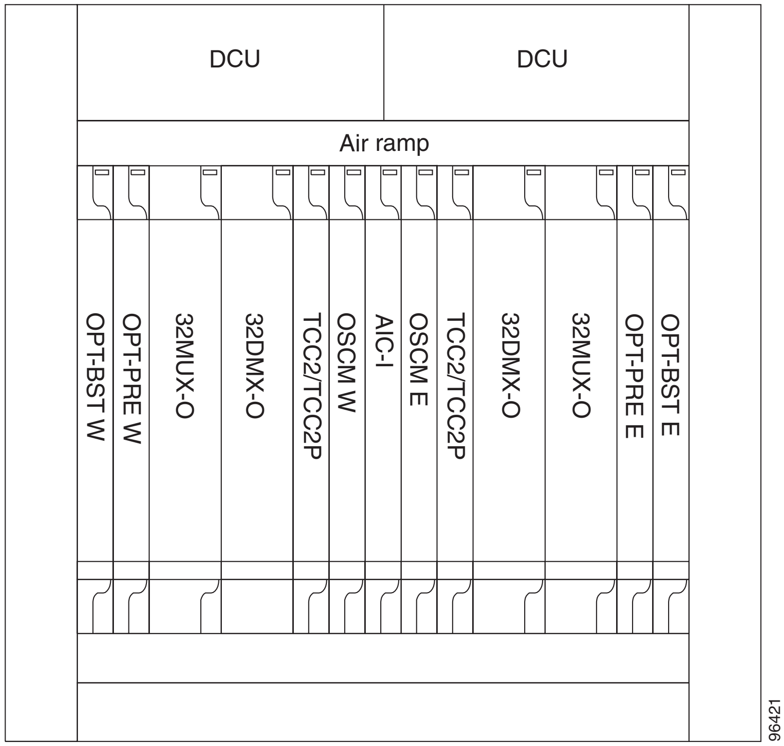
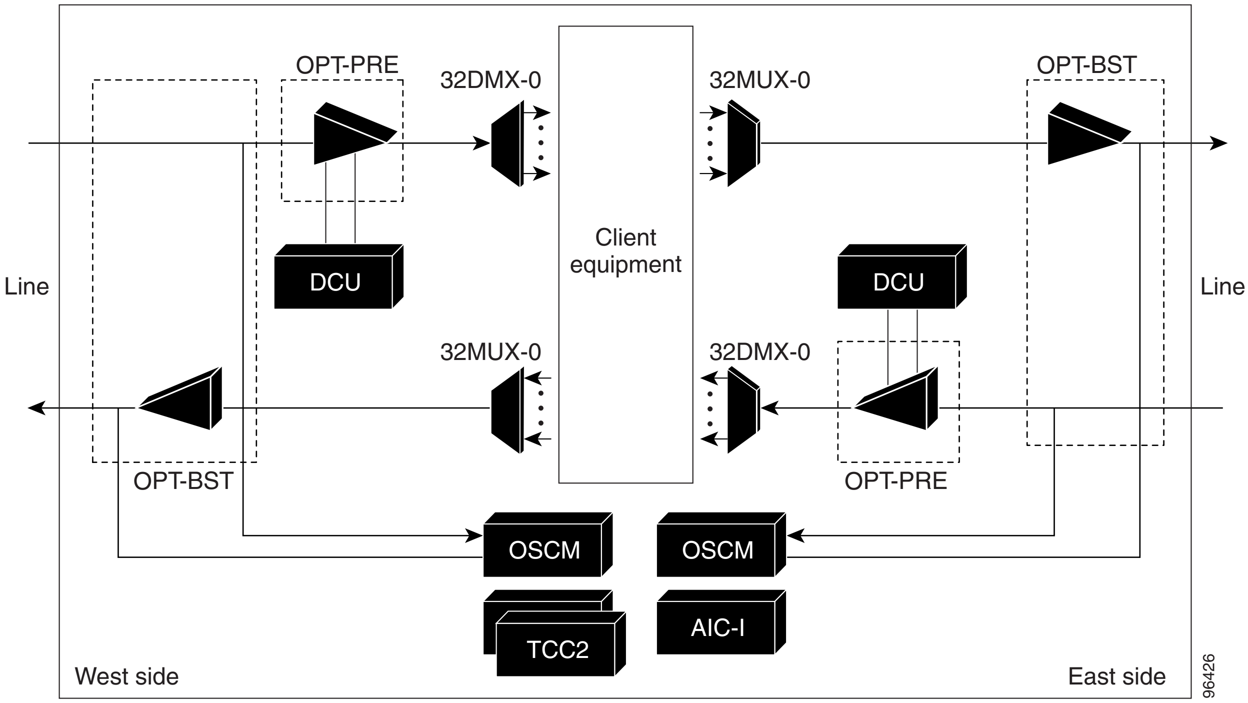


Figure 12-2 shows the channel flow for a hub node. Up to 32-channels from the client ports are multiplexed and equalized onto one fiber using the 32 MUX-O card. Then, multiplexed channels are transmitted on the line in the eastward direction and fed to the Optical Booster (OPT-BST) amplifier. The output of this amplifier is combined with an output signal from the optical service channel modem (OSCM) card, and transmitted toward the east line.

Received signals from the east line port are split between the OSCM card and an Optical Preamplifier (OPT-PRE). Dispersion compensation is applied to the signal received by the OPT-PRE amplifier, and it is then sent to the 32 DMX-O card, which demultiplexes and attenuates the input signal. The west receive fiber path is identical through the west OPT-BST amplifier, the west OPT-PRE amplifier, and the west 32 DMX-O card.

Figure 12-2 Hub Node Channel Flow Example

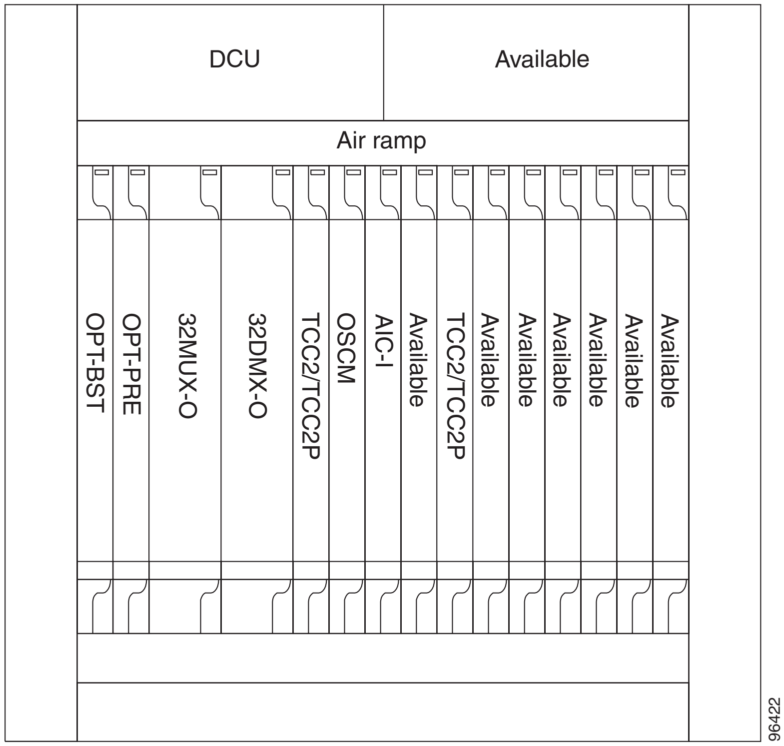


12.2.2 Terminal Node

A hub node can be changed into a terminal node by removing either the east or west cards. A terminal node is a single ONS 15454 node equipped with at least one 32 MUX-O card, one 32 DMX-O card, and two TCC2 cards. Figure 12-3 shows an example of an east terminal configuration. The channel flow for a terminal node is the same as the hub node (see Figure 12-2).

Note AD-xC-xx.x or AD-xB-xx.x cards are not part of a terminal node because pass-through connections are not allowed. However the AD-4C-xx.x card does support linear end nodes (terminals) in Release 4.6.

Figure 12-3 Terminal Node Configuration Example



12.2.3 OADM Node

An OADM node is a single ONS 15454 node equipped with at least one AD-xC-xx.x card or one AD-xB-xx.x card and two TCC2 cards. The 32 MUX-O or 32 DMX-O cards should not be provisioned. In an OADM node, channels can be added or dropped independently from each direction, passed through the reflected bands of all OADMs in the DWDM node (called express path), or passed through one OADM card to another OADM card without using a TDM ITU line card (called optical pass through).

Unlike express path, an optical pass-through channel can be converted later to an add/drop channel in an altered ring without affecting another channel. OADM amplifier placement and required card placement is determined by the MetroPlanner tool or your site plan.

There are different categories of OADM nodes, such as amplified, passive, and anti-ASE. For anti-ASE node information, see the "12.2.4 Anti-ASE Node" section on page 12-9.

Figure 12-4 shows an example of an amplified OADM node configuration.

Figure 12-4 Amplified OADM Node Configuration Example

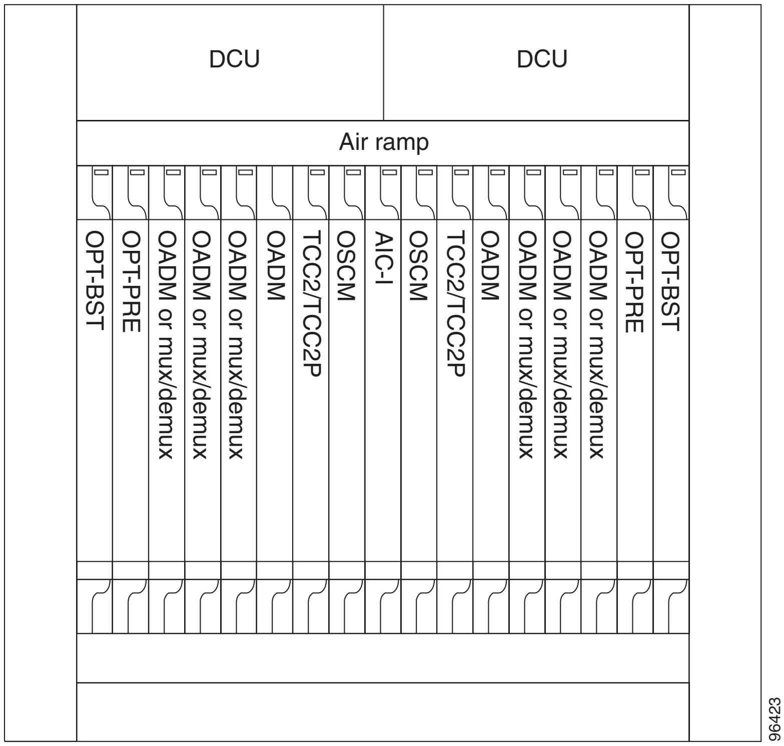


Figure 12-5 shows an example of a passive OADM node configuration.

Figure 12-5 Passive OADM Node Configuration Example

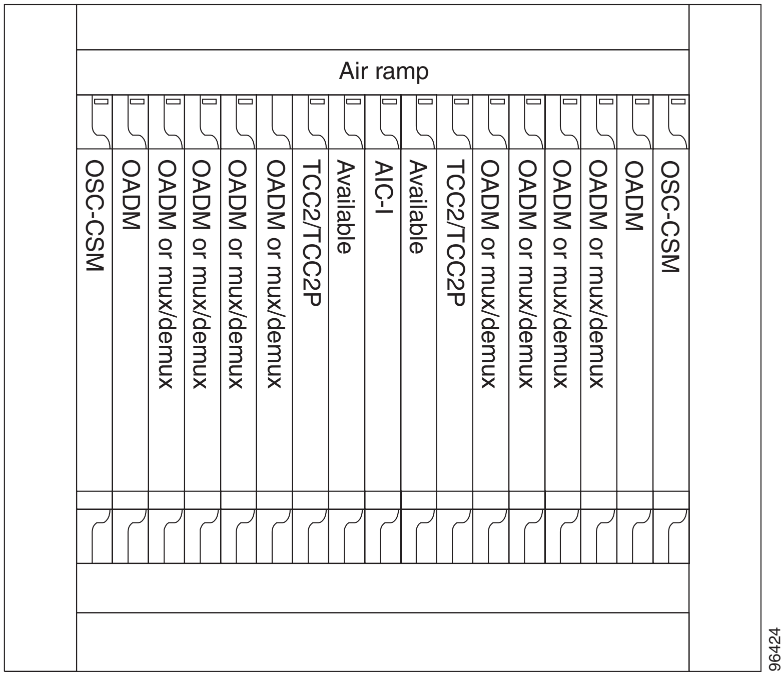


Figure 12-6 shows an example of the channel flow on the amplified OADM node. Since the 32-wavelength plan is based on eight bands (each band contains four channels), optical adding and dropping can be performed at the band level and/or at the channel level (meaning individual channels can be dropped). An example of an OADM node created using band or channel filters is shown in Figure 12-6. The OPT-PRE and the OPT-BST amplifiers are installed on the east and west sides of the node. Only one band, one four-channel multiplexer/demultiplexer, and one-channel OADMs are installed on the east and west sides of the node.

Figure 12-6 Amplified OADM Node Channel Flow Example

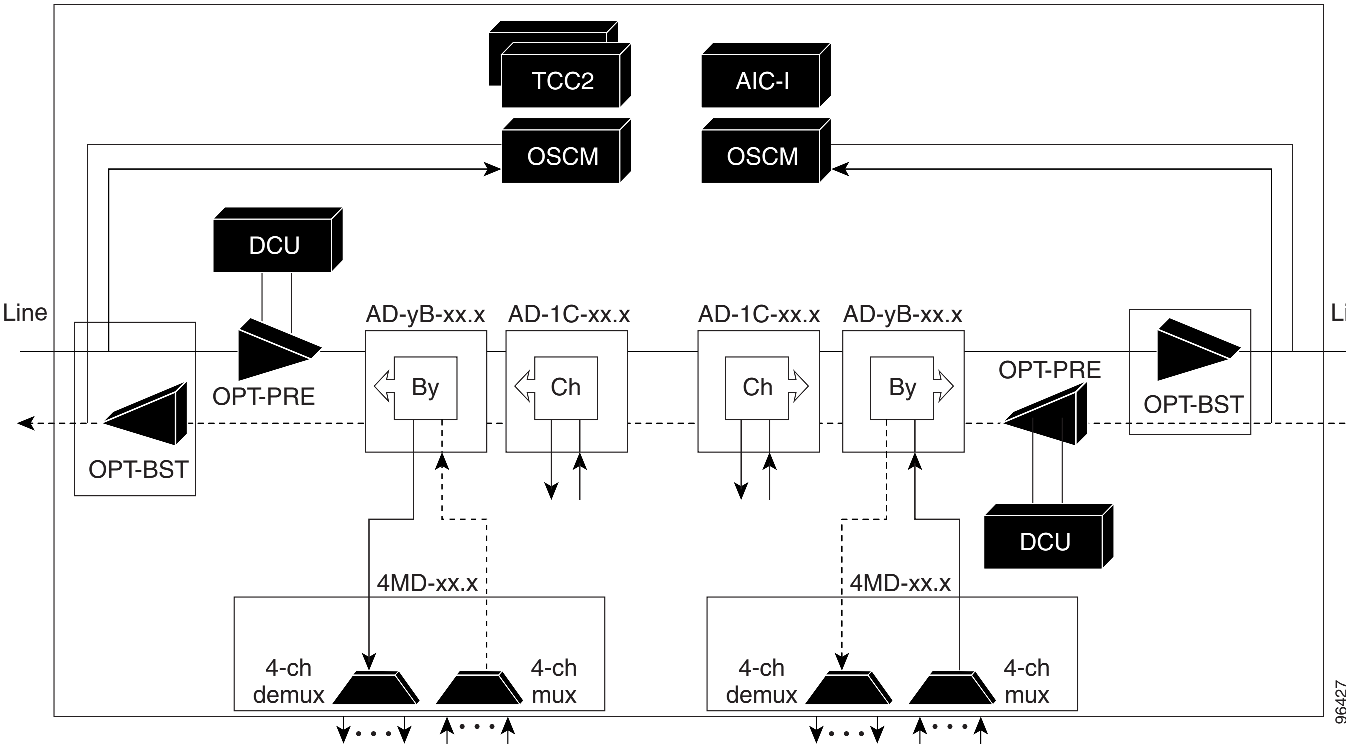
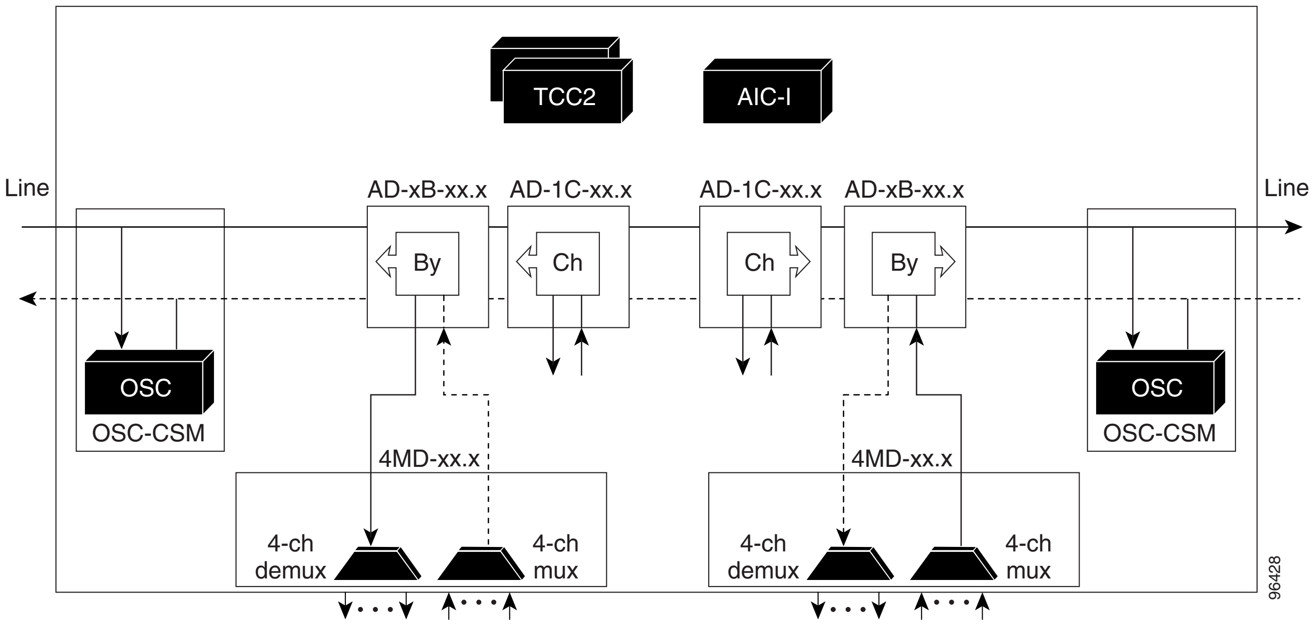


Figure 12-7 shows an example of traffic flow on the passive OADM node. The passive OADM node is equipped with a band filter, one four-channel multiplexer/demultiplexer, and a channel filter on each side of the node. The signal flow of the channels is the same as described in Figure 12-6 except that the Optical Service Channel and Combiner/Separator Module (OSC-CSM) card is being used instead of the OPT-BST amplifier and the OSCM card.

Figure 12-7 Passive OADM Node Channel Flow Example



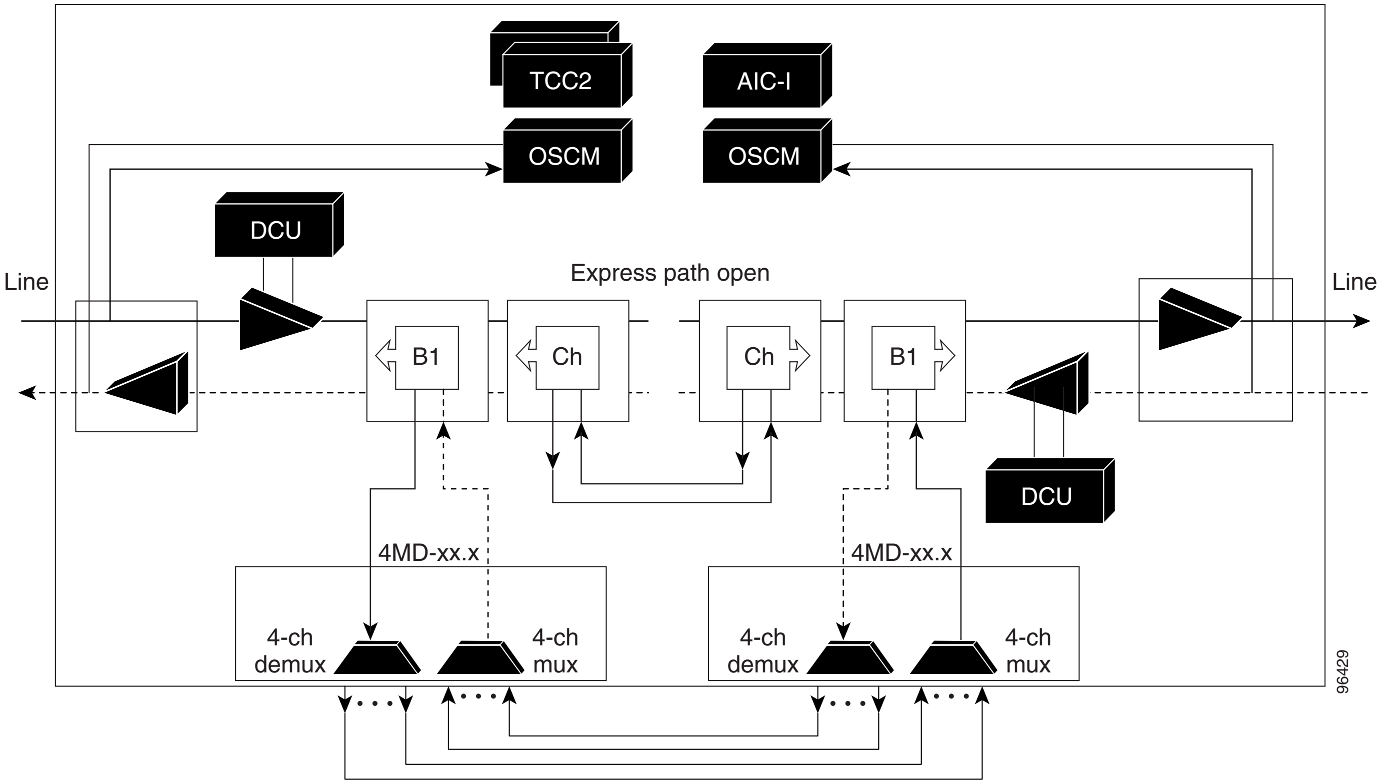
12.2.4 Anti-ASE Node

In a meshed ring network, the ONS 15454 requires a node configuration that prevents amplified spontaneous emission (ASE) accumulation and lasing. An anti-ASE node can be created by configuring a hub node or an OADM node with some modifications. No channels can travel through the express path, but they can be demultiplexed and dropped at the channel level on one side and added and multiplexed on the other side.

The hub node is the preferred node configuration when some channels are connected in pass-through mode. For rings that require a limited number of channels, combine AD-xB-xx.x and 4MD-xx.x cards, or cascade AD-xC-xx.x cards. See Figure 12-6 on page 12-8.

Figure 12-8 shows an anti-ASE node that uses all wavelengths in the pass-through mode. Use MetroPlanner or another network planning tool to determine the best configuration for anti-ASE nodes.

Figure 12-8 Anti-ASE Node Channel Flow Example

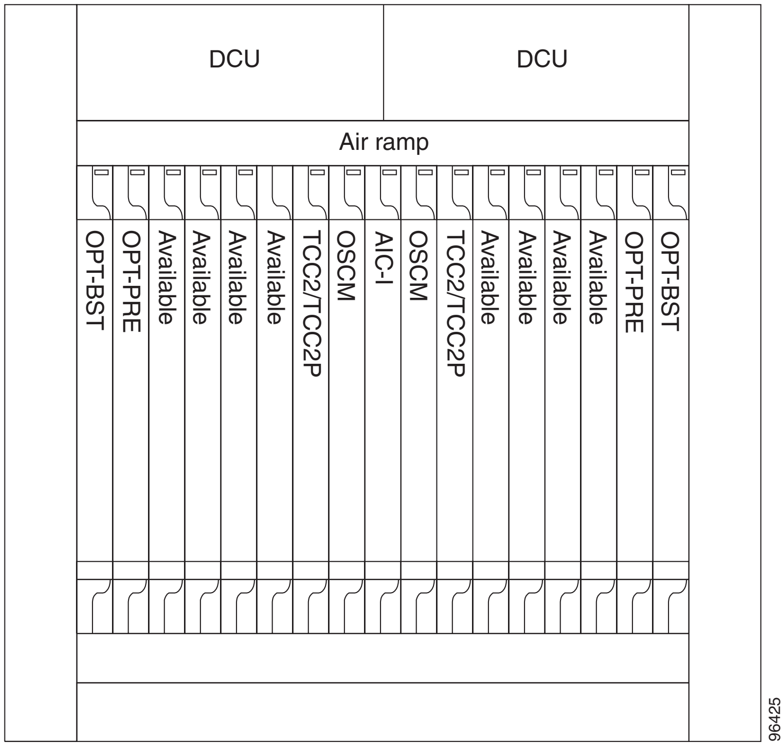


12.2.5 Line Amplifier Node

A line node is a single ONS 15454 node equipped with OPT-PRE amplifiers or OPT-BST amplifiers and TCC2 cards. Attenuators might also be required between each preamplifier and booster amplifier to match the optical input power value and to maintain the amplifier gain tilt value.

Two OSCM cards are connected to the east or west ports of the booster amplifiers to multiplex the optical service channel (OSC) signal with the pass-though channels. If the node does not contain OPT-BST amplifiers, you must use OSC-CSM cards rather than OSCM cards in your configuration. Figure 12-9 shows an example of a line node configuration.

Figure 12-9 Line Node Configuration Example



12.3 DWDM and TDM Hybrid Node Types

The node type in a network configuration is determined by the type of card that is installed in an ONS 15454 hybrid node. The ONS 15454 supports the following hybrid DWDM and TDM node types: 1+1 protected flexible terminal, scalable terminal, hybrid terminal, hybrid OADM, hybrid line amplifier, and amplified TDM.

Note The MetroPlanner tool creates a plan for amplifier placement and proper equipment for DWDM node configurations. Although TDM cards can be used with DWDM node configuration, the MetroPlanner tool does not create a plan for TDM card placement. MetroPlanner will support TDM configurations in a future release.

12.3.1 1+1 Protected Flexible Terminal Node

The 1+1 protected flexible terminal node is a single ONS 15454 node equipped with a series of OADM cards acting as a hub node configuration. This configuration uses a single hub or OADM node connected directly to the far-end hub or OADM node through four fiber links. This node type is used in a ring configured with two point-to-point links. The advantage of the 1+1 protected flexible terminal node configuration is that it provides path redundancy for 1+1 protected TDM networks (two transmit paths and two receive paths) using half of the DWDM equipment that is usually required. In the following example (Figure 12-10), one node transmits traffic to the other node on both east and west sides of the ring for protection purposes. If the fiber is damaged on one side of the ring, traffic still arrives safely through fiber on the other side of the ring.

Figure 12-10 Double Terminal Protection Configuration

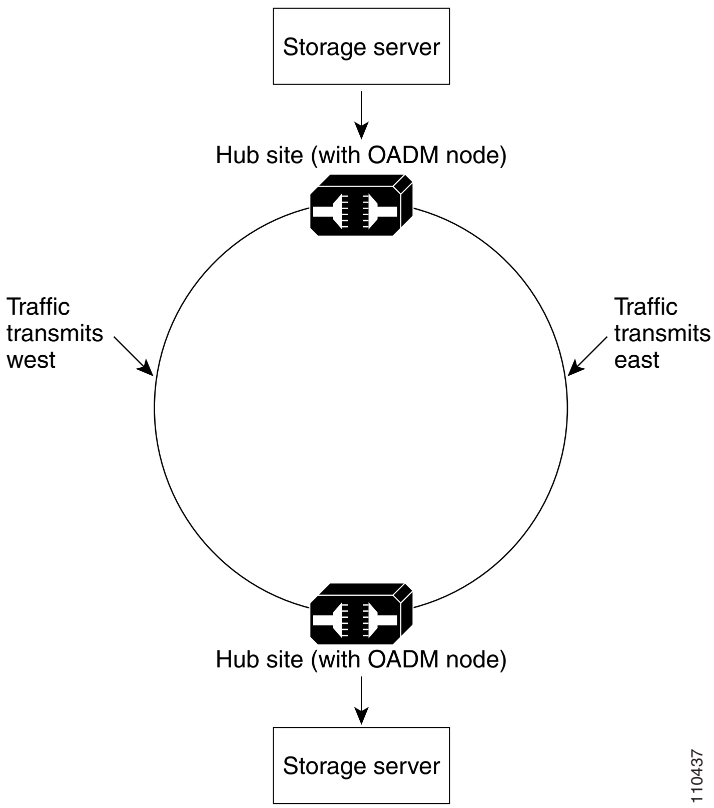


Figure 12-11 shows a 1+1 protected single-span link with hub nodes. This node type cannot be used in a hybrid configuration.

Figure 12-11 1+1 Protected Single-Span Link with Hub Nodes

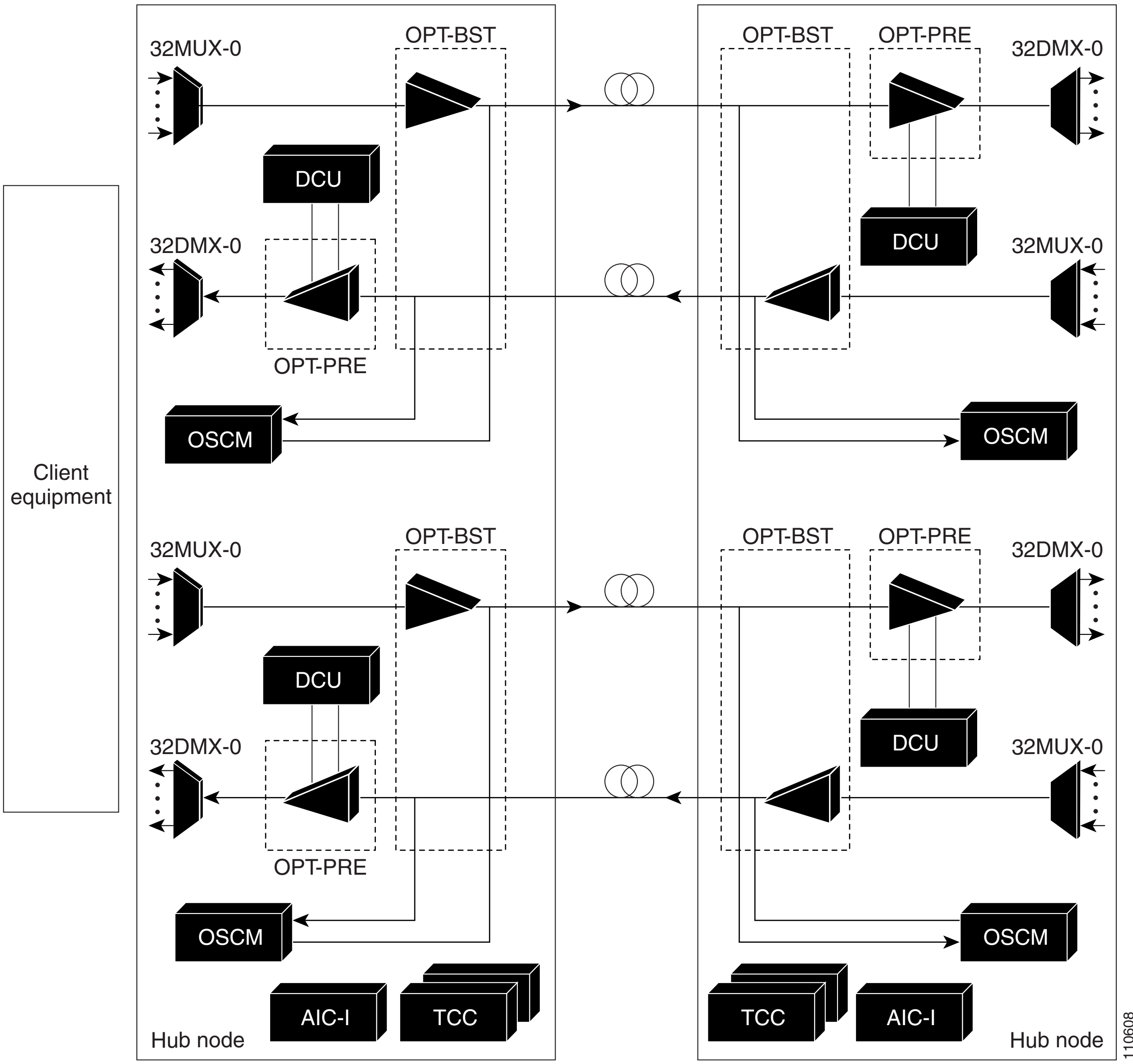


Figure 12-12 shows a 1+1 protected single-span link with active OADM nodes. This node type can be used in a hybrid configuration.

Figure 12-12 1+1 Protected Single-Span Link with Active OADM Nodes

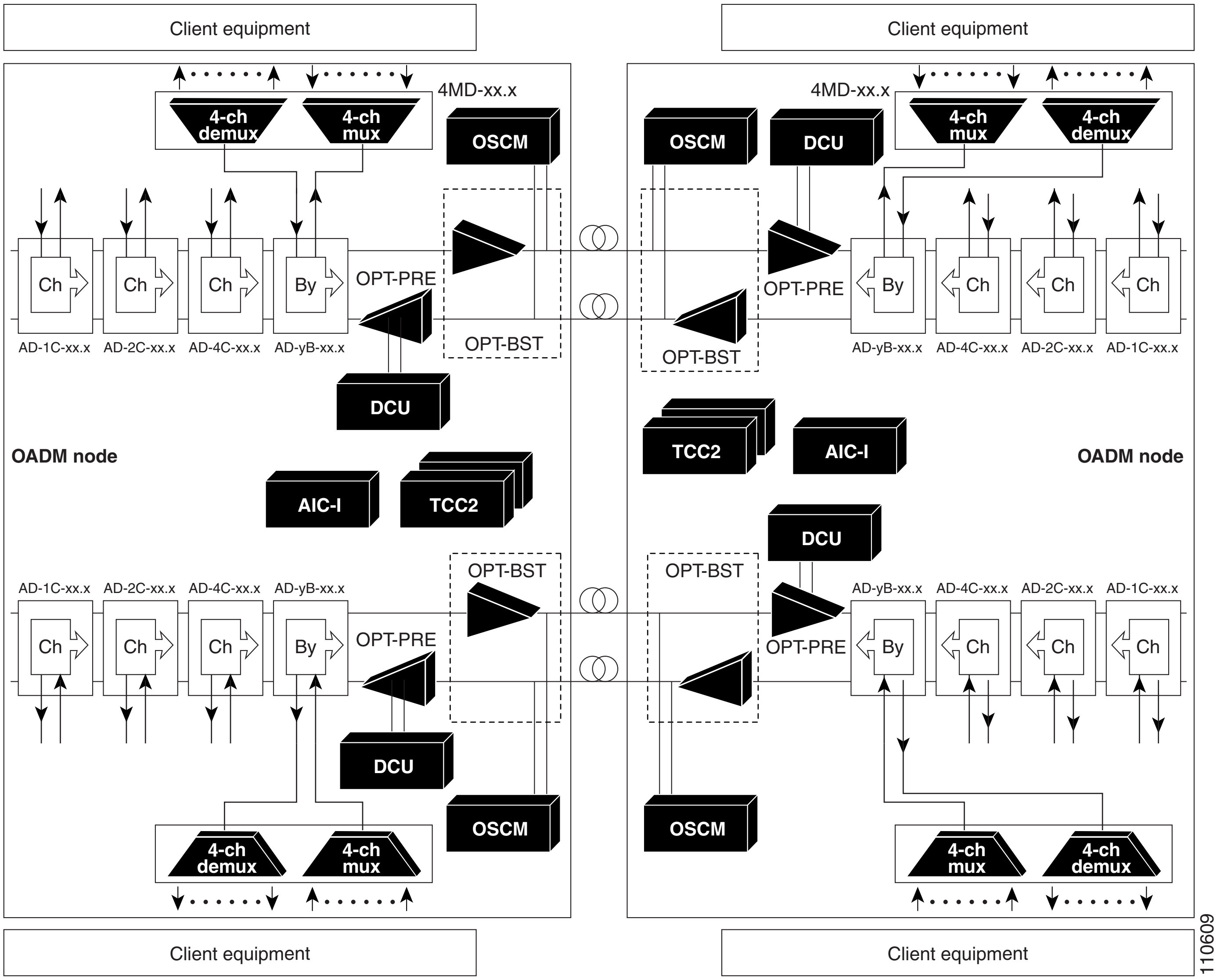
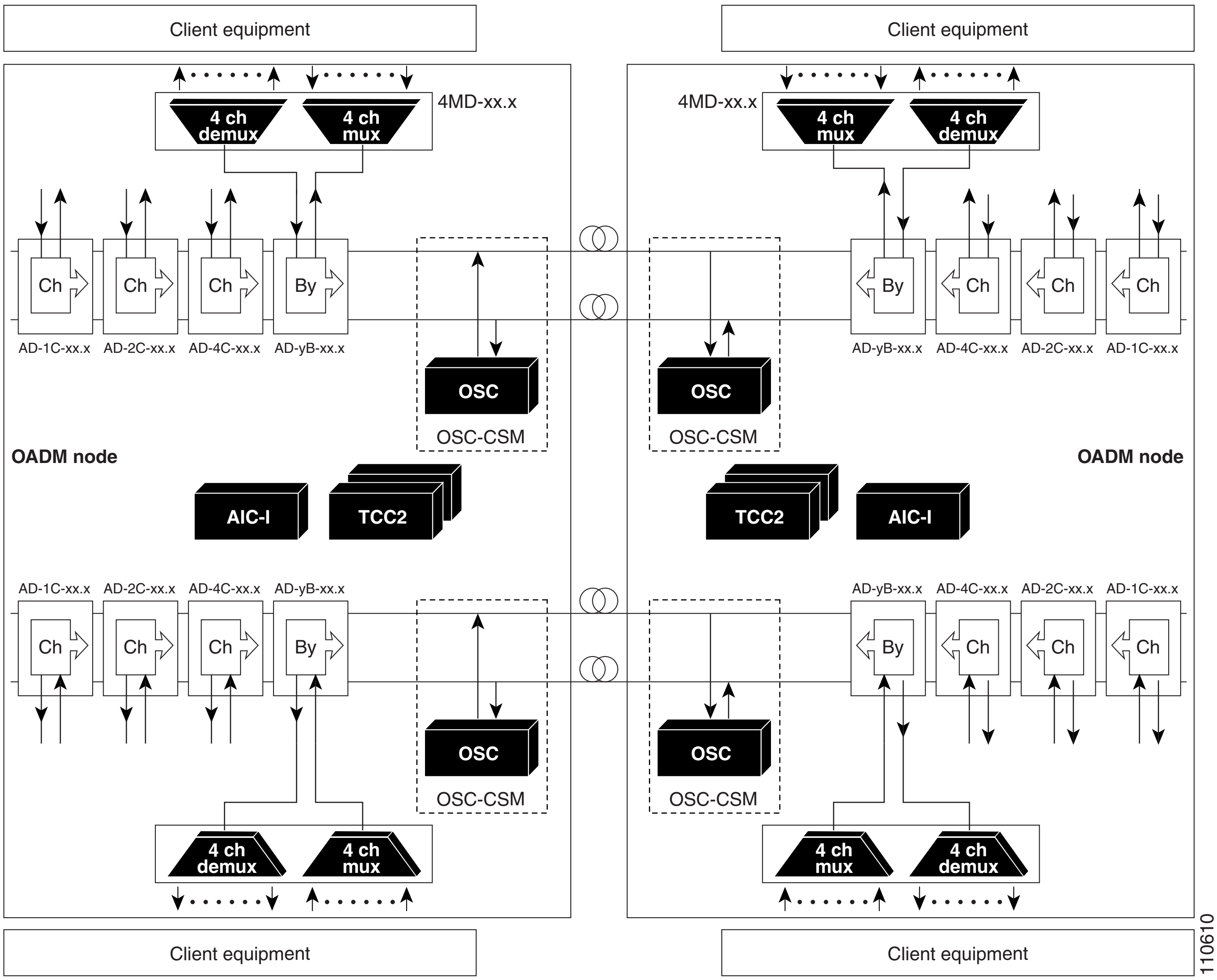


Figure 12-13 shows a 1+1 protected single-span link with passive OADM nodes. This node type can be used in a hybrid configuration.

Figure 12-13 1+1 Protected Single-Span Link with Passive OADM Nodes



12.3.2 Scalable Terminal Node

The scalable terminal node is a single ONS 15454 node equipped with a series of OADM cards and amplifier cards. This node type is more cost effective if a maximum of 16 channels are used (Table 12-2). This node type does not support a terminal configuration exceeding 16 channels because the 32-channel terminal site is more cost effective for 17 channels and beyond.

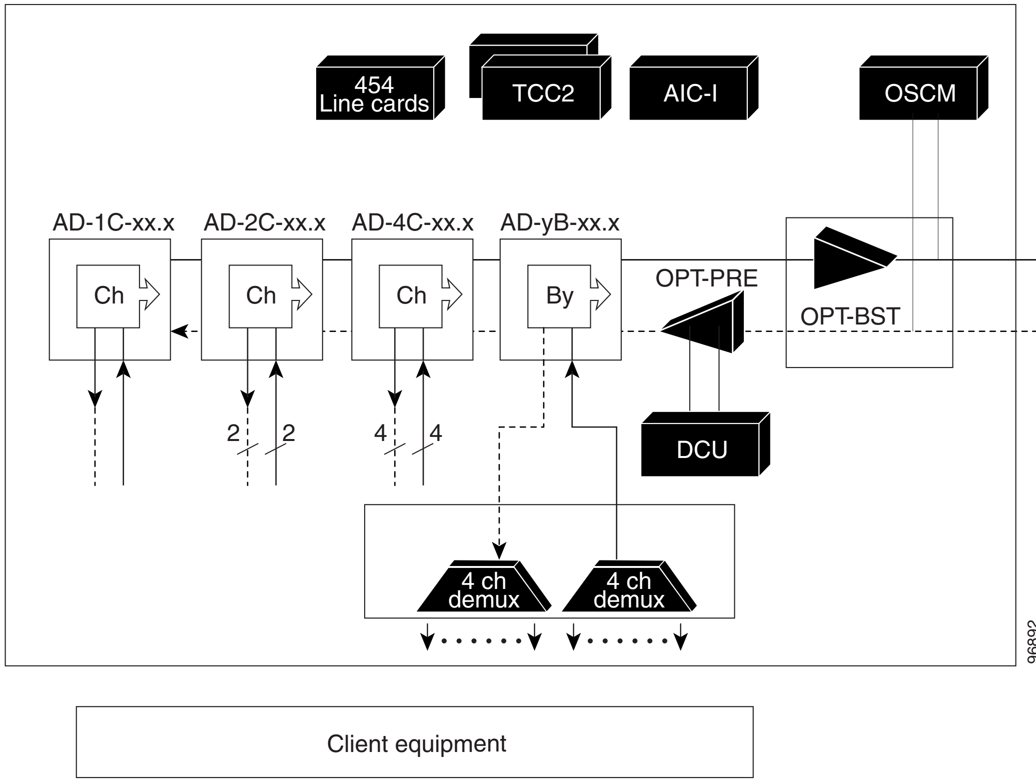
Note The dash (—) in the table below means not applicable.

Table 12-2 Typical AD Configurations for Scalable Terminal Nodes

Number of Channels	Terminal Configuration	
	Option 1	Option 2
1	AD-1C-xx.x	—
2	AD-2C-xx.x	—
3	AD-4C-xx.x	AD-1B-xx.x + 4MD-xx.x
4	AD-4C-xx.x	AD-1B-xx.x + 4MD-xx.x
5	AD-1C-xx.x + AD-4C-xx.x	AD-1C-xx.x + AD-1B-xx.x + 4MD-xx.x
6	AD-2C-xx.x + AD-4C-xx.x	AD-2C-xx.x + AD-1B-xx.x + 4MD-xx.x
7	2 x AD-4C-xx.x	2 x (AD-1B-xx.x + 4MD-xx.x)
8	2 x AD-4C-xx.x	2 x (AD-1B-xx.x + 4MD-xx.x)
9	AD-1C-xx.x + (2 x AD-4C-xx.x)	AD-1C-xx.x + 2 x (AD-1B-xx.x + 4MD-xx.x)
10	AD-2C-xx.x + (2 x AD-4C-xx.x)	AD-2C-xx.x + 2 x (AD-1B-xx.x + 4MD-xx.x)
11	3 x AD-4C-xx.x	AD-4B-xx.x + (3 x 4MD-xx.x)
12	3 x AD-4C-xx.x	AD-4B-xx.x + (3 x 4MD-xx.x)
13	AD-4B-xx.x + (3 x 4MD-xx.x) + AD-1C-xx.x	AD-4B-xx.x + (4 x 4MD-xx.x)
14	AD-4B-xx.x + (3 x 4MD-xx.x) + AD-1C-xx.x	AD-4B-xx.x + (4 x 4MD-xx.x)
15	—	AD-4B-xx.x + (4 x 4MD-xx.x)
16	—	AD-4B-xx.x + (4 x 4MD-xx.x)

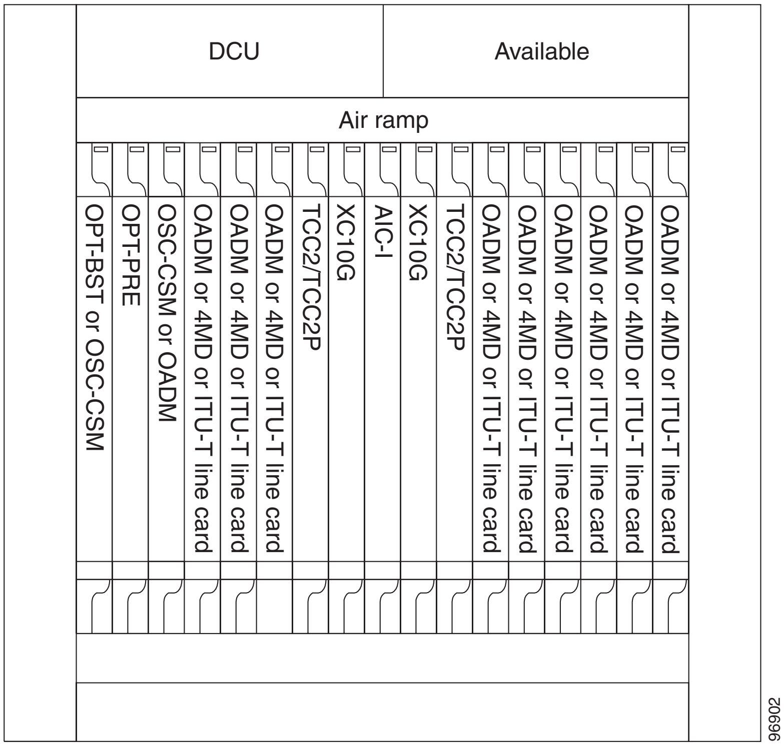
The OADM cards that can be used in this type of node are: AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, and AD-1B-xx.x. You can also use AD-4B-xx.x and up to four 4MD-xx.x cards. The OPT-PRE and/or OPT-BST amplifiers can be used. The OPT-PRE or OPT-BST configuration depends on the node loss and the span loss. When the OPT-BST is not installed, the OSC-CSM must be used instead of the OSCM card. Figure 12-14 on page 12-17 shows a channel flow example of a scalable terminal node configuration.

Figure 12-14 Scalable Terminal Channel Flow Example



A scalable terminal node can be created by using band and/or channel OADM filter cards. This node type is the most flexible of all node types because the OADM filter cards can be configured to accommodate node traffic. If the node does not contain amplifiers, it is considered a passive hybrid terminal node. Figure 12-15 shows an example of a scalable terminal node configuration. This node type can be used without add or drop cards.

Figure 12-15 Scalable Terminal Example



12.3.3 Hybrid Terminal Node

A hybrid terminal node is a single ONS 15454 node equipped with at least one 32 MUX-O card, one 32 DMX-O card, two TCC2 cards, and TDM cards. If the node is equipped with OPT-PRE or OPT-BST amplifiers, it is considered an amplified terminal node. The node becomes passive if the amplifiers are removed. The hybrid terminal node type is based on the DWDM terminal node type described in the "12.2.2 Terminal Node" section on page 12-4. Figure 12-16 shows an example of an amplified hybrid terminal node configuration.

Figure 12-16 Amplified Hybrid Terminal Example

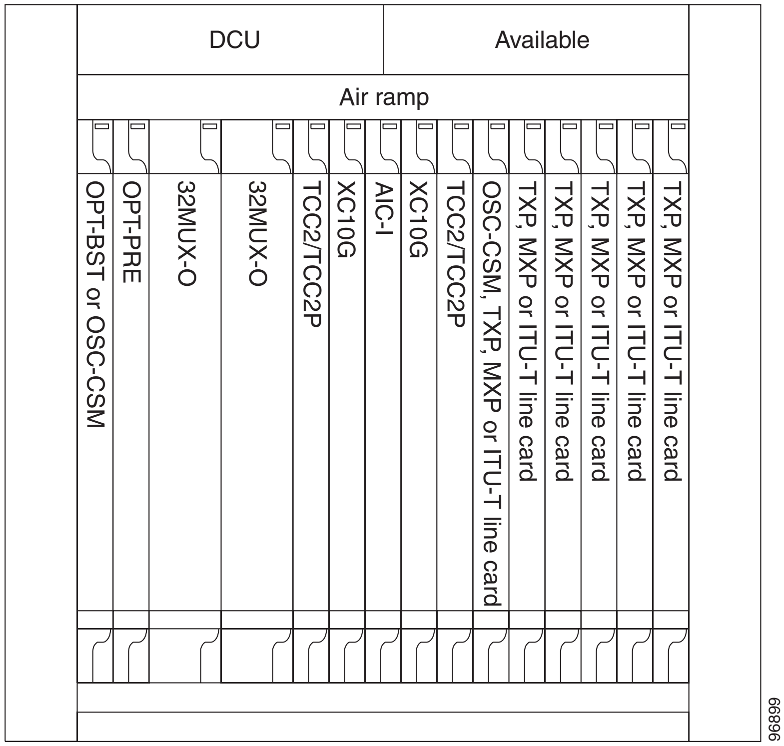
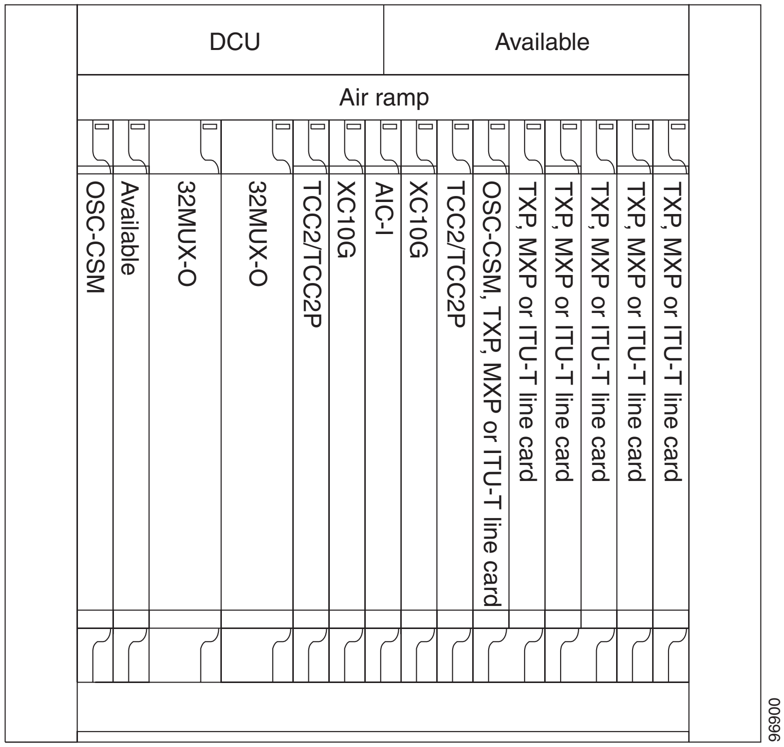


Figure 12-17 shows an example of a passive hybrid terminal node configuration.

Figure 12-17 Passive Hybrid Terminal Example

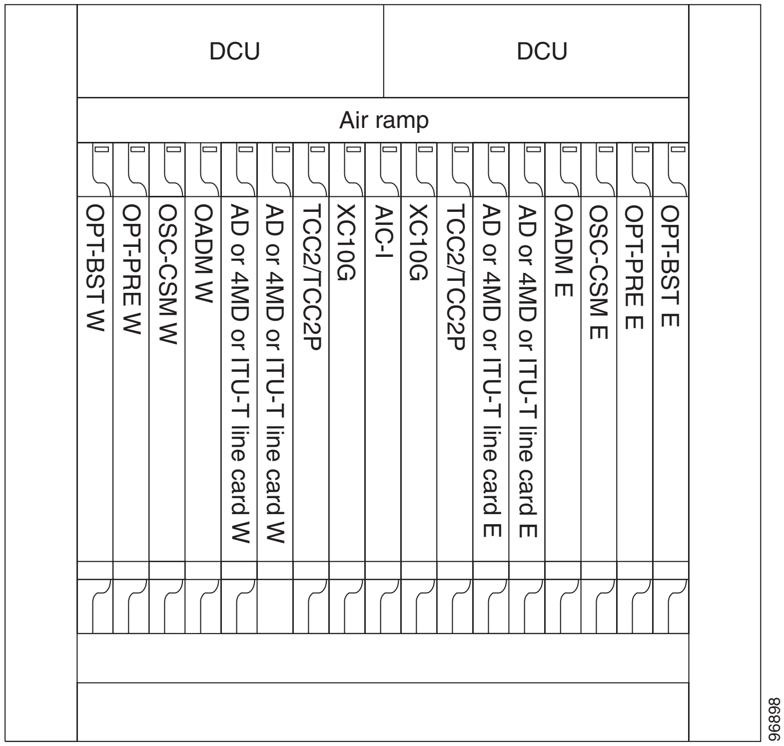


12.3.4 Hybrid OADM Node

A hybrid OADM node is a single ONS 15454 node equipped with at least one AD-xC-xx.x card or one AD-xB-xx.x card, and two TCC2 cards. The hybrid OADM node type is based on the DWDM OADM node type described in the "12.2.3 OADM Node" section on page 12-5. TDM cards can be installed in any available slot. Review the plan produced by MetroPlanner to determine slot availability.

Figure 12-18 shows an example of an amplified hybrid OADM node configuration. The hybrid OADM node can also become passive by removing the amplifier cards.

Figure 12-18 Hybrid Amplified OADM Example



12.3.5 Hybrid Line Amplifier Node

A hybrid line amplifier node is a single ONS 15454 node with open slots for both TDM and DWDM cards. Figure 12-19 shows an example of an hybrid line amplifier node configuration. Figure 12-20 on page 12-23 shows a channel flow example of a hybrid line node configuration. Since this node contains both TDM and DWDM rings, both TDM and DWDM rings should be terminated even if no interactions are present between them.

Note For DWDM applications, if the OPT-BST is not installed within the node, the OSC-CSM card must be used instead of the OSCM card.

Figure 12-19 Hybrid Line Amplifier Example

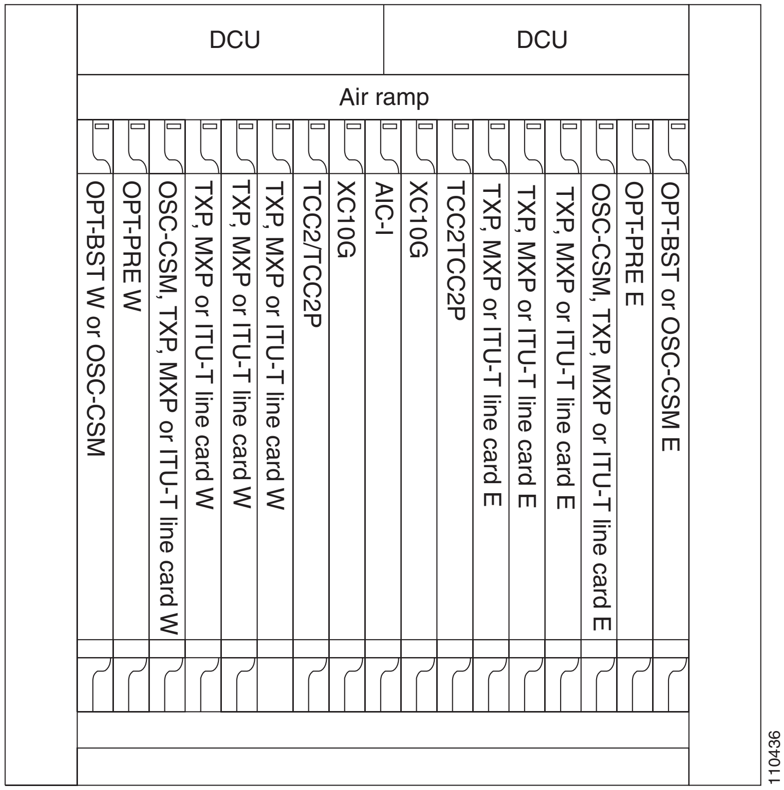
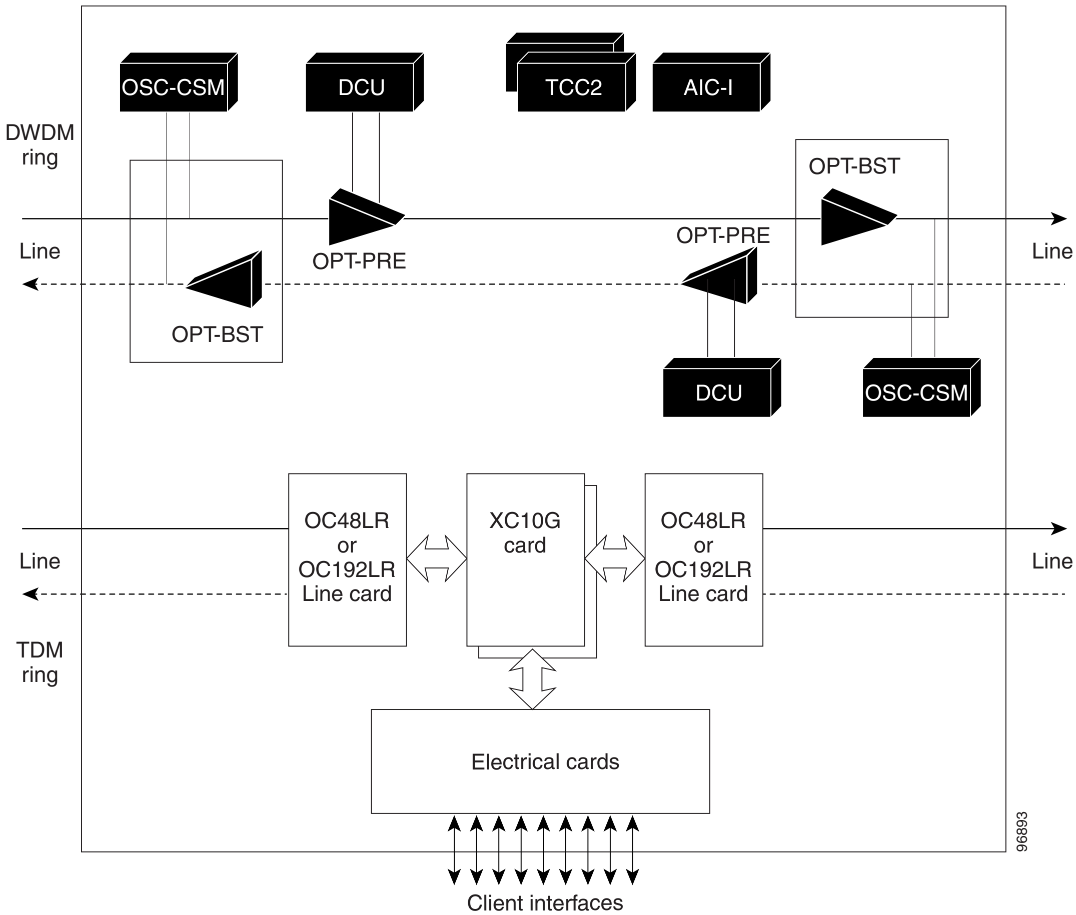


Figure 12-20 Hybrid Line Amplifier Channel Flow Example



A hybrid line node is another example of the hybrid line amplifier OADM node. A hybrid line node is single ONS 15454 node equipped with OPT-PRE amplifiers, OPT-BST amplifiers, and TCC2 cards for each line direction. Both types of amplifiers can be used or just one type of amplifier. Attenuators might also be required between each preamplifier and booster amplifier to match the optical input power value and to maintain the amplifier gain tilt value. TDM cards can be installed in any available slot. Review the plan produced by MetroPlanner to determine slot availability.

12.3.6 Amplified TDM Node

An amplified TDM node is a single ONS 15454 node that increases the span length between two ONS 15454 nodes that contain TDM cards and optical amplifiers. There are three possible installation configurations for an amplified TDM node. Scenario 1 uses client cards and OPT-BST amplifiers. Scenario 2 uses client cards, OPT-BST amplifiers, OPT-PRE amplifiers, and FlexLayer filters. Scenario 3 uses client cards, OPT-BST amplifiers, OPT-PRE amplifiers, AD-1C-xx.x cards, and OSC-CSM cards.

The client cards that can be used in an amplified TDM node are: TXP_MR_10G, MXP_2.5G_10G, TXP_MR_2.5G, TXPP_MR_2.5G, OC-192 LR/STM 64 ITU 15xx.xx, and OC-48 ELR/STM 16 EH 100 GHz.

Figure 12-21 shows the first amplified TDM node scenario with an OPT-BST amplifier.

Figure 12-21 Amplified TDM Example with an OPT-BST Amplifier

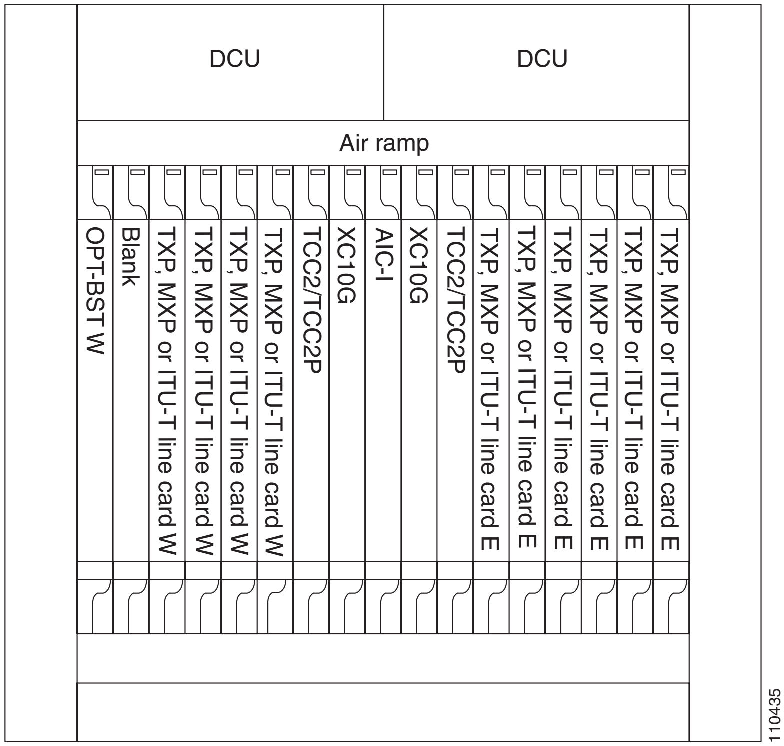


Figure 12-22 shows the first amplified TDM node channel flow scenario configured with OPT-BST amplifiers.

Figure 12-22 Amplified TDM Channel Flow Example With OPT-BST Amplifiers

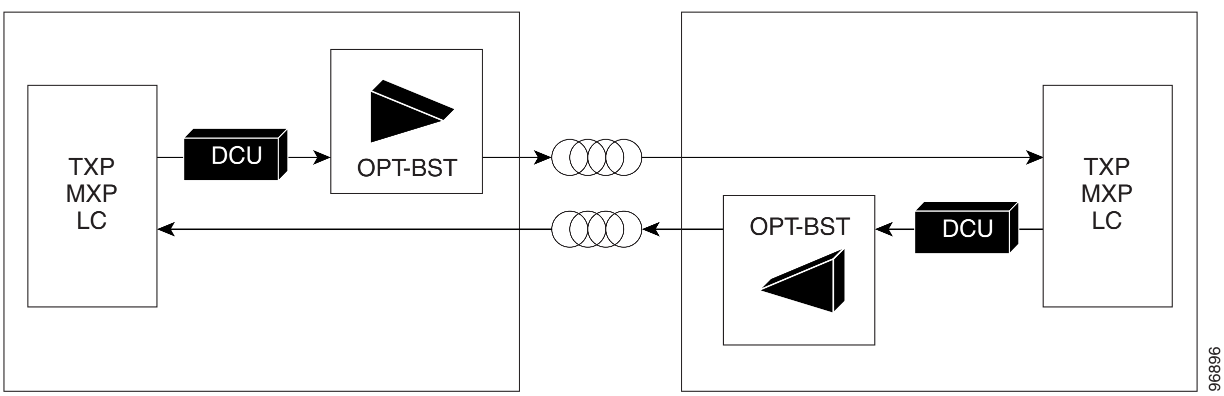


Figure 12-23 shows the second amplified TDM node configuration scenario with client cards, AD-1C-xx.x cards, OPT-BST amplifiers, OPT-PRE amplifiers, and FlexLayer filters.

Figure 12-23 Amplified TDM Example with FlexLayer Filters

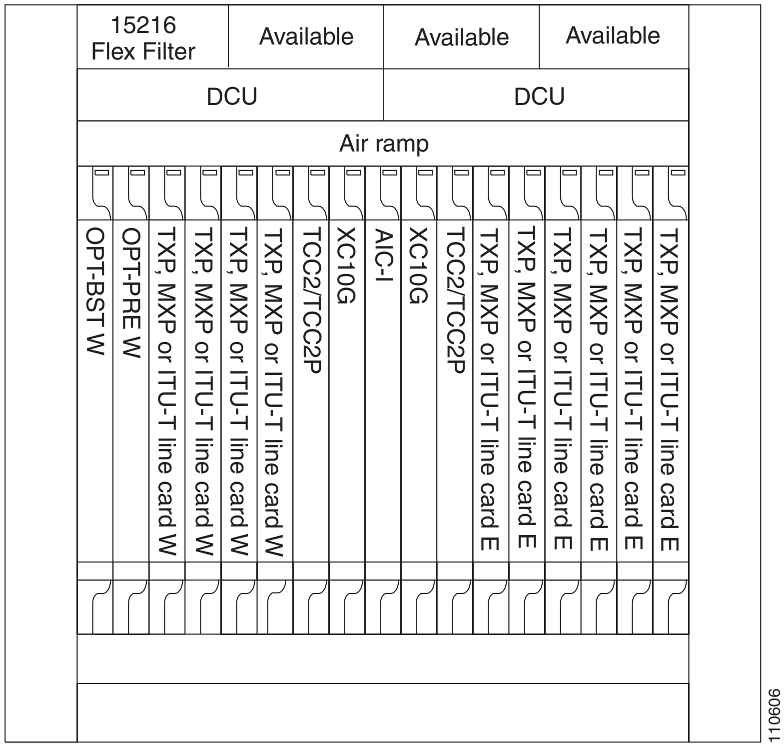


Figure 12-24 shows the second amplified TDM node channel flow configuration scenario with client cards, OPT-BST amplifiers, OPT-PRE amplifiers, and FlexLayer filters.

Figure 12-24 Amplified TDM Channel Flow Example With FlexLayer Filters

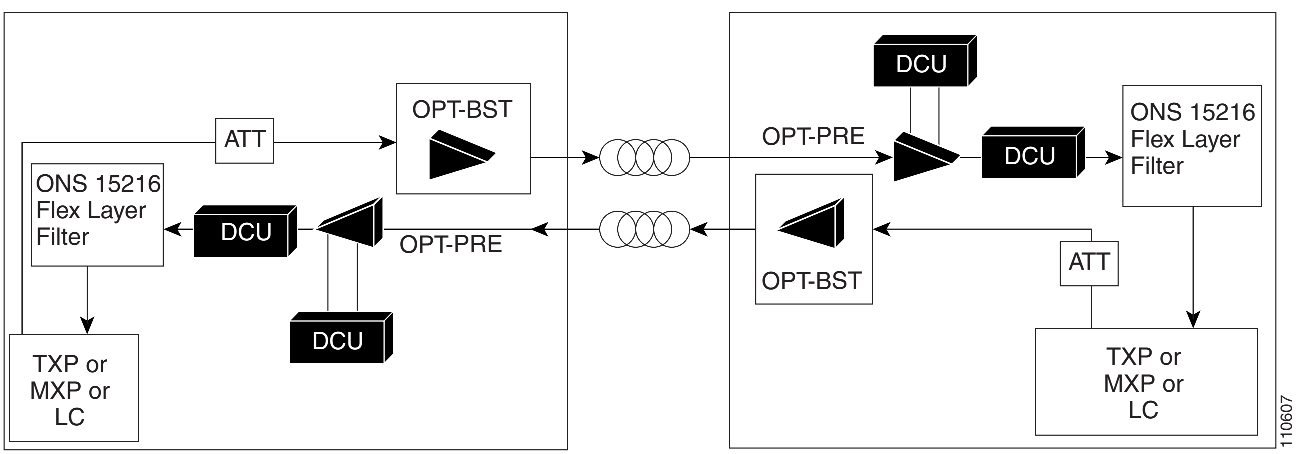
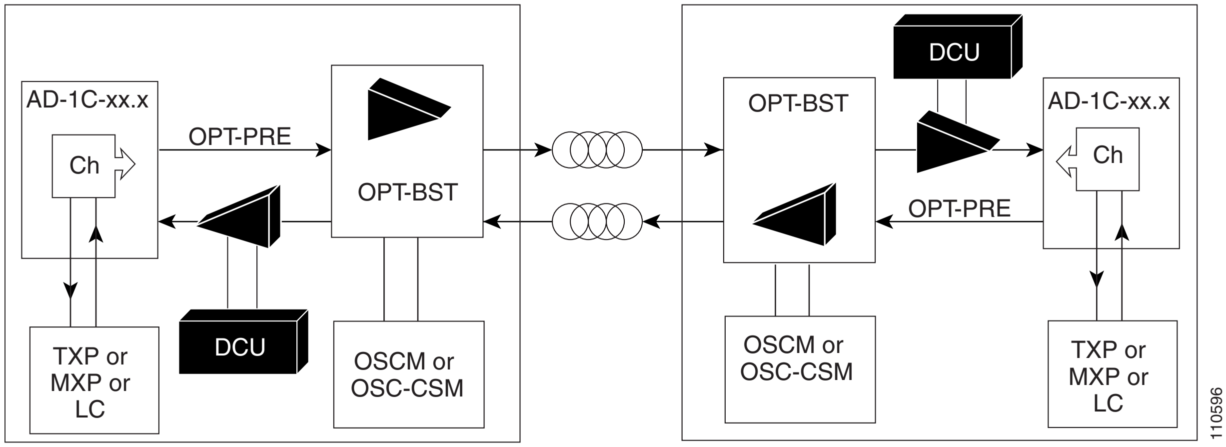


Figure 12-25 shows the third amplified TDM channel flow configuration scenario with client cards, OPT-BST amplifiers, OPT-PRE amplifiers, AD-1C-xx.x cards, and OSC-CSM cards.

Figure 12-25 Amplified TDM Channel Flow Example With Amplifiers, AD-1C-xx.x Cards, and OSC-CSM Cards



12.4 Hubbed Rings

In the hubbed ring topology (Figure 12-26), a hub node terminates all the DWDM channels. A channel can be provisioned to support protected traffic between the hub node and any node in the ring. Both working and protected traffic use the same wavelength on both sides of the ring. Protected traffic can also be provisioned between any pair of OADM nodes, except that either the working or the protected path must be regenerated in the hub node.

Protected traffic saturates a channel in a hubbed ring, that is, no channel reuse is possible. However, the same channel can be reused in difference sections of the ring by provisioning unprotected multihop traffic. From a transmission point of view, this network topology is similar to two bidirectional point-to-point links with OADM nodes.

Figure 12-26 Hubbed Ring

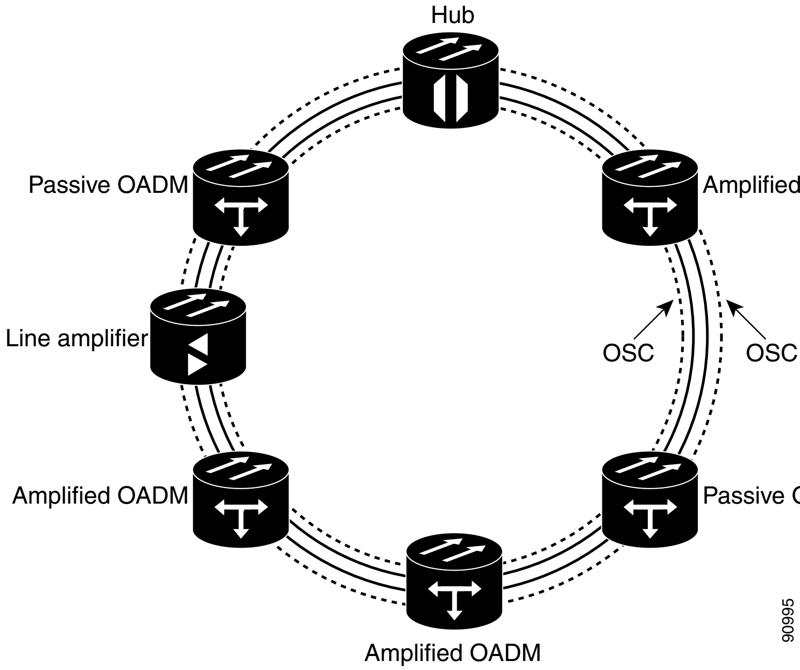


Table 12-3 lists the span loss for a hubbed ring. This applies to metro core networks only.

Note The dash (—) in the table below means not applicable.

Table 12-3 Span Loss for a Hubbed Ring, Metro Core Network

Number of Spans[1, 2]	Class A[3]	Class B[3]	Class C[3]	Class D[3]	Class E[3]	Class F[3]	Class G[3]
	Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
1	30 dB	23 dB	24 dB	34 dB	31 dB	28 dB	29 dB
2	26 dB	19 dB	19 dB	28 dB	26 dB	23 dB	26 dB
3	23 dB	—	—	26 dB	23 dB	21 dB	23 dB
4	21 dB	—	—	24 dB	22 dB	18 dB	21 dB
5	20 dB	—	—	23 dB	20 dB	13 dB	20 dB
6	17 dB	—	—	22 dB	18 dB	—	17 dB

Table 12-3 Span Loss for a Hubbed Ring, Metro Core Network (continued)

Number of Spans[1, 2]	Class A[3]	Class B[3]	Class C[3]	Class D[3]	Class E[3]	Class F[3]	Class G[3]
7	15 dB	—	—	21 dB	16 dB	—	15 dB

1. The optical performance values are valid assuming that all OADM nodes have a loss of 16 dB and equal span losses.
2. The maximum channel count allowed for the link budget is 32.
3. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with forward error correction (FEC) or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in regenerate and reshape (2R) mode

Class G—OC-48 ELR 100 GHz

Table 12-4 lists the maximum ring circumference and maximum number of amplifiers in each subnetwork for a hubbed ring. This applies to metro access networks only. Metro Planner supports the same interface classes (Classes A through G) for both Metro Access and Metro Core networks. Each card class has a limit to the fiber length before chromatic dispersion occurs as shown in the SMF fiber field of Table 12-4. In Classes A, B, and C, the maximum link length is limited by the interface's chromatic dispersion strength. In Classes D, E, F, and G, the maximum link length is limited by the interface's receive sensitivity and not by the chromatic dispersion; therefore, you will see that the maximum chromatic dispersion allowed is significantly lower than the maximum interface strength. For DWDM card specifications, see Chapter 6, "DWDM Cards."

Table 12-4 Span Loss for a Hubbed Ring, Metro Access Network

Parameter[1]	Class A[2]	Class B[2]	Class C[2]	Class D[2]	Class E[2]	Class F[2]	Class G[2]
	Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
Maximum dispersion	680 ps/nm	750 ps/nm	750 ps/nm	2000 ps/nm	2000 ps/nm	2000 ps/nm	2000 ps/nm
Maximum link length with G.652 fiber (SMF)	40 km	45 km	45 km	120 km	120 km	120 km	120 km
Maximum ring circumference	120 km						
Maximum number of amplifiers for each subnetwork	5 amplifiers						
Average per channel power at the amplifier output[3]	5 dBm						
Maximum per channel power at the amplifier output	8 dBm						
Minimum per channel power at the amplifier output	-7 dBm						

1. The optical performance values are valid assuming that all OADM nodes have a loss of 16 dB and equal span losses.
2. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

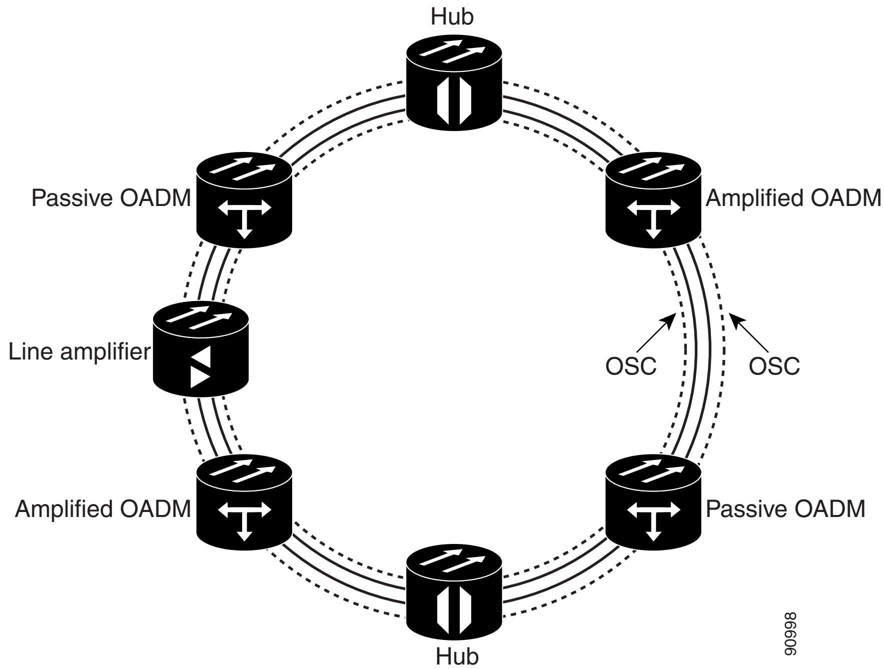
Class G—OC-48 ELR 100 GHz

3. The maximum average power per channel at the amplifier output is set as indicated to avoid saturating the total output power from the amplifiers.

12.5 Multihubbed Rings

A multihubbed ring (Figure 12-27) is based on the hubbed ring topology, except that two or more hub nodes are added. Protected traffic can only be established between the two hub nodes. Protected traffic can be provisioned between a hub node and any OADM node only if the allocated wavelength channel is regenerated through the other hub node. Multihop traffic can be provisioned on this ring. From a transmission point of view, this network topology is similar to two or more point-to-point links with OADM nodes.

Figure 12-27 Multihubbed Ring



For information on span losses in a ring configuration, see Table 12-3 on page 12-27. This applies to metro core networks only.

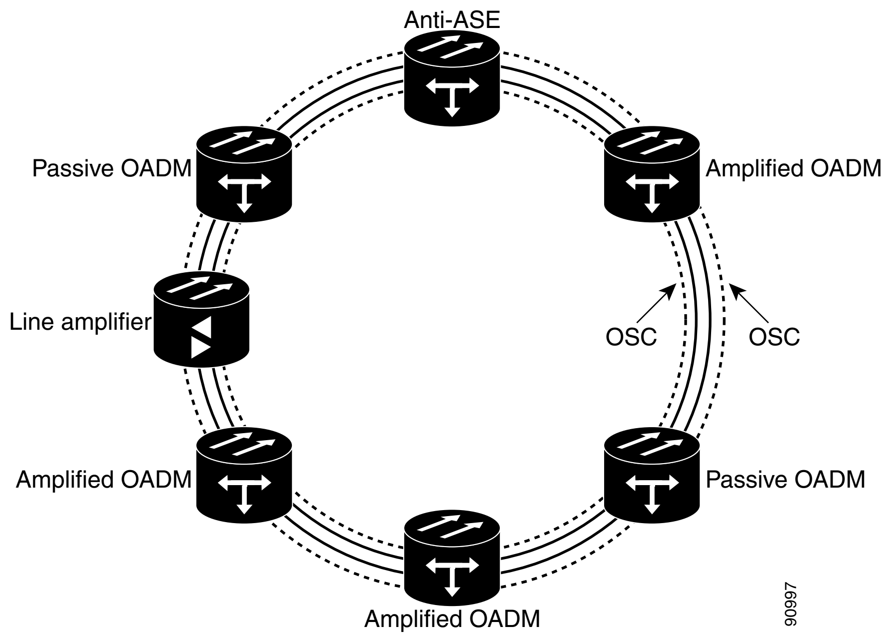
12.6 Meshed Rings

The meshed ring topology (Figure 12-28) does not use hubbed nodes; only amplified and passive OADM nodes are present. Protected traffic can be provisioned between any two nodes; however, the selected channel cannot be reused in the ring. Unprotected multihop traffic can be provisioned in the ring. A meshed ring must be designed to prevent ASE lasing. This is done by configuring a particular node as an anti-ASE node. An anti-ASE node can be created in two ways:

- Equip an OADM node with 32 MUX-O cards and 32 DMX-O cards. This solution is adopted when the total number of wavelengths deployed in the ring is higher than ten. OADM nodes equipped with 32 MUX-O cards and 32 DMX-O cards are called full OADM nodes.
- When the total number of wavelengths deployed in the ring is lower than ten, the anti-ASE node is configured by using an OADM node where all the channels that are not terminated in the node are configured as “optical pass-through.” In other words, no channels in the anti-ASE node can travel through the express path of the OADM node.

For more information about anti-ASE nodes, see the “12.2.4 Anti-ASE Node” section on page 12-9.

Figure 12-28 Meshed Ring



For information on span losses in a ring configuration, see Table 12-3 on page 12-27. For information on span losses in a ring without OADMs, see Table 12-6 on page 12-33. The tables apply to metro core networks only.

12.7 Linear Configurations

Linear configurations are characterized by the use of two terminal nodes (west and east). The terminal nodes must be equipped with a 32 MUX-O card and a 32 DMX-O card. OADM or line amplifier nodes can be installed between the two terminal nodes. Only unprotected traffic can be provisioned in a linear configuration. Figure 12-29 shows five ONS 15454 nodes in a linear configuration with an OADM node.

Figure 12-29 Linear Configuration with an OADM Node

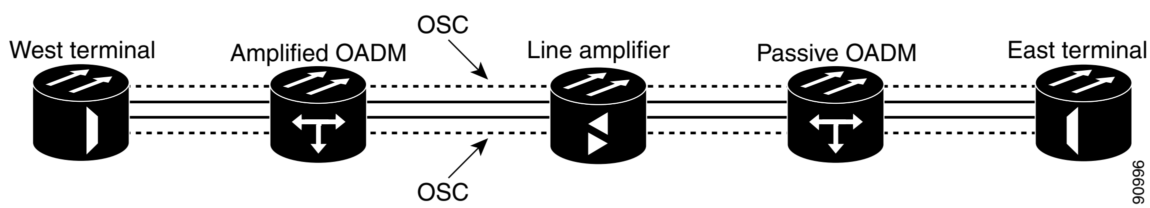


Table 12-5 on page 12-32 lists the span loss for a linear configuration with OADM nodes for metro core networks only.

Note The dash (—) in Table 12-5 means not applicable.

Table 12-5 Span Loss for Linear Configuration with OADM Nodes

Number of Spans[1, 2]	Class A[3]	Class B[2]	Class C[2]	Class D[2]	Class E[2]	Class F[2]	Class G[2]
	Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
1	30 dB	23 dB	24 dB	34 dB	31 dB	28 dB	29 dB
2	26 dB	19 dB	19 dB	28 dB	26 dB	23 dB	26 dB
3	23 dB	—	—	26 dB	23 dB	21 dB	23 dB
4	21 dB	—	—	24 dB	22 dB	18 dB	21 dB
5	20 dB	—	—	23 dB	20 dB	13 dB	20 dB
6	17 dB	—	—	22 dB	18 dB	—	17 dB
7	15 dB	—	—	21 dB	16 dB	—	15 dB

1. The optical performance values are valid assuming that all OADM nodes have a loss of 16 dB and equal span losses.
2. The maximum channel count allowed for the link budget is 32.
3. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC
Class B—10-Gbps multirate transponder without FEC
Class C—OC-192 LR ITU
Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled
Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled
Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode
Class G—OC-48 ELR 100 GHz

Figure 12-30 shows five ONS 15454 nodes in a linear configuration without an OADM node.

Figure 12-30 Linear Configuration without an OADM Node

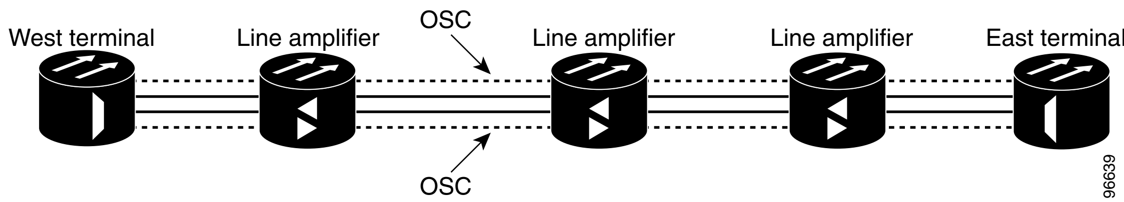


Table 12-6 lists the span loss for a linear configuration without OADMs.

Note The dash (—) in Table 12-6 means not applicable.

Table 12-6 Span Loss for a Linear Configuration without OADM Nodes

Number of Spans	Class A[1]	Class B[1]	Class C[1]	Class D[1]	Class E[1]	Class F[1]	Class G[1]
	Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
1	30 dB	23 dB	24 dB	34 dB	31 dB	28 dB	29 dB
2	26 dB	19 dB	20 dB	28 dB	26 dB	23 dB	25 dB
3	24 dB	16 dB	17 dB	25 dB	24 dB	21 dB	22 dB
4	22 dB	14 dB	14 dB	24 dB	22 dB	20 dB	21 dB
5	21 dB	—	—	23 dB	21 dB	19 dB	20 dB
6	20 dB	—	—	22 dB	20 dB	15 dB	19 dB
7	20 dB	—	—	21 dB	20 dB	14 dB	18 dB

1. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

Class G—OC-48 ELR 100 GHz

12.8 Single-Span Link

Single-span link is a type of linear configuration characterized by a single-span link with pre-amplification and post-amplification. A span link is also characterized by the use of two terminal nodes (west and east). The terminal nodes are usually equipped with a 32 MUX-O card and a 32 DMX-O card; however, it is possible to scale terminal nodes according to site requirements. Software R4.6 also supports single-span links with AD-4C-xx.x cards. Only unprotected traffic can be provisioned on a single-span link. For more information, see the "12.3.6 Amplified TDM Node" section on page 12-23.

Figure 12-31 shows ONS 15454s in a single-span link. Eight channels are carried on one span. Single-span link losses apply to OC-192 LR ITU cards. The optical performance values are valid assuming that the sum of the OADM passive nodes insertion losses and the span losses does not exceed 35 dB.

Figure 12-31 Single-Span Link

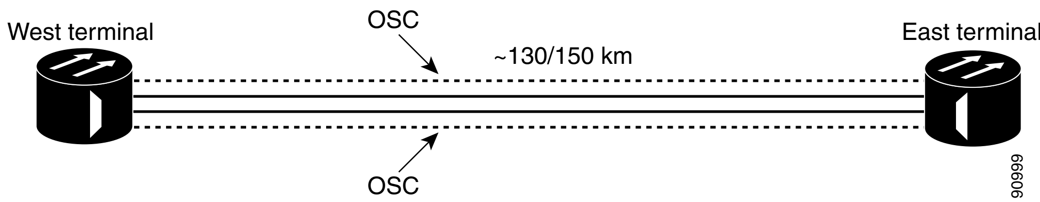


Table 12-7 lists the span loss for a single-span link configuration with eight channels. The optical performance for this special configuration is given only for Classes A and C. This configuration assumes a maximum channel capacity of eight channels (8-dBm nominal channel power) used without any restrictions on the 32 available channels.

Note The dash (—) in Table 12-7 means not applicable.

Table 12-7 Single-Span Link with Eight Channels

Node Configuration	Number of Spans	Class A[1]	Class B[1]	Class C[1]	Class D[1]	Class E[1]	Class F[1]	Class G[1]
		Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
With OSCM card	1x	37 dB	—	37 dB	—	—	—	—
With OSC-CSM card	1x	35 dB	—	35 dB	—	—	—	—

1. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

Class G—OC-48 ELR 100 GHz

Table 12-8 lists the span loss for a single-span link configuration with 16 channels. The optical performance for this special configuration is given only for Class A and Class C. This configuration assumes a maximum channel capacity of 16 channels (5-dBm nominal channel power) used without any restrictions on the 32 available channels.

Note The dash (—) in Table 12-8 means not applicable.

Table 12-8 Single-Span Link with 16 Channels

Node Configuration	Number of Spans	Class A[1]	Class B[1]	Class C[1]	Class D[1]	Class E[1]	Class F[1]	Class G[1]
		Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
With OSCM or OSC-SCM cards	1x	35 dB	—	35 dB	—	—	—	—

1. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

Class G—OC-48 ELR 100 GHz

Table 12-9 lists the span loss for a single-span link configuration with one-channel, AD-1C-x.xx cards, OPT-PRE amplifiers, and OPT-BST amplifiers. The single-span link with a flexible channel count is used both for transmitting and receiving. If dispersion compensation is required, a DCU can be used with an OPT-PRE amplifier. The optical performance for this special configuration is given for Classes A through G (8-dBm nominal channel power) used without any restrictions on the 32 available channels.

Table 12-9 Single-Span Link with One Channel, AD-1C-xx.x Cards, OPT-PRE Amplifiers, and OPT-BST Amplifiers

Node Configuration	Number of Spans	Class A[1]	Class B[1]	Class C[1]	Class D[1]	Class E[1]	Class F[1]	Class G[1]
		Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
With OSCM cards[2]	1x	37 dB	31 dB	31 dB	37 dB	37 dB	37 dB	37 dB
Hybrid with OSC-CSM cards[3]	1x	35 dB	31 dB	31 dB	35 dB	35 dB	35 dB	35 dB

1. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

Class G—OC-48 ELR 100 GHz

2. OSCM sensitivity limits the performance to 37 dB.
3. OSC-CSM sensitivity limits the performance to 35 dB when it replaces the OSCM in a hybrid node.

Table 12-10 lists the span loss for a single-span link configuration with one channel and OPT-BST amplifiers. The optical performance for this special configuration is given for Classes A through G. Classes A, B, and C use 8-dBm nominal channel power. Classes D, E, F, and G use 12-dBm nominal channel power. There are no restriction on the 32 available channels. That is, a line card, transponder, or muxponder wavelength can be extracted from the 32 available wavelengths. Also, the optical service channel is not required.

Table 12-10 Single-Span Link with One Channel and OPT-BST Amplifiers

Number of Spans	Class A[1]	Class B[1]	Class C[1]	Class D[1]	Class E[1]	Class F[1]	Class G[1]
	Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
1x	20 to 30 dB	17 to 26 dB	17 to 28 dB	Unprotected from 29 to 41 dB Protected from 25 to 41 dB	Unprotected from 28 to 37 dB Protected from 24 to 40 dB	Unprotected from 21 to 34 dB Protected from 18 to 34 dB	From 23 to 36 dB

1. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

Class G—OC-48 ELR 100 GHz

Table 12-11 lists the span loss for a single-span link configuration with one channel, OPT-BST amplifiers, OPT-PRE amplifiers, and ONS 15216 FlexLayer filters. ONS 15216 FlexLayer filters are used instead of the AD-1C-xx.x cards to reduce equipment costs and increase the span length since the optical service channel is not necessary. The optical performance for this special configuration is given Classes A through G. Classes A, B, and C use 8-dBm nominal channel power. Classes D, E, F, and G use 12-dBm nominal channel power. There are no restriction on the first 16 available wavelengths (from 1530.33 to 1544.53 nm).

Table 12-11 Single-Span Link with One Channel, OPT-BST Amplifiers, OPT-PRE Amplifiers, and ONS 15216 FlexLayer Filters

Number of Spans	Class A[1]	Class B[1]	Class C[1]	Class D[1]	Class E[1]	Class F[1]	Class G[1]
	Classes A through C are 10-Gbps interfaces			Classes D through G are 2.5-Gbps interfaces			
1x	38 dB	30 dB	30 dB	44 dB	40 dB	38 dB	40 dB

1. The following class definitions refer to the ONS 15454 card being used:

Class A—10-Gbps multirate transponder with FEC or 10-Gbps muxponder with FEC

Class B—10-Gbps multirate transponder without FEC

Class C—OC-192 LR ITU

Class D—2.5-Gbps multirate transponder both protected and unprotected with FEC enabled

Class E—2.5-Gbps multirate transponder both protected and unprotected without FEC enabled

Class F—2.5-Gbps multirate transponder both protected and unprotected in 2R mode

Class G—OC-48 ELR 100 GHz

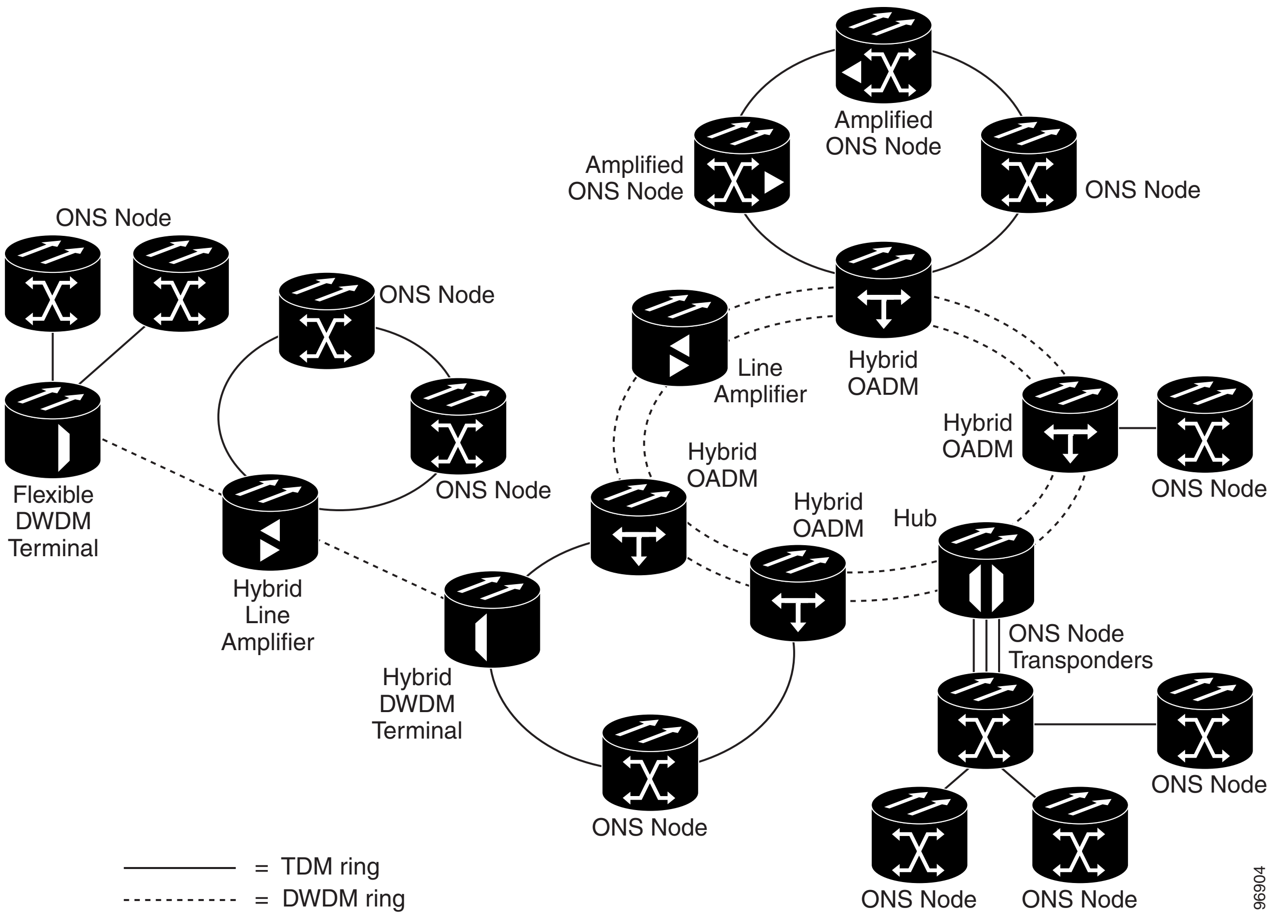
12.9 Hybrid Networks

The hybrid network configuration is determined by the type of node that is used in an ONS 15454 network. Along with TDM nodes, the ONS 15454 supports the following hybrid node types: 1+1 protected flexible terminal, scalable terminal, hybrid terminal, hybrid OADM, hybrid line amplifier, and amplified TDM. For more information about hybrid node types see the "12.3 DWDM and TDM Hybrid Node Types" section on page 12-11. For hybrid node turn-up procedures and hybrid network turn-up procedures, refer to the "DWDM Node Turn Up" chapter and the "DWDM Network Turn Up" chapter in the *Cisco ONS 15454 Procedure Guide*.

Note The MetroPlanner tool creates a plan for amplifier placement and proper equipment for DWDM node configurations. Although TDM cards can be used with DWDM node configuration, the MetroPlanner tool does not create a plan for TDM card placement. MetroPlanner will support TDM configurations in a future release.

Figure 12-32 shows ONS 15454s in a hybrid TDM and DWDM configurations.

Figure 12-32 Hybrid Network Example



DWDM and TDM layers can be mixed in the same node; however they operate and are provisioned independently. The following TDM configurations can be added to a hybrid network: point-to-point, linear add/drop multiplexer (ADM), BLSR, and path protection.

Figure 12-33 shows ONS 15454s in a hybrid point-to-point configuration.

Figure 12-33 Hybrid Point-to-Point Network Example

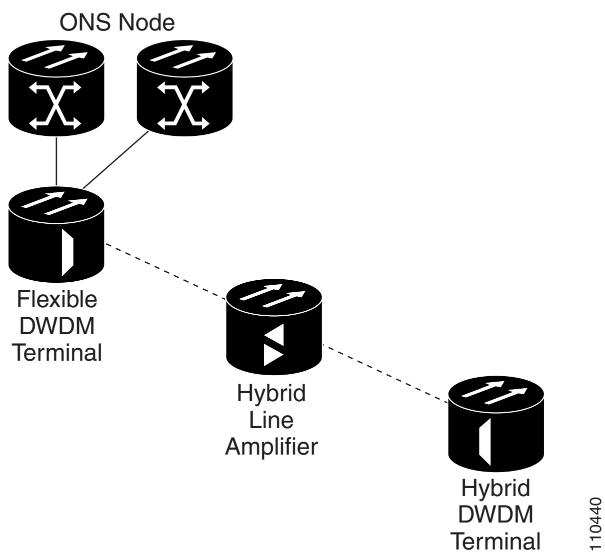


Figure 12-34 shows ONS 15454s in a hybrid linear ADM configuration.

Figure 12-34 Hybrid Linear ADM Network Example

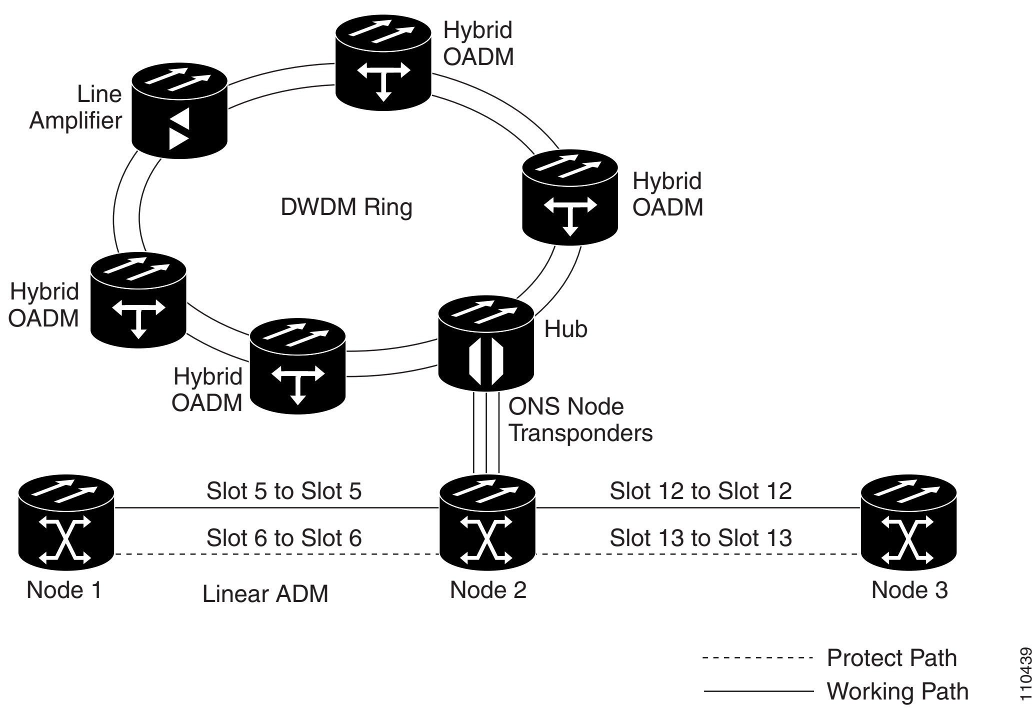


Figure 12-35 shows ONS 15454s in a hybrid BLSR configuration.

Figure 12-35 Hybrid BLSR Network Example

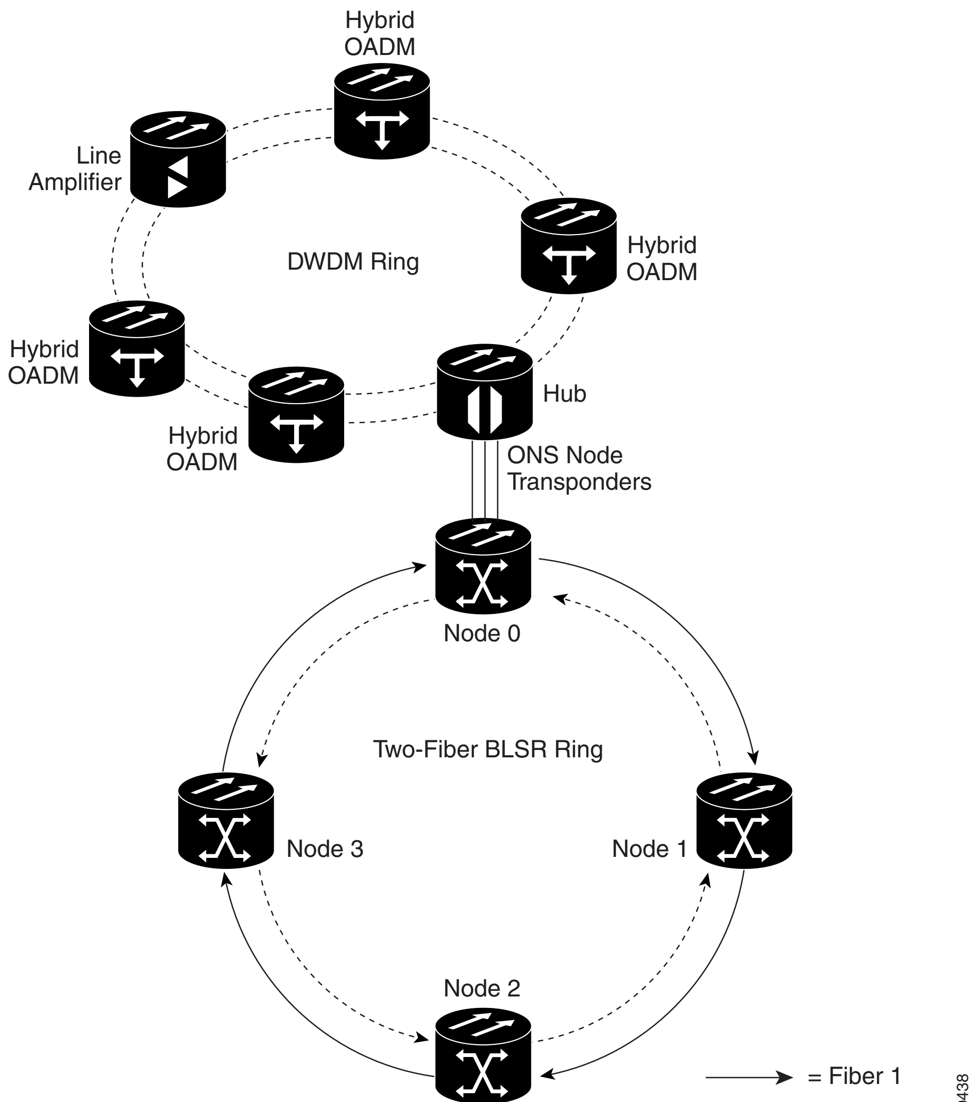
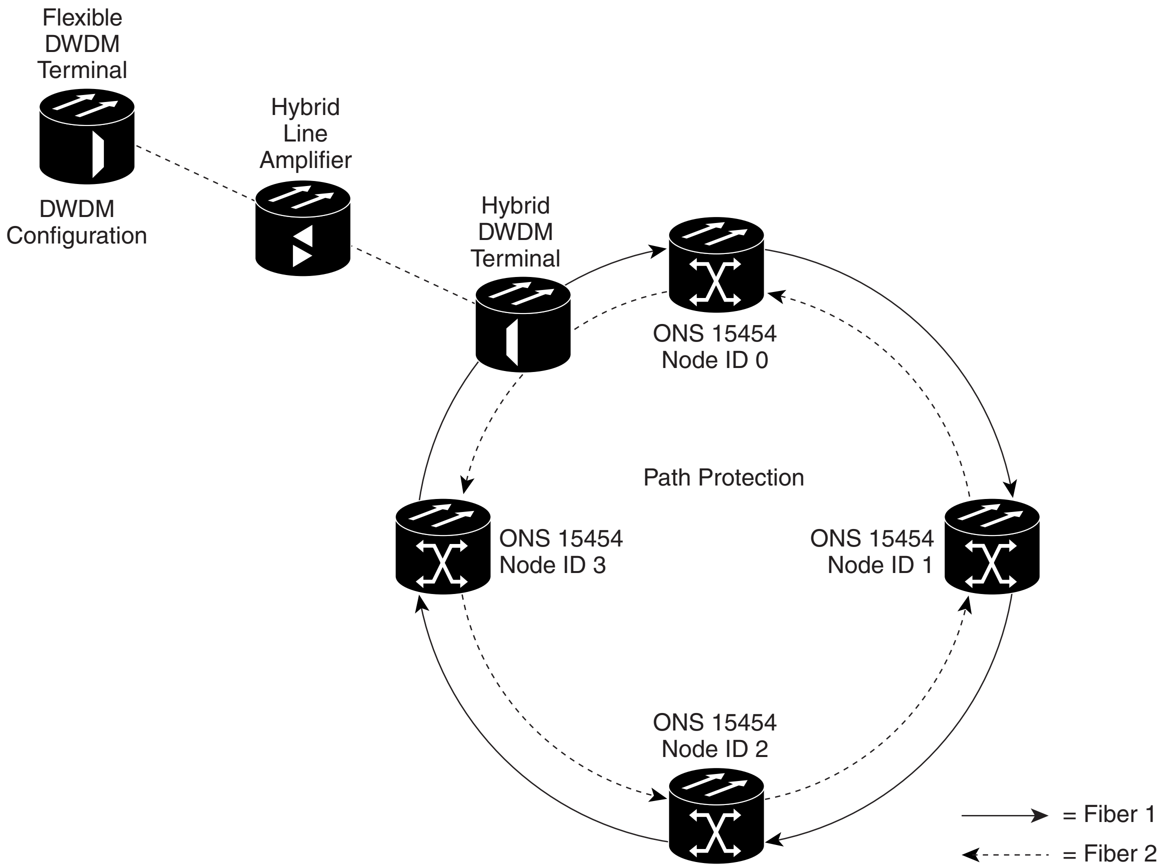


Figure 12-36 shows ONS 15454s in a hybrid path protection configuration.

Figure 12-36 Hybrid Path Protection Network Example



12.10 Automatic Power Control

The ONS 15454 automatic power control (APC) feature performs the following functions:

- Maintains constant per-channel power when changes to the number of channels occur.
- Compensates for optical network degradation (aging effects).
- Simplifies the installation and upgrade of DWDM optical networks by automatically calculating the amplifier setpoints.

Note APC functions are performed by software algorithms on the OPT-BST, OPT-PRE, and TCC2 cards.

Amplifier software uses a control gain loop with fast transient suppression to keep the channel power constant regardless of any changes in the number of channels. Amplifiers monitor the changes to the input power and change the output power according to the calculated gain setpoint. The shelf controller software emulates the control output power loop to adjust for fiber degradation. To perform this function, the TCC2 needs to know the channel distribution, which is provided by a signaling protocol, and the expected per-channel power, which you can provision. The TCC2 compares the actual amplifier output power with the expected amplifier output power and modifies the setpoints if any discrepancies occur.

12.10.1 APC at the Amplifier Card Level

In constant gain mode, the amplifier power out control loop performs the following input and output power calculations, where G represents the gain and t represents time.

Pout (t) = G * Pin (t) (mW)

Pout (t) = G + Pin (t) (dB)

In a power-equalized optical system, the total input power is proportional to the number of channels. The amplifier software compensates for any variation of the input power due to changes in the number of channels carried by the incoming signal.

Amplifier software identifies changes in the read input power in two different instances, t1 and t2 as a change in the carried traffic. The letters m and n in the following formula represent two different channel numbers. Pin/ch represents the per-channel input power:

Pin (t1)= nPin/ch

Pin (t2) = mPin/ch

Amplifier software applies the variation in the input power to the output power with a reaction time that is a fraction of a millisecond. This keeps the power constant on each channel at the output amplifier, even during a channel upgrade or a fiber cut.

Amplifier parameters are configured using east and west conventions for ease of use. Selecting west provisions parameters for the preamplifier receiving from the west and the booster amplifier transmitting to the west. Selecting east provisions parameters for the preamplifiers receiving from the east and the booster amplifier transmitting to the east.

Starting from the expected per-channel power, the amplifiers automatically calculate the gain setpoint after the first channel is provisioned. An amplifier gain setpoint is calculated in order to make it equal to the loss of the span preceding the amplifier itself. After the gain is calculated, the setpoint is no longer changed by the amplifier. Amplifier gain is recalculated every time the number of provisioned channels returns to zero. If you need to force a recalculation of the gain, move the number of channels back to zero.

12.10.2 APC at the Node and Network Levels

The amplifier adjusts the gain to compensate for span loss. Span loss changes due to aging fiber and components, or changes in operating conditions. To correct the gain or express variable optical attenuator (VOA) setpoints, APC calculates the difference between the power value read by the photodiodes and the expected power value. The expected power values is calculated using:

- Provisioned per-channel power value
- Channel distribution (the number of express, add, and drop channels in the node)
- ASE estimation

Channel distribution is determined by the sum of the provisioned and failed channels. Information about provisioned wavelengths is sent to APC on the applicable nodes during circuit creation. Information about failed channels is collected through a signaling protocol that monitors alarms on ports in the applicable nodes and distributes that information to all the other nodes in the network.

ASE calculations purify the noise from the power level reported from the photodiode. Each amplifier can compensate for its own noise, but cascaded amplifiers cannot compensate for ASE generated by preceding nodes. The ASE effect increases when the number of channels decreases; therefore, a correction factor must be calculated in each amplifier of the ring to compensate for ASE build-up.

APC is a network-level feature. The APC algorithm designates a master node that is responsible for starting APC hourly or every time a new circuit is provisioned or removed. Every time the master node signals for APC to start, gain and VOA setpoints are evaluated on all nodes in the network. If corrections are needed in different nodes, they are always performed sequentially following the optical paths starting from the master node.

APC corrects the power level only if the variation exceeds the hysteresis thresholds of +/– 0.5 dB. Any power level fluctuation within the threshold range is skipped since it is considered negligible. Because APC is designed to follow slow time events, it skips corrections greater than 3 dB. This is the typical total aging margin that is provisioned during the network design phase. After you provision the first channel or the amplifiers are turned up for the first time, APC does not apply the 3 dB rule. In this case, APC corrects all the power differences to turn up the node.

Note Software R4.6 does not report corrections that are not performed and exceed the 3 dB correction factor to management interfaces (Cisco Transport Controller [CTC], Cisco Transport Manager [CTM], and Transaction Language One [TL1]).

To avoid large power fluctuations, APC adjusts power levels incrementally. The maximum power correction is +/– 0.5 dB. This is applied to each iteration until the optimal power level is reached. For example, a gain deviation of 2 dB is corrected in four steps. Each of the four steps requires a complete APC check on every node in the network. APC can correct up to a maximum of 3 dB on an hourly basis. If degradation occurs over a longer time period, APC will compensate for it by using all margins that you provision during installation.

When no margin is available, adjustments cannot be made because setpoints exceed ranges. APC communicates the event to CTC, CTM, and TL1 through an APC Fail condition. APC will clear the APC fail condition when the setpoints return to the allowed ranges.

APC automatically disables itself when:

- A HW FAIL alarm is raised by any card in any of the network nodes.
- A Mismatch Equipment Alarm (MEA) is raised by any card in any of the network nodes.
- An Improper Removal alarm is raised by any card in any of the network nodes.
- Gain Degrade, Power Degrade, and Power Fail Alarms are raised by the output port of any amplifier card in any of the network nodes.
- A VOA degrade or Fail alarm is raised by any of the cards in any of the network nodes.

12.10.3 Managing APC

The APC state (Enable/Disable) is located on every node and can be retrieved by the CTC or TL1 interface. If an event that disables APC occurs in one of the network nodes, APC will be disabled on all the others and the APC state will be shown as DISABLE. On the contrary, the APC DISABLE condition is raised only by the node where the problem occurred to simplify troubleshooting.

APC DISABLE is a reversible state. After the error condition is cleared, signaling protocol will enable APC on the network and the APC DISABLE condition will be cleared. Since APC is required after channel provisioning to compensate for ASE effects, all optical channel network connection (OCHNC) circuits that a user provisioned during the disabled APC State will be kept in OOS-AINS status until APC is enabled. OCHNC will automatically go into the IS state only when APC is enabled.

12.11 Automatic Node Setup

Automatic node setup (ANS) is a TCC2 function that adjusts values of the VOAs on the DWDM channel paths to equalize the per-channel power at the amplifier input. This power equalization means that at launch, all the channels have the same amplifier power level, independent from the input signal on the client interface and independent from the path crossed by the signal inside the node. This equalization is needed for two reasons:

- Every path introduces a different penalty on the signal that crosses it.
- Client interfaces add their signal to the ONS 15454 DWDM ring with different power levels.

To support ANS, the integrated VOAs and photodiodes are provided in the following ONS 15454 DWDM cards:

- OADM band cards (AD-xB-xx.x) express and drop path
- OADM channel cards (AD-xC-xx.x) express and add path
- 4-Channel Terminal Multiplexer/Demultiplexer (4MD-xx.x) input port
- 32-Channel Terminal Multiplexer (32 MUX-O) input port
- 32-Channel Terminal Demultiplexer (32 DMX-O) output port

Optical power is equalized by regulating the VOAs. Knowing the expected per-channel power, ANS automatically calculates the VOA values by:

- Reconstructing the different channels paths
- Retrieving the path insertion loss (stored in each DWDM transmission element)

VOAs operate in one of three working modes:

- Automatic VOA Shutdown—In this mode, the VOA is set at maximum attenuation value. Automatic VOA shutdown mode is set when the channel is not provisioned to ensure system reliability in the event that power is accidentally inserted.
- Constant Attenuation Value—In this mode, the VOA is regulated to a constant attenuation independent from the value of the input signal. Constant attenuation value mode is set on the following VOAs:
  - OADM band card VOAs on express and drop paths (as operating mode)
  - OADM channel card VOAs during power insertion startup
  - The multiplexer/demultiplexer card VOAs during power insertion startup
- Constant Power Value—In this mode, the VOA values are automatically regulated to keep a constant output power when changes occur to the input power signal. This working condition is set on OADM channel card VOAs as “operating” and on multiplexer/demultiplexer card VOAs as “operating mode.”

In the normal operating mode, OADM band card VOAs are set to a constant attenuation, while OADM channel card VOAs are set to a constant power. ANS requires the following VOA provisioning parameters to be specified:

- Target attenuation (OADM band card VOA and OADM channel card startup)
- Target power (channel VOA)

To allow you to modify ANS values based on your DWDM deployment, provisioning parameters are divided into two contributions:

- Reference Contribution (read only)—Set by ANS.
- Calibration Contribution (read and write)—Set by user.

The ANS equalization algorithm requires knowledge of the DWDM transmission element layout:

- The order in which the DWDM elements are connected together on the express paths
- Channels that are dropped and added
- Channels or bands that have been configured as pass through

ANS assumes that every DWDM port has a line direction parameter that is either West to East (W-E) or East to West (E-W). ANS automatically configures the mandatory optical connections according to following main rules:

- Cards equipped in Slots 1 to 6 have a drop section facing west.
- Cards equipped in Slots 12 to 17 have a drop section facing east.
- Contiguous cards are cascaded on the express path.
- 4MD-xx.x and AD-xB-xx.x are always optically coupled.
- A 4MD-xx.x absence forces an optical pass-through connection.
- Transmit (Tx) ports are always connected to receive (Rx) ports.

Optical patch cords are passive devices that are not autodiscovered by ANS. However, optical patch cords are used to build the alarm correlation graph. ANS uses Cisco Transport Controller (CTC) and TL1 as the user interface to:

- Calculate the default connections on the NE.
- Retrieve the list of existing connections.
- Retrieve the list of free ports.
- Create new connections or modify existing ones.
- Launch ANS.

Optical connections are identified by the two termination points, each with an assigned slot and port. ANS checks that a new connection is feasible (according to embedded connection rules) and returns a denied message in the case of a violation.

ANS requires provisioning of the expected wavelength. When provisioning the expected wavelength, the following rules apply:

- The card name is generically characterized by the card family, and not the particular wavelengths supported (for example, AD-2C for all 2-channel OADMs).
- At the provisioning layer, you can provision a generic card for a specific slot using CTC or TL1.
- Wavelength assignment is done at the port level.
- An equipment mismatch alarm is raised when a mismatch between the identified and provisioned value occurs. The default value for the provisioned attribute is AUTO.

12.12 DWDM Network Topology Discovery

Each ONS 15454 DWDM node has a network topology discovery function that can:

- Identify other ONS 15454 DWDM nodes in an ONS 15454 DWDM network.
- Identify the different types of DWDM networks.
- Identify when the DWDM network is complete and when it is incomplete.

ONS 15454 DWDM nodes use node services protocol (NSP) to automatically update nodes whenever a change in the network occurs. NSP uses two information exchange mechanisms: hop-by-hop message protocol and broadcast message protocol. Hop-by-hop message protocol elects a master node and exchanges information between nodes in a sequential manner simulating a token ring protocol:

- Each node that receives a hop-by-hop message passes it to the next site according to the ring topology and the line direction from which the token was received.
- The message originator always receives the token after it has been sent over the network.
- Only one hop-by-hop message can run on the network at any one time.

NSP broadcast message protocol distributes information that is to be shared by all ONS 15454 DWDM nodes on the same network. Broadcast message delivery is managed in an independent way from delivery of the two tokens. Moreover, no synchronization among broadcast messages is required; every node is authorized to send a broadcast message any time it is necessary.

IP Networking

This chapter provides eight scenarios showing Cisco ONS 15454s in common IP network configurations. The chapter does not provide a comprehensive explanation of IP networking concepts and procedures. For IP setup instructions, refer to the *Cisco ONS 15454 Procedure Guide*.

Chapter topics include:

Note To connect ONS 15454s to an IP network, you must work with a LAN administrator or other individual at your site who has IP networking training and experience.

13.1 IP Networking Overview

ONS 15454s can be connected in many different ways within an IP environment:

- They can be connected to LANs through direct connections or a router.
- IP subnetting can create ONS 15454 node groups that allow you to provision non-data communication channel (DCC) connected nodes in a network.
- Different IP functions and protocols can be used to achieve specific network goals. For example, Proxy Address Resolution Protocol (ARP) enables one LAN-connected ONS 15454 to serve as a gateway for ONS 15454s that are not connected to the LAN.
- Static routes can be created to enable connections among multiple Cisco Transport Controller (CTC) sessions with ONS 15454s that reside on the same subnet with multiple CTC sessions.
- ONS 15454s can be connected to Open Shortest Path First (OSPF) networks so ONS 15454 network information is automatically communicated across multiple LANs and WANs.
- The ONS 15454 proxy server can control the visibility and accessibility between CTC computers and ONS 15454 element nodes.

13.2 IP Addressing Scenarios

ONS 15454 IP addressing generally has eight common scenarios or configurations. Use the scenarios as building blocks for more complex network configurations. Table 13-1 provides a general list of items to check when setting up ONS 15454s in IP networks.

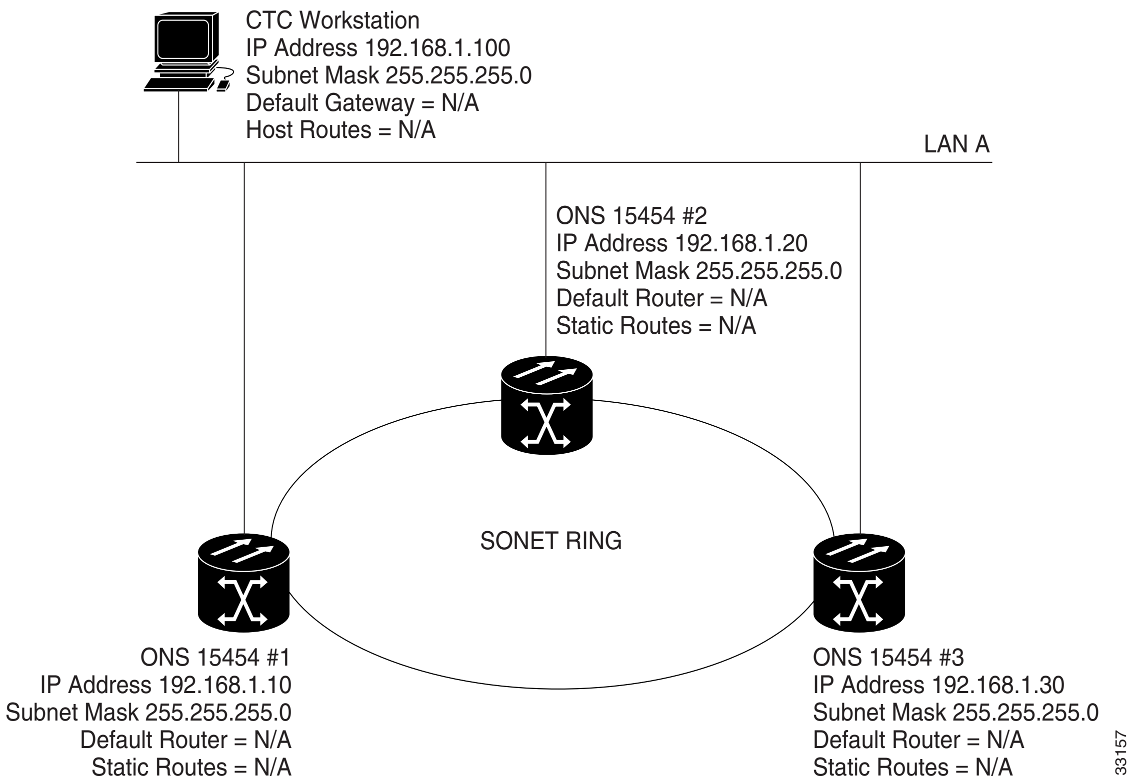
Table 13-1 General ONS 15454 IP Troubleshooting Checklist

Item	What to Check
Link integrity	Verify that link integrity exists between: • CTC computer and network hub/switch • ONS 15454s (backplane wire-wrap pins or RJ-45 port) and network hub/switch • Router ports and hub/switch ports
ONS 15454 hub/switch ports	If connectivity problems occur, set the hub or switch port that is connected to the ONS 15454 to 10 Mbps half-duplex.
Ping	Ping the node to test connections between computers and ONS 15454s.
IP addresses/subnet masks	Verify that ONS 15454 IP addresses and subnet masks are set up correctly.
Optical connectivity	Verify that ONS 15454 optical trunk ports are in service and that a DCC is enabled on each trunk port.

13.2.1 Scenario 1: CTC and ONS 15454s on Same Subnet

Scenario 1 shows a basic ONS 15454 LAN configuration (Figure 13-1). The ONS 15454s and CTC computer reside on the same subnet. All ONS 15454s connect to LAN A, and all ONS 15454s have DCC connections.

Figure 13-1 Scenario 1: CTC and ONS 15454s on Same Subnet

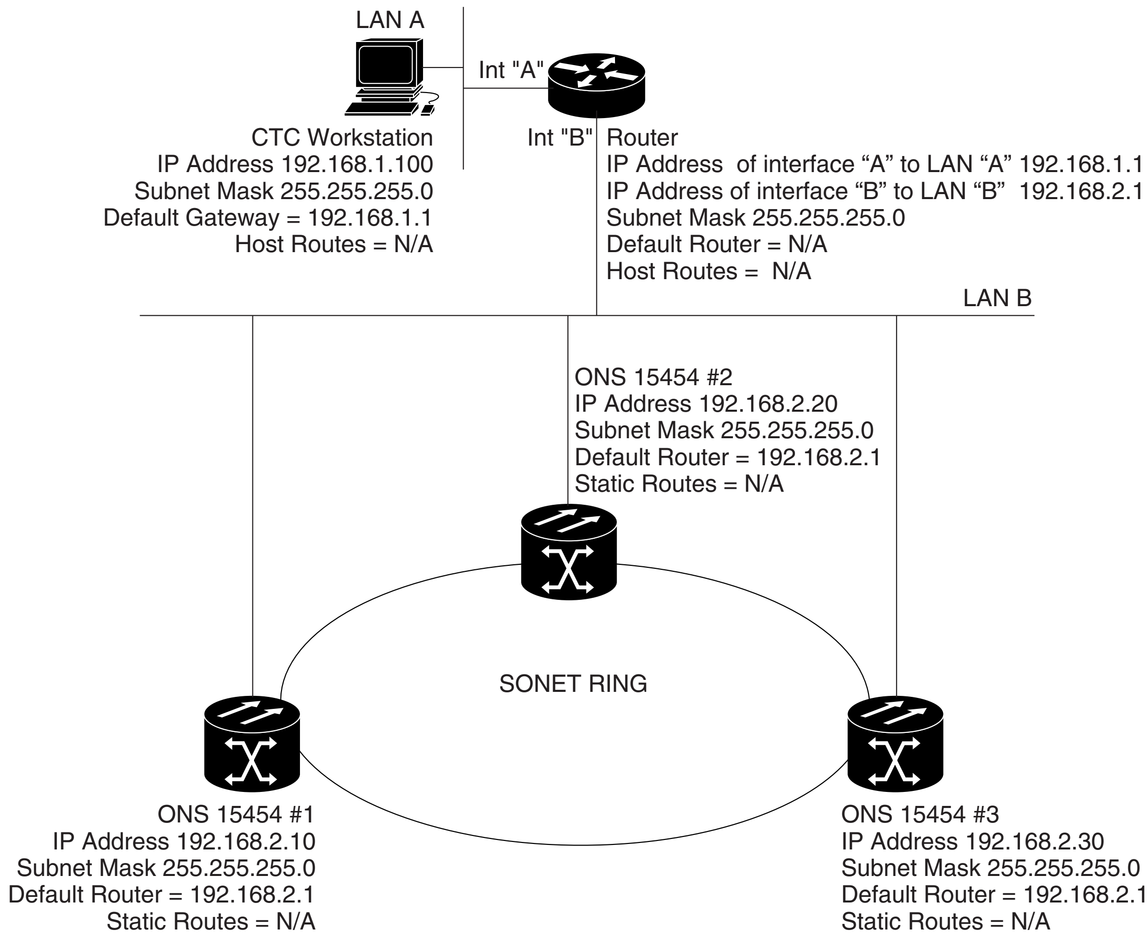


13.2.2 Scenario 2: CTC and ONS 15454s Connected to a Router

In Scenario 2 the CTC computer resides on a subnet (192.168.1.0) and attaches to LAN A (Figure 13-2). The ONS 15454s reside on a different subnet (192.168.2.0) and attach to LAN B. A router connects LAN A to LAN B. The IP address of router interface A is set to LAN A (192.168.1.1), and the IP address of router interface B is set to LAN B (192.168.2.1).

On the CTC computer, the default gateway is set to router interface A. If the LAN uses DHCP (Dynamic Host Configuration Protocol), the default gateway and IP address are assigned automatically. In the Figure 13-2 example, a DHCP server is not available.

Figure 13-2 Scenario 2: CTC and ONS 15454s Connected to Router



13.2.3 Scenario 3: Using Proxy ARP to Enable an ONS 15454 Gateway

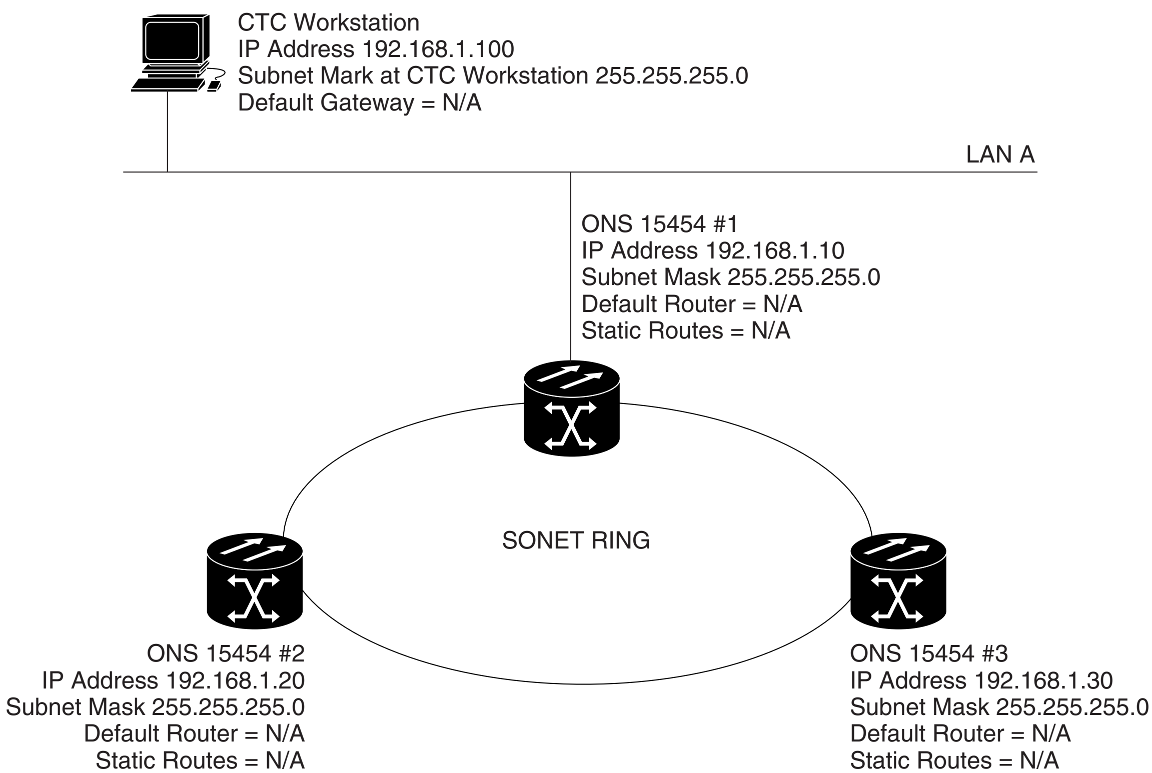
ARP matches higher-level IP addresses to the physical addresses of the destination host. It uses a lookup table (called ARP cache) to perform the translation. When the address is not found in the ARP cache, a broadcast is sent out on the network with a special format called the ARP request. If one of the machines on the network recognizes its own IP address in the request, it sends an ARP reply back to the requesting host. The reply contains the physical hardware address of the receiving host. The requesting host stores this address in its ARP cache so that all subsequent datagrams (packets) to this destination IP address can be translated to a physical address.

Proxy ARP enables one LAN-connected ONS 15454 to respond to the ARP request for ONS 15454s not connected to the LAN. (ONS 15454 proxy ARP requires no user configuration.) For this to occur, the DCC-connected ONS 15454s must reside on the same subnet. When a LAN device sends an ARP request to an ONS 15454 that is not connected to the LAN, the gateway ONS 15454 returns its MAC address to the LAN device. The LAN device then sends the datagram for the remote ONS 15454 to the MAC address of the proxy ONS 15454. The proxy ONS 15454 uses its routing table to forward the datagram to the non-LAN ONS 15454.

Scenario 3 is similar to Scenario 1, but only one ONS 15454 (#1) connects to the LAN (Figure 13-3). Two ONS 15454s (#2 and #3) connect to ONS 15454 #1 through the SONET DCC. Because all three ONS 15454s are on the same subnet, proxy ARP enables ONS 15454 #1 to serve as a gateway for ONS 15345 #2 and #3.

Note This scenario assumes all CTC connections are to Node 1. If you connect a laptop to either ONS 15454 #2 or #3, network partitioning occurs; neither the laptop or the CTC computer can see all nodes. If you want laptops to connect directly to external network elements, you must create static routes (see Scenario 5) or enable the ONS 15454 proxy server (see Scenario 7).

Figure 13-3 Scenario 3: Using Proxy ARP

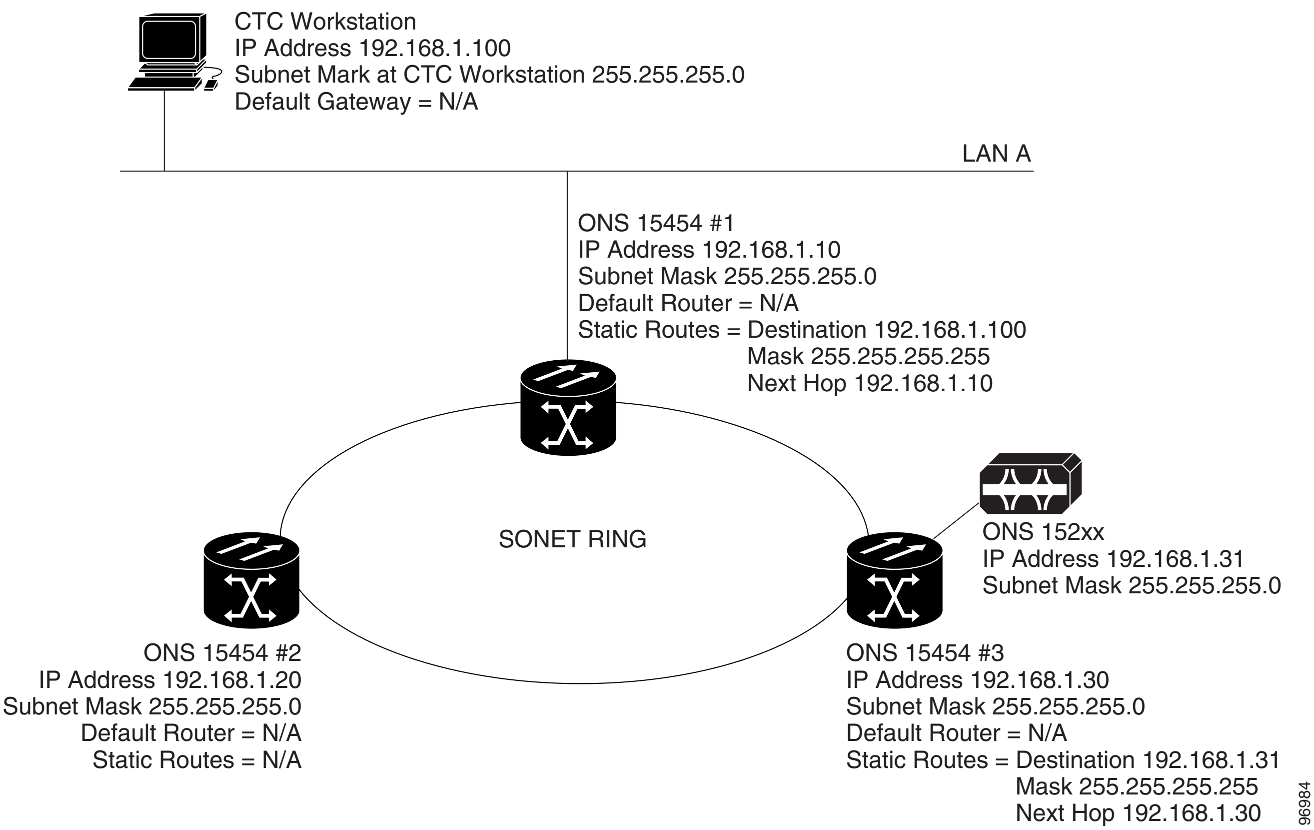


You can also use proxy ARP to communicate with hosts attached to the craft Ethernet ports of DCC-connected nodes (Figure 13-4). The node with an attached host must have a static route to the host. Static routes are propagated to all DCC peers using OSPF. The existing proxy ARP node is the gateway for additional hosts. Each node examines its routing table for routes to hosts that are not connected to the DCC network but are within the subnet. The existing proxy server replies to ARP requests for these additional hosts with the node MAC address. The existence of the host route in the routing table ensures that the IP packets addressed to the additional hosts are routed properly. Other than establishing a static route between a node and an additional host, no provisioning is necessary. The following restrictions apply:

- Only one node acts as the proxy ARP server for any given additional host.
- A node cannot be the proxy ARP server for a host connected to its Ethernet port.

In Figure 13-4, Node 1 announces to Node 2 and 3 that it can reach the CTC host. Similarly, Node 3 announces that it can reach the ONS 152xx. The ONS 152xx is shown as an example; any network element can be set up as an additional host.

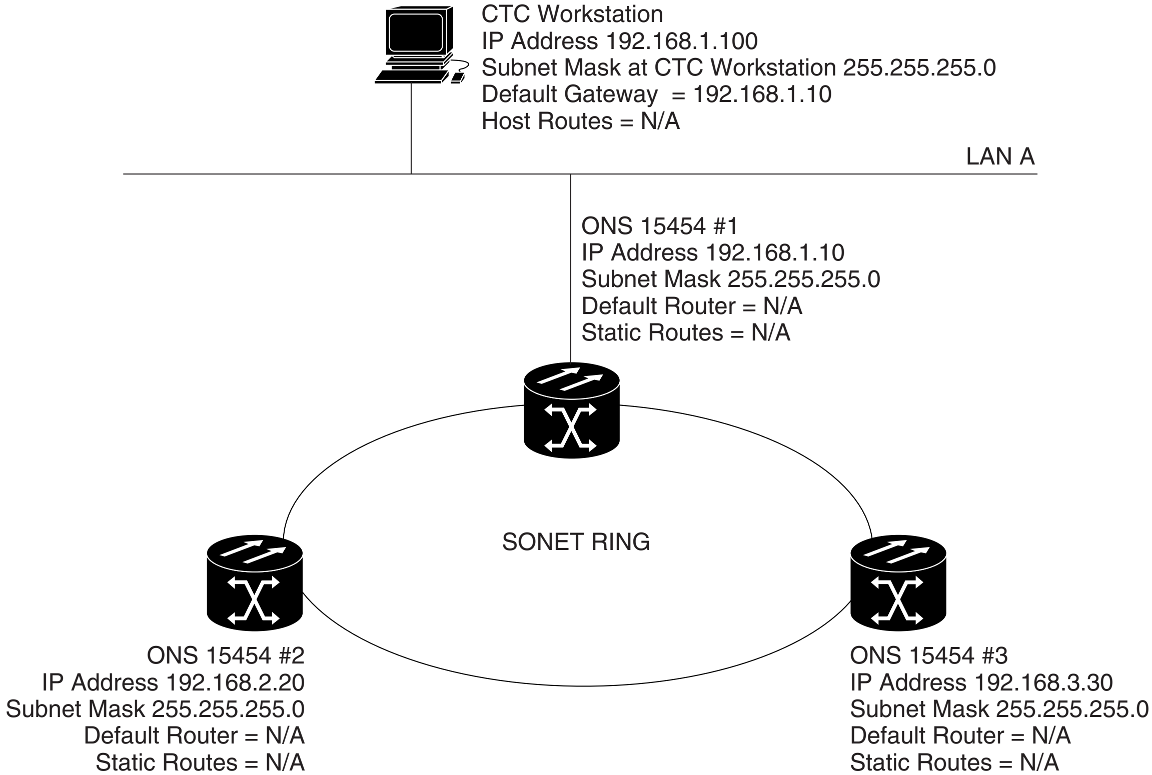
Figure 13-4 Scenario 3: Using Proxy ARP with Static Routing



13.2.4 Scenario 4: Default Gateway on CTC Computer

Scenario 4 is similar to Scenario 3, but Nodes 2 and 3 reside on different subnets, 192.168.2.0 and 192.168.3.0, respectively (Figure 13-5). Node 1 and the CTC computer are on subnet 192.168.1.0. Proxy ARP is not used because the network includes different subnets. For the CTC computer to communicate with Nodes 2 and 3, Node 1 is entered as the default gateway on the CTC computer.

Figure 13-5 Scenario 4: Default Gateway on a CTC Computer



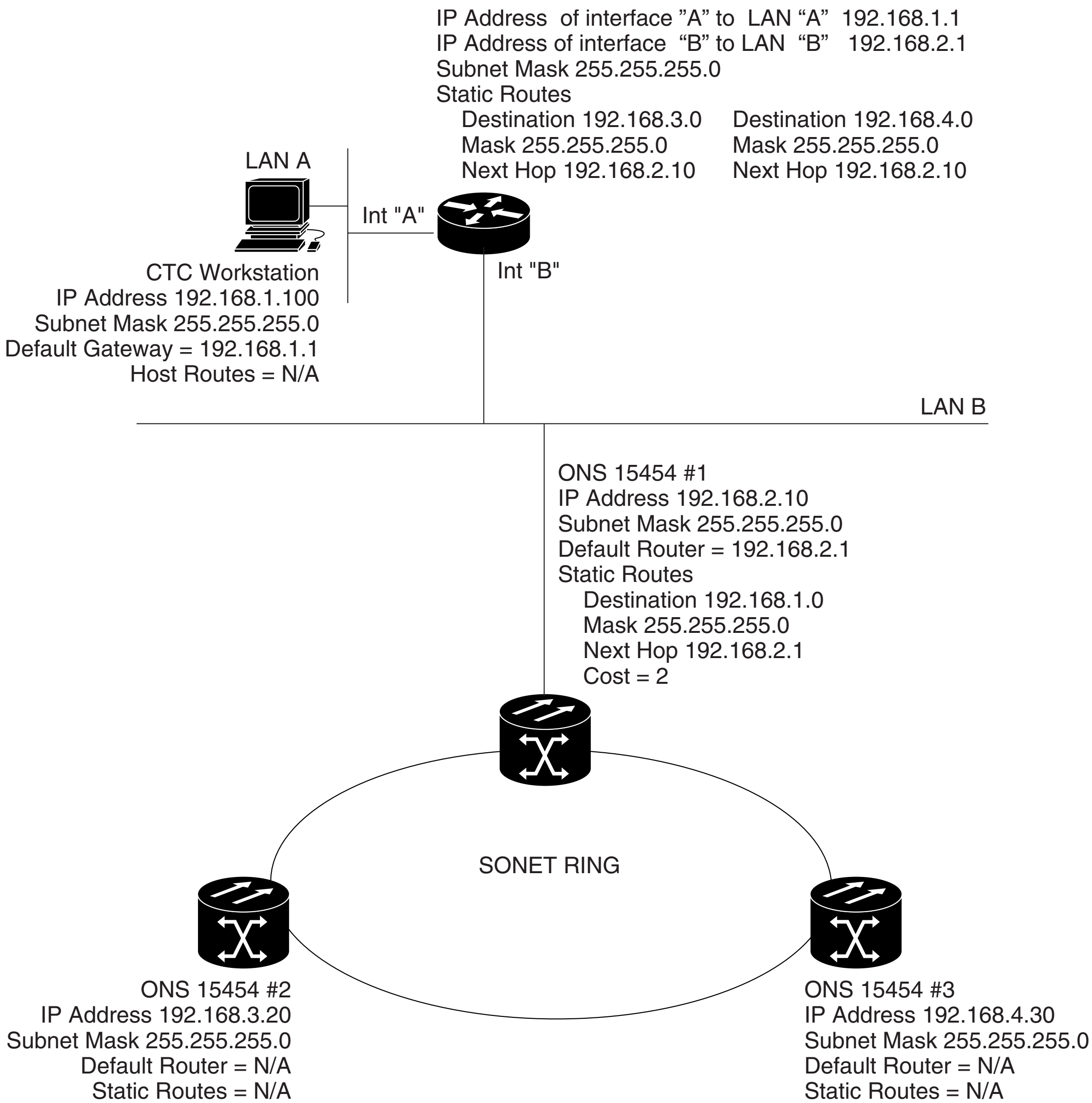
13.2.5 Scenario 5: Using Static Routes to Connect to LANs

Static routes are used for two purposes:

- To connect ONS 15454s to CTC sessions on one subnet connected by a router to ONS 15454s residing on another subnet. (These static routes are not needed if OSPF is enabled. Scenario 6 shows an OSPF example.)
- To enable multiple CTC sessions among ONS 15454s residing on the same subnet.

In Figure 13-6, one CTC residing on subnet 192.168.1.0 connects to a router through interface A. (The router is not set up with OSPF.) ONS 15454s residing on different subnets are connected through Node 1 to the router through interface B. Because Nodes 2 and 3 are on different subnets, proxy ARP does not enable Node 1 as a gateway. To connect to the CTC computer on LAN A (subnet 192.168.1.0), you must create a static route on Node 1. You must also manually add static routes between the CTC computer on LAN A and Nodes 2 and 3 because these nodes are on different subnets.

Figure 13-6 Scenario 5: Static Route With One CTC Computer Used as a Destination

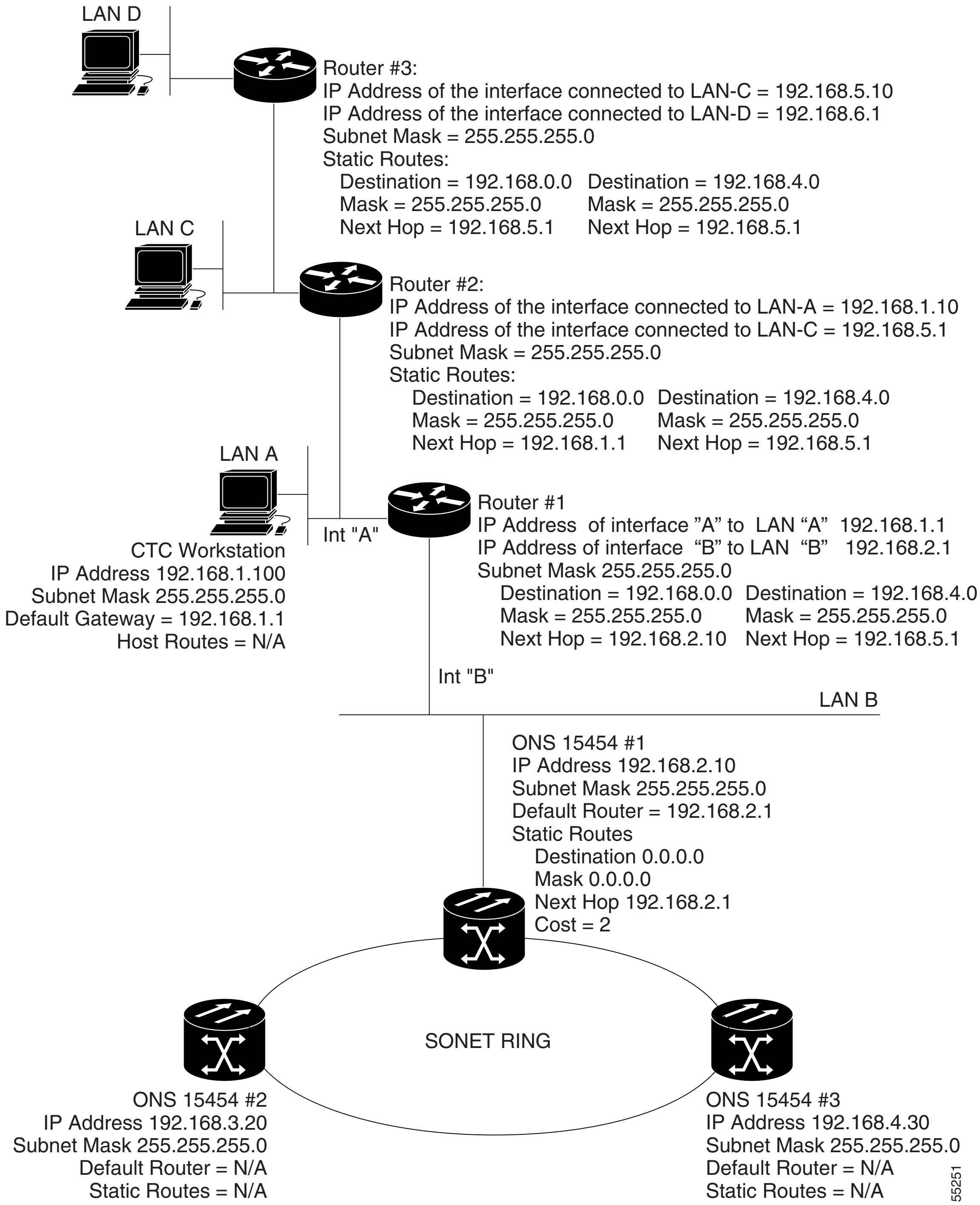


The destination and subnet mask entries control access to the ONS 15454s:

- If a single CTC computer is connected to a router, enter the complete CTC "host route" IP address as the destination with a subnet mask of 255.255.255.255.
- If CTC computers on a subnet are connected to a router, enter the destination subnet (in this example, 192.168.1.0) and a subnet mask of 255.255.255.0.
- If all CTC computers are connected to a router, enter a destination of 0.0.0.0 and a subnet mask of 0.0.0.0. Figure 13-7 shows an example.

The IP address of router interface B is entered as the next hop, and the cost (number of hops from source to destination) is 2. You must manually add static routes between the CTC computers on LAN A, B, and C and Nodes 2 and 3 because these nodes are on different subnets.

Figure 13-7 Scenario 5: Static Route With Multiple LAN Destinations



13.2.6 Scenario 6: Using OSPF

Open Shortest Path First (OSPF) is a link state Internet routing protocol. Link state protocols use a "hello protocol" to monitor their links with adjacent routers and to test the status of their links to their neighbors. Link state protocols advertise their directly connected networks and their active links. Each link state router captures the link state "advertisements" and puts them together to create a topology of the entire network or area. From this database, the router calculates a routing table by constructing a shortest path tree. Routes are recalculated when topology changes occur.

ONS 15454s use the OSPF protocol in internal ONS 15454 networks for node discovery, circuit routing, and node management. You can enable OSPF on the ONS 15454s so that the ONS 15454 topology is sent to OSPF routers on a LAN. Advertising the ONS 15454 network topology to LAN routers eliminates the need to manually enter static routes for ONS 15454 subnetworks. Figure 13-8 shows a network enabled for OSPF. Figure 13-9 shows the same network without OSPF. Static routes must be manually added to the router for CTC computers on LAN A to communicate with Nodes 2 and 3 because these nodes reside on different subnets.

OSPF divides networks into smaller regions, called areas. An area is a collection of networked end systems, routers, and transmission facilities organized by traffic patterns. Each OSPF area has a unique ID number, known as the area ID. Every OSPF network has one backbone area called "area 0." All other OSPF areas must connect to area 0.

When you enable an ONS 15454 OSPF topology for advertising to an OSPF network, you must assign an OSPF area ID in decimal format to the ONS 15454 network. Coordinate the area ID number assignment with your LAN administrator. All DCC-connected ONS 15454s should be assigned the same OSPF area ID.

Figure 13-8 Scenario 6: OSPF Enabled

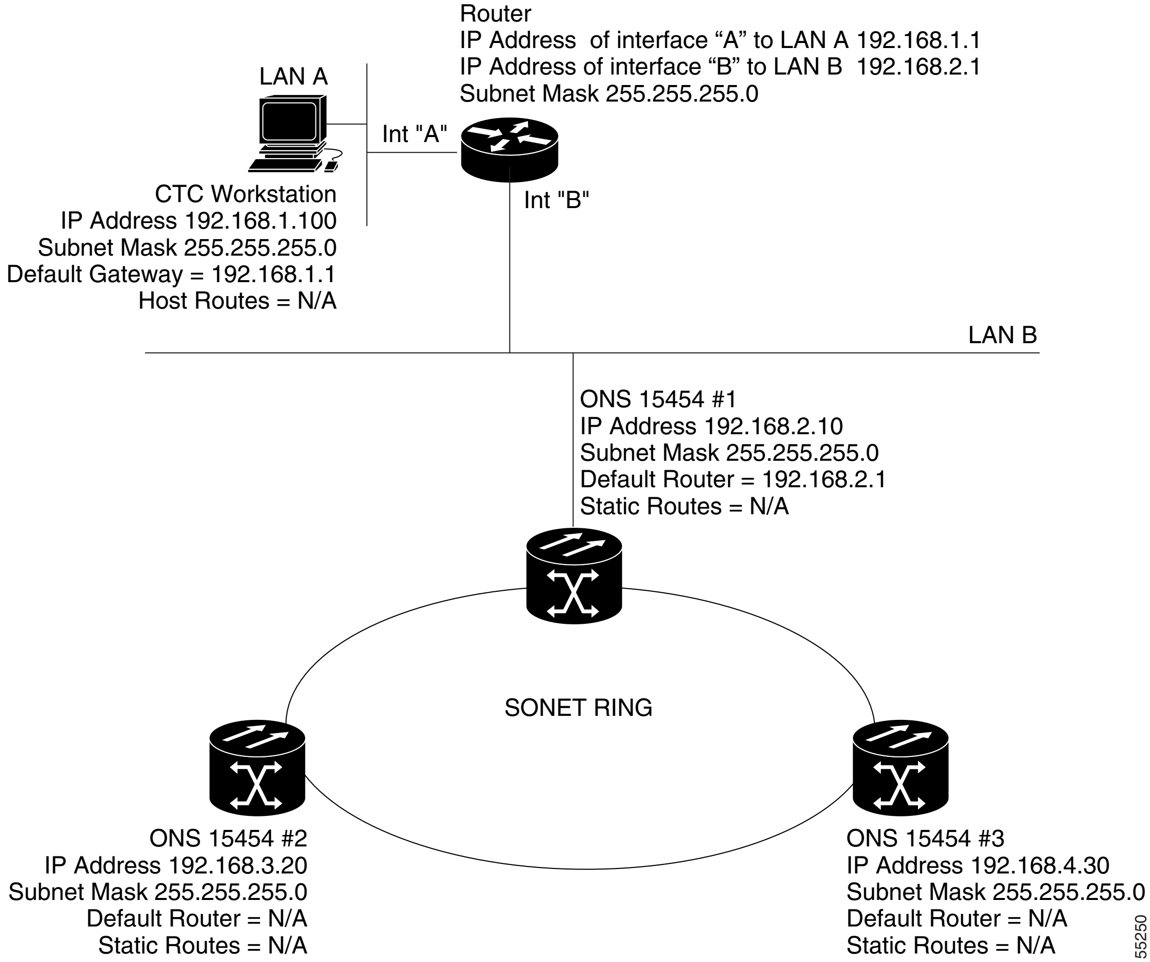
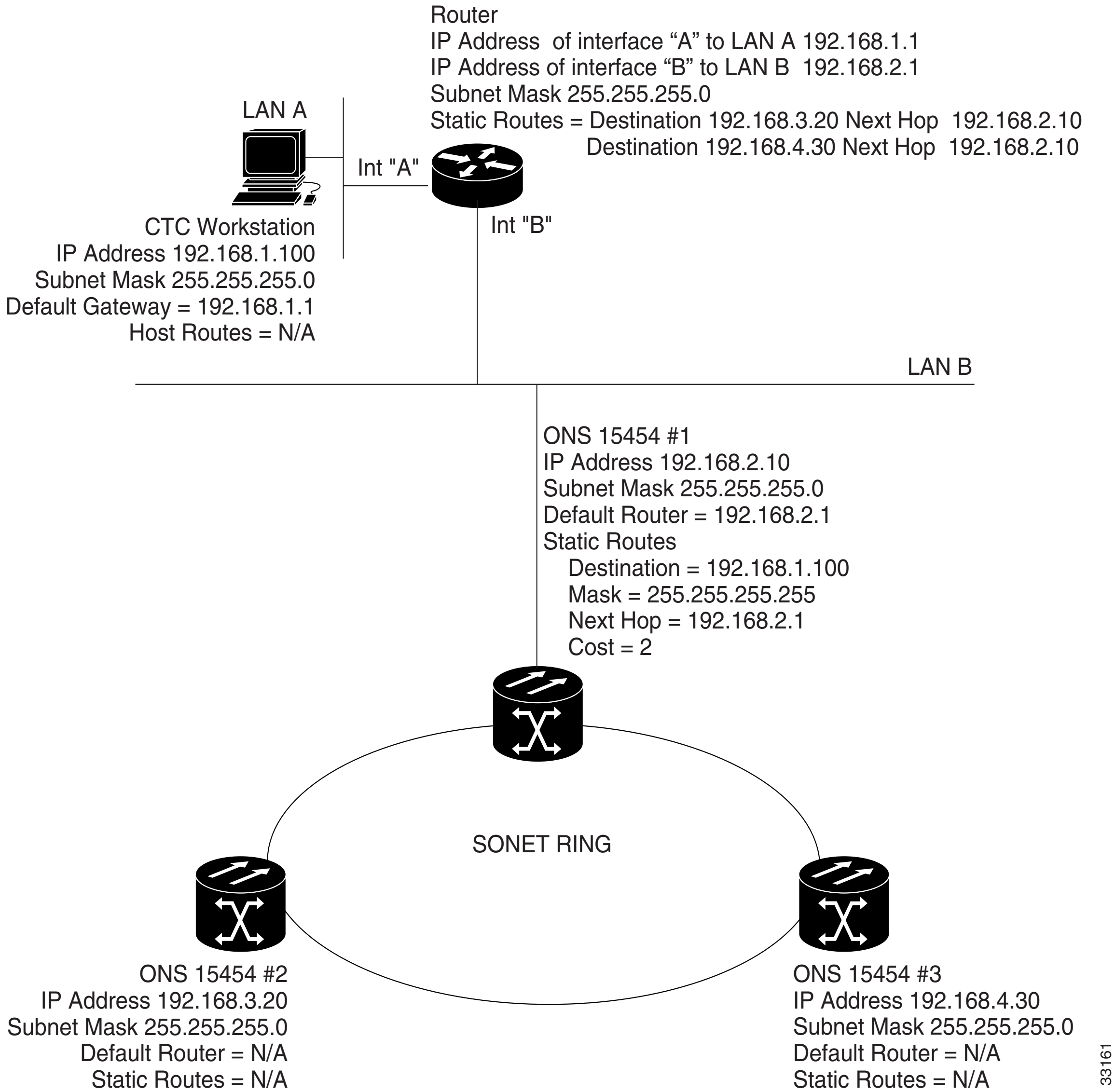


Figure 13-9 Scenario 6: OSPF Not Enabled



13.2.7 Scenario 7: Provisioning the ONS 15454 Proxy Server

The ONS 15454 proxy server is a set of functions that allows you to network ONS 15454s in environments where visibility and accessibility between ONS 15454s and CTC computers must be restricted. For example, you can set up a network so that field technicians and network operating center (NOC) personnel can both access the same ONS 15454s while preventing the field technicians from accessing the NOC LAN. To do this, one ONS 15454 is provisioned as a gateway network element (GNE) and the other ONS 15454s are provisioned as external network elements (ENEs). The GNE ONS 15454 tunnels connections between CTC computers and ENE ONS 15454s, providing management capability while preventing access for non-ONS 15454 management purposes.

The ONS 15454 gateway setting performs the following tasks:

- Isolates DCC IP traffic from Ethernet (craft port) traffic and accepts packets based on filtering rules. The filtering rules (see Table 13-3 on page 13-17 and Table 13-4 on page 13-18) depend on whether the packet arrives at the ONS 15454 DCC or TCC2 Ethernet interface.
- Processes SNTP (Simple Network Time Protocol) and NTP (Network Time Protocol) requests. ONS 15454 ENEs can derive time-of-day from an SNTP/NTP LAN server through the GNE ONS 15454.
- Processes SNMPv1 traps. The GNE ONS 15454 receives SNMPv1 traps from the ENE ONS 15454s and forwards or relays the traps to SNMPv1 trap destinations or ONS 15454 SNMP relay nodes.

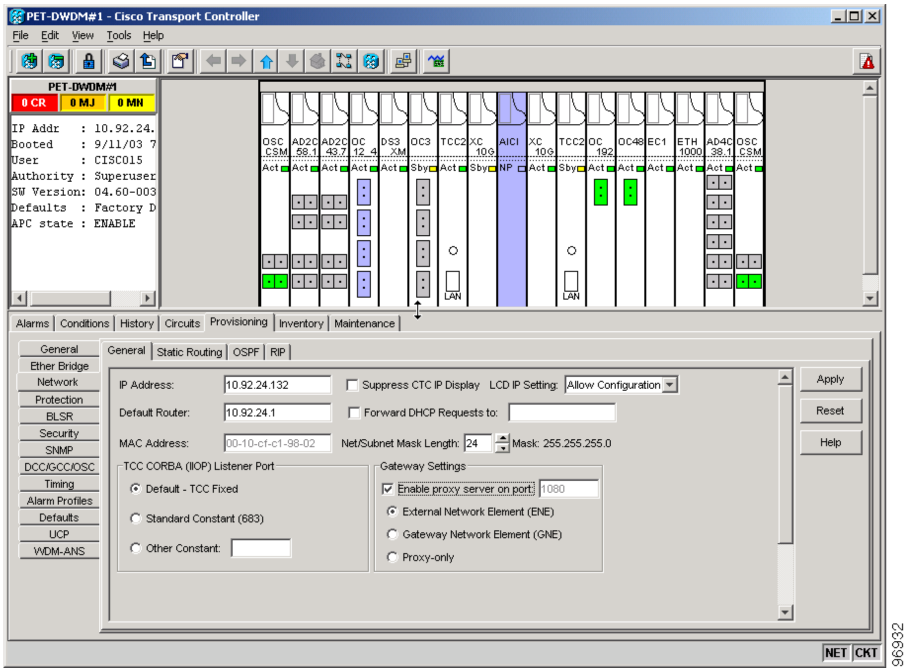
The ONS 15454 proxy server is provisioned using the Enable proxy server on port check box on the Provisioning > Network > General tab (see Figure 13-10). If checked, the ONS 15454 serves as a proxy for connections between CTC clients and ONS 15454s that are DCC-connected to the proxy ONS 15454. The CTC client establishes connections to DCC-connected nodes through the proxy node. The CTC client can connect to nodes that it cannot directly reach from the host on which it runs. If not selected, the node does not proxy for any CTC clients, although any established proxy connections continue until the CTC client exits. In addition, you can set the proxy server as an ENE or a GNE:

Note If you launch CTC against a node through a NAT (Network Address Translation) or PAT (Port Address Translation) router and that node does not have proxy enabled, your CTC session starts and initially appears to be fine. However CTC never receives alarm updates and disconnects and reconnects every two minutes. If the proxy is accidentally disabled, it is still possible to enable the proxy during a reconnect cycle and recover your ability to manage the node, even through a NAT/PAT firewall.

- External Network Element (ENE)—If set as an ENE, the ONS 15454 neither installs nor advertises default or static routes. CTC computers can communicate with the ONS 15454 using the TCC2 craft port, but they cannot communicate directly with any other DCC-connected ONS 15454.

  In addition, firewall is enabled, which means that the node prevents IP traffic from being routed between the DCC and the LAN port. The ONS 15454 can communicate with machines connected to the LAN port or connected through the DCC. However, the DCC-connected machines cannot communicate with the LAN-connected machines, and the LAN-connected machines cannot communicate with the DCC-connected machines. A CTC client using the LAN to connect to the firewall-enabled node can use the proxy capability to manage the DCC-connected nodes that would otherwise be unreachable. A CTC client connected to a DCC-connected node can only manage other DCC-connected nodes and the firewall itself.
- Gateway Network Element (GNE)—If set as a GNE, the CTC computer is visible to other DCC-connected nodes and firewall is enabled.
- Proxy-only—If Proxy-only is selected, firewall is not enabled. CTC can communicate with any other DCC-connected ONS 15454s.

Figure 13-10 Proxy Server Gateway Settings



[Figure 13-11](#) shows an ONS 15454 proxy server implementation. A GNE ONS 15454 is connected to a central office LAN and to ENE ONS 15454s. The central office LAN is connected to a NOC LAN, which has CTC computers. The NOC CTC computer and craft technicians must both be able to access the ONS 15454 ENEs. However, the craft technicians must be prevented from accessing or seeing the NOC or central office LANs.

In the example, the ONS 15454 GNE is assigned an IP address within the central office LAN and is physically connected to the LAN through its LAN port. ONS 15454 ENEs are assigned IP addresses that are outside the central office LAN and given private network IP addresses. If the ONS 15454 ENEs are collocated, the craft LAN ports could be connected to a hub. However, the hub should have no other network connections.

Figure 13-11 ONS 15454 Proxy Server with GNE and ENEs on the Same Subnet

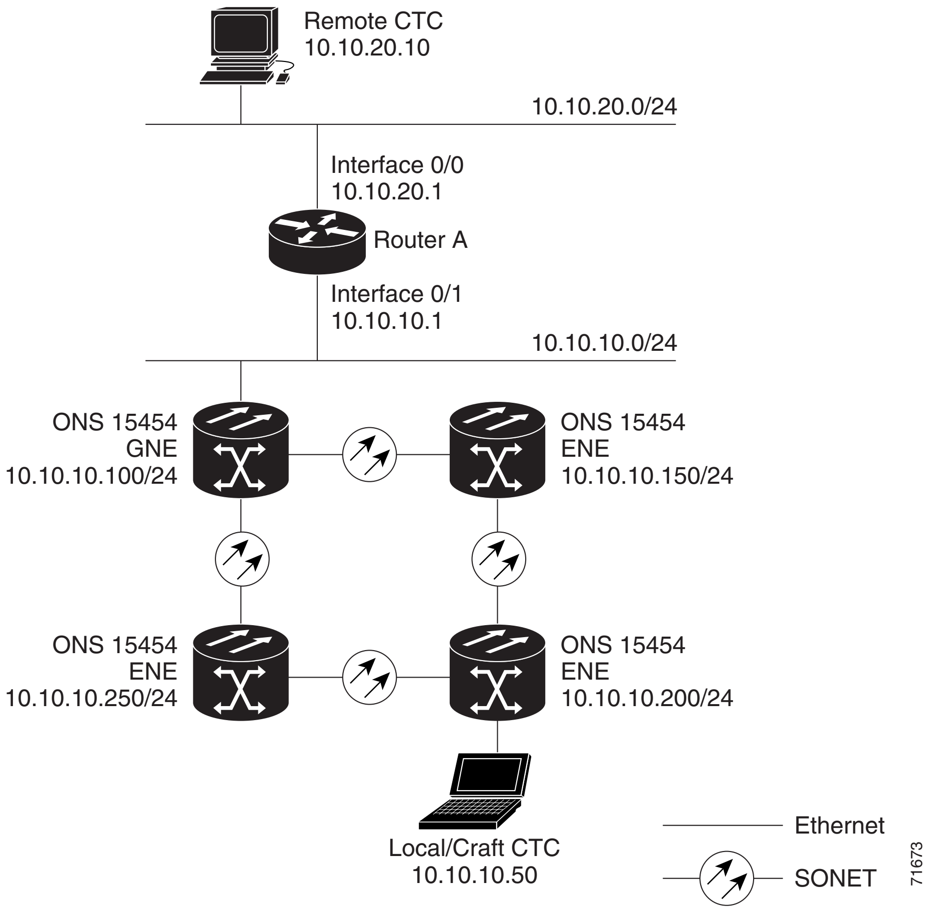


Table 13-2 shows recommended settings for ONS 15454 GNEs and ENEs in the configuration shown in Figure 13-11.

Table 13-2 ONS 15454 Gateway and External NE Settings

Setting	ONS 15454 Gateway NE	ONS 15454 External NE
OSPF	Off	Off
SNTP server (if used)	SNTP server IP address	Set to ONS 15454 GNE IP address
SNMP (if used)	SNMPv1 trap destinations	Set SNMPv1 trap destinations to ONS 15454 GNE, port 391

Figure 13-12 shows the same proxy server implementation with ONS 15454 ENEs on different subnets. Figure 13-13 on page 13-17 shows the implementation with ONS 15454 ENEs in multiple rings. In each example, ONS 15454 GNEs and ENEs are provisioned with the settings shown in Table 13-2.

Figure 13-12 Scenario 7: ONS 15454 Proxy Server with GNE and ENEs on Different Subnets

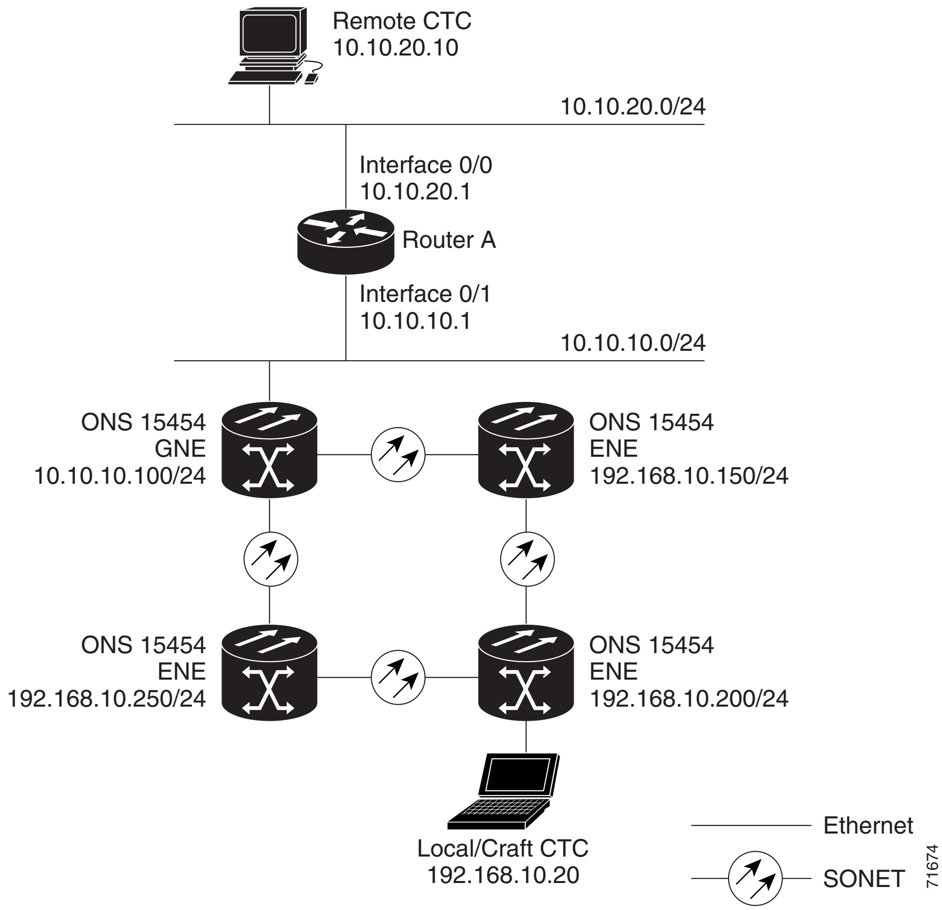


Figure 13-13 Scenario 7: ONS 15454 Proxy Server With ENEs on Multiple Rings

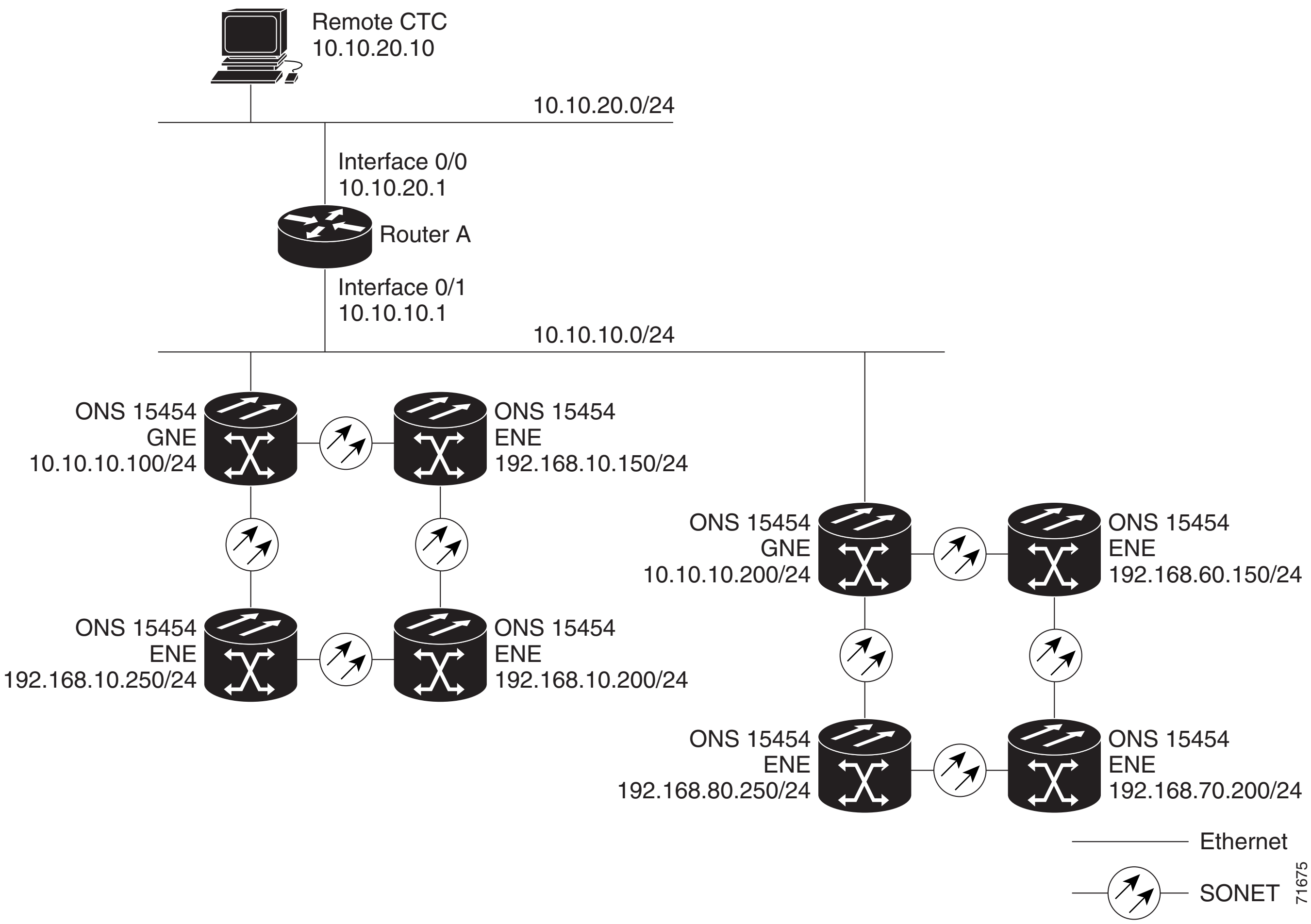


Table 13-3 shows the rules the ONS 15454 follows to filter packets for the firewall when nodes are configured as ENEs and GNEs. If the packet is addressed to the ONS 15454, additional rules, shown in Table 13-4, are applied. Rejected packets are silently discarded.

Table 13-3 Proxy Server Firewall Filtering Rules

Packets Arriving At:	Are Accepted if the Destination IP Address is:
TCC2 Ethernet interface	• The ONS 15454 itself • The ONS 15454's subnet broadcast address • Within the 224.0.0.0/8 network (reserved network used for standard multicast messages) • Subnet mask = 255.255.255.255
DCC interface	• The ONS 15454 itself • Any destination connected through another DCC interface • Within the 224.0.0.0/8 network

Table 13-4 Proxy Server Firewall Filtering Rules When Packet Addressed to ONS 15454

Packets Arriving At	Accepts	Rejects
TCC2 Ethernet interface	• All UDP[1] packets except those in the Rejected column	• UDP packets addressed to the SNMP trap relay port (391)
DCC interface	• All UDP packets • All TCP[2] protocols except those in the Rejected column • OSPF packets • ICMP[3] packets	• TCP packets addressed to the Telnet port • TCP packets addressed to the proxy server port • All packets other than UDP, TCP, OSPF, ICMP

1. UDP = User Datagram Protocol
2. TCP = Transmission Control Protocol
3. ICMP = Internet Control Message Protocol

If you implement the proxy server, note that all DCC-connected ONS 15454s on the same Ethernet segment must have the same gateway setting. Mixed values produce unpredictable results, and might leave some nodes unreachable through the shared Ethernet segment.

If nodes become unreachable, correct the setting by performing one of the following:

- Disconnect the craft computer from the unreachable ONS 15454. Connect to the ONS 15454 through another network ONS 15454 that has a DCC connection to the unreachable ONS 15454.
- Disconnect all DCCs to the node by disabling them on neighboring nodes. Connect a CTC computer directly to the ONS 15454 and change its provisioning.

13.2.8 Scenario 8: Dual GNEs on a Subnet

The ONS 15454 provides GNE load balancing, which allows CTC to reach ENEs over multiple GNEs without the ENEs being advertised over OSPF. This feature allows a network to quickly recover from the loss of GNE, even if the GNE is on a different subnet. If a GNE fails, all connections through that GNE fail. CTC disconnects from the failed GNE and from all ENEs for which the GNE was a proxy, and then reconnects through the remaining GNEs. Figure 13-14 shows a network with dual GNEs on the same subnet. Figure 13-15 shows a network with dual GNEs on different subnets.

Figure 13-14 Scenario 8: Dual GNEs on the Same Subnet

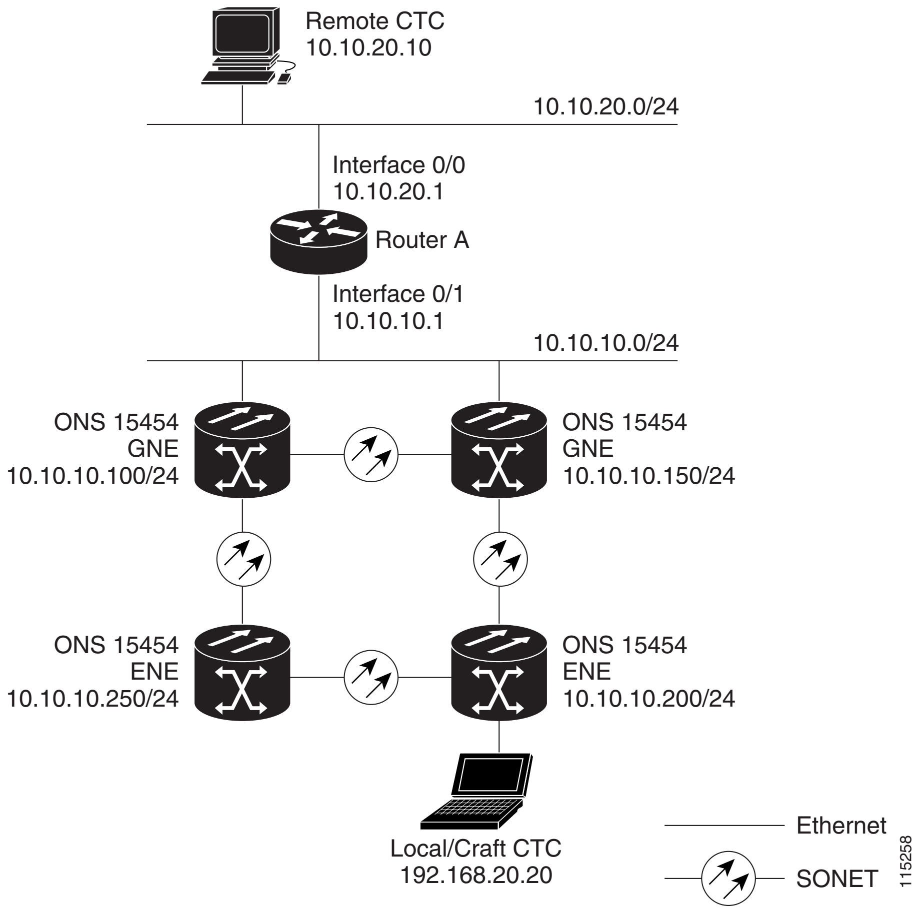
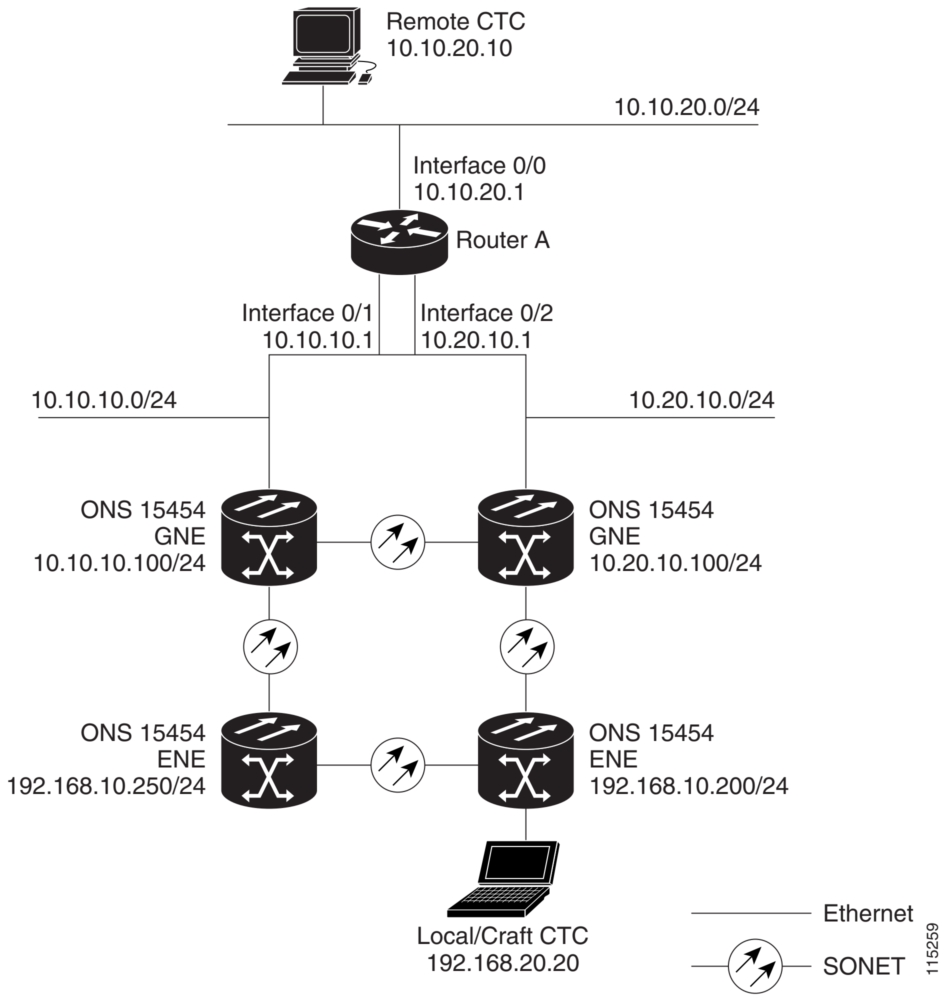


Figure 13-15 Scenario 8: Dual GNEs on Different Subnets



13.3 Routing Table

ONS 15454 routing information is displayed on the Maintenance > Routing Table tabs. The routing table provides the following information:

- Destination—Displays the IP address of the destination network or host.
- Mask—Displays the subnet mask used to reach the destination host or network.
- Gateway—Displays the IP address of the gateway used to reach the destination network or host.
- Usage—Shows the number of times the listed route has been used.
- Interface—Shows the ONS 15454 interface used to access the destination. Values are:
  - motfcc0—The ONS 15454 Ethernet interface, that is, the RJ-45 jack on the TCC2 and the LAN 1 pins on the backplane
  - pdcc0—A SONET data communications channel (SDCC) interface, that is, an OC-N trunk card identified as the SDCC termination

- lo0—A loopback interface

Table 13-5 shows sample routing entries for an ONS 15454.

Table 13-5 Sample Routing Table Entries

Entry	Destination	Mask	Gateway	Usage	Interface
1	0.0.0.0	0.0.0.0	172.20.214.1	265103	motfcc0
2	172.20.214.0	255.255.255.0	172.20.214.92	0	motfcc0
3	172.20.214.92	255.255.255.255	127.0.0.1	54	lo0
4	172.20.214.93	255.255.255.255	0.0.0.0	16853	pdcc0
5	172.20.214.94	255.255.255.255	172.20.214.93	16853	pdcc0

Entry 1 shows the following:

- Destination (0.0.0.0) is the default route entry. All undefined destination network or host entries on this routing table are mapped to the default route entry.
- Mask (0.0.0.0) is always 0 for the default route.
- Gateway (172.20.214.1) is the default gateway address. All outbound traffic that cannot be found in this routing table or is not on the node's local subnet is sent to this gateway.
- Interface (motfcc0) indicates that the ONS 15454 Ethernet interface is used to reach the gateway.

Entry 2 shows the following:

- Destination (172.20.214.0) is the destination network IP address.
- Mask (255.255.255.0) is a 24-bit mask, meaning all addresses within the 172.20.214.0 subnet can be a destination.
- Gateway (172.20.214.92) is the gateway address. All outbound traffic belonging to this network is sent to this gateway.
- Interface (motfcc0) indicates that the ONS 15454 Ethernet interface is used to reach the gateway.

Entry 3 shows the following:

- Destination (172.20.214.92) is the destination host IP address.
- Mask (255.255.255.255) is a 32 bit mask, meaning only the 172.20.214.92 address is a destination.
- Gateway (127.0.0.1) is a loopback address. The host directs network traffic to itself using this address.
- Interface (lo0) indicates that the local loopback interface is used to reach the gateway.

Entry 4 shows the following:

- Destination (172.20.214.93) is the destination host IP address.
- Mask (255.255.255.255) is a 32 bit mask, meaning only the 172.20.214.93 address is a destination.
- Gateway (0.0.0.0) means the destination host is directly attached to the node.
- Interface (pdcc0) indicates that a DCC interface is used to reach the destination host.

Entry 5 shows a DCC-connected node that is accessible through a node that is not directly connected:

- Destination (172.20.214.94) is the destination host IP address.
- Mask (255.255.255.255) is a 32-bit mask, meaning only the 172.20.214.94 address is a destination.

- Gateway (172.20.214.93) indicates that the destination host is accessed through a node with IP address 172.20.214.93.
- Interface (pdcc0) indicates that a DCC interface is used to reach the gateway.

13.4 External Firewalls

This section provides sample access control lists for external firewalls. Table 13-6 lists the ports that are used by the TCC2.

Table 13-6 Ports Used by the TCC2

Port	Function
0	Reserved
21	FTP control
23	Telnet
80	HTTP
111	rpc (not used; but port is in use)
513	rlogin (not used; but port is in use)
>1023	Default CTC listener ports
1080	Proxy server
2001-2017	I/O card Telnet
2018	Reserved
2361	TL1
3082	TL1
3083	TL1
5001	BLSR server port
5002	BLSR client port
7200	SNMP input port
9100	EQM port
9101	EQM port 2
9401	TCC boot port
9999	Flash manager
10240-12288	Proxy client
57790	Default TCC listener port

The following ACL (access control list) example shows a firewall configuration when the proxy server gateway setting is not enabled. In the example, the CTC workstation's address is 192.168.10.10. and the ONS 15454 address is 10.10.10.100. The firewall is attached to the GNE, so inbound is CTC to the GNE and outbound is from the GNE to CTC. The CTC Common Object Request Broker Architecture (CORBA) Standard constant is 683 and the TCC CORBA Default is TCC Fixed (57790).

```
access-list 100 remark *** Inbound ACL, CTC -> NE ***
access-list 100 remark
```

```
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq www
access-list 100 remark *** allows initial contact with ONS 15454 using http (port 80) ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq 57790
access-list 100 remark *** allows CTC communication with ONS 15454 GNE (port 57790) ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 established
access-list 100 remark *** allows ACKs back from CTC to ONS 15454 GNE ***

access-list 101 remark *** Outbound ACL, NE -> CTC ***
access-list 101 remark
access-list 101 permit tcp host 10.10.10.100 host 192.168.10.10 eq 683
access-list 101 remark *** allows alarms etc., from the 15454 (random port) to the CTC
workstation (port 683) ***
access-list 100 remark
access-list 101 permit tcp host 10.10.10.100 host 192.168.10.10 established
access-list 101 remark *** allows ACKs from the 15454 GNE to CTC ***
```

The following ACL (access control list) example shows a firewall configuration when the proxy server gateway setting is enabled. As with the first example, the CTC workstation address is 192.168.10.10 and the ONS 15454 address is 10.10.10.100. The firewall is attached to the GNE, so inbound is CTC to the GNE and outbound is from the GNE to CTC. CTC CORBA Standard constant (683) and TCC CORBA Default is TCC Fixed (57790).

```
access-list 100 remark *** Inbound ACL, CTC -> NE ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq www
access-list 100 remark *** allows initial contact with the 15454 using http (port 80) ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq 1080
access-list 100 remark *** allows CTC communication with the 15454 GNE (port 1080) ***
access-list 100 remark

access-list 101 remark *** Outbound ACL, NE -> CTC ***
access-list 101 remark
access-list 101 permit tcp host 10.10.10.100 host 192.168.10.10 established
access-list 101 remark *** allows ACKs from the 15454 GNE to CTC ***
```

Alarm Monitoring and Management

This chapter describes Cisco Transport Controller (CTC) alarm management. To troubleshoot specific alarms, refer to the *Cisco ONS 15454 Troubleshooting Guide*. Chapter topics include:

14.1 Overview

The CTC detects and reports SONET alarms generated by the Cisco ONS 15454 and the larger SONET network. You can use CTC to monitor and manage alarms at the card, node, or network level. Default alarm severities conform to the Telcordia GR-253 standard, but you can reset alarm severities in customized alarm profiles or suppress CTC alarm reporting. For a detailed description of the standard Telcordia categories employed by Optical Networking System (ONS) nodes, refer to the *Cisco ONS 15454 Troubleshooting Guide.*

Note ONS 15454 alarms can also be monitored and managed through Transaction Language One (TL1) or a network management system (NMS).

14.2 Documenting Existing Provisioning

In the card-, node-, or network-level CTC view, choose File > Print to print CTC information in graphical or tabular form on a Windows-provisioned printer. Choose File > Export to export card, node, or network information as editable delineated text files to other applications. Printing and exporting data are useful for record keeping or troubleshooting purposes.

Print card-, node-, or network-level CTC information in graphical or tabular form on a Windows-provisioned printer, or export card, node, or network information as editable delineated text files to other applications. This feature is useful for viewing the node inventory, circuit routing, or alarm data in network record-keeping and troubleshooting.

Whether you choose to print or export data, you can choose from the following options:

- Entire frame—Prints or exports the entire CTC window including the graphical view of the card, node, or network. This option is available for all windows.
- Tabbed view—Prints or exports the lower half of the CTC window containing tabs and data. The printout includes the selected tab (on top) and the data shown in the tab window. For example, if you print the History window Tabbed view, you print only history items appearing in the window. This option is available for all windows.
- Table Contents—Prints or exports CTC data in table format without graphical representations of shelves, cards, or tabs. This option applies to all windows except:
  - Provisioning > General > General, Power Monitor windows
  - Provisioning > Network > General, RIP windows
  - Provisioning > Security > Policy, Access, or Legal Disclaimer windows
  - Provisioning > SNMP window
  - Provisioning > Timing window
  - Provisioning > UCP > Node window
  - Provisioning > WDM-ANS > Provisioning window
  - Maintenance > Cross-Connect > Cards window
  - Maintenance > Database window
  - Maintenance > Diagnostic window
  - Maintenance > Protection window
  - Maintenance > Timing > Source window

  The Table Contents option prints all the data contained in a table with the same column headings. For example, if you print the History window Table Contents view, you print all data included in the table whether or not items appear in the window.

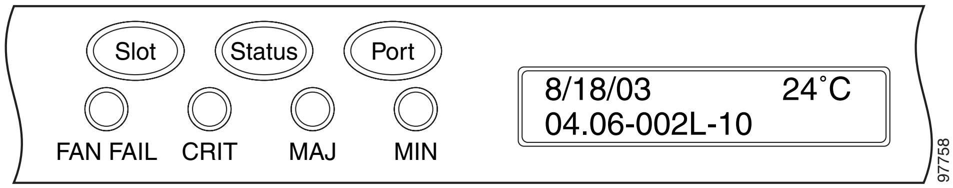
  The above items are also not available for the Export option.

14.3 Viewing Alarm Counts on the LCD for a Node, Slot, or Port

You can view node, slot, or port-level alarm counts and summaries using the buttons on the ONS 15454 LCD panel. The Slot and Port buttons toggle between display types; the Slot button toggles between node display and slot display, and the Port button toggles between slot and port views. Pressing the Status button after you choose the display mode changes the display from alarm count to alarm summary.

The ONS 15454 has a one-button update for some commonly viewed alarm counts. If you press the Slot button once and then wait eight seconds, the display automatically changes from a slot alarm count to a slot alarm summary. If you press the Port button to toggle to port-level display, you can use the Port button to toggle to a specific slot and to view each port's port-level alarm count. Figure 14-1 shows the LCD panel layout.

Figure 14-1 Shelf LCD Panel



14.4 Viewing Alarms

In the card-, node-, or network-level CTC view, click the Alarms tab to display the alarms for that card, node, or network. The Alarms window shows alarms in conformance with Telcordia GR-253. This means that if a network problem causes two alarms, such as loss of frame (LOF) and loss of signal (LOS), CTC only shows the LOS alarm in this window because it supersedes the LOF and replaces it.

In Release 4.6, the Path Width column has been added to the Alarms and Conditions tabs. This column expands upon alarmed object information contained in the AID string (such as "STS-4-1-3") by giving the number of STSs contained in the alarmed path. For example, the Path Width will tell you whether a critical alarm applies to an STS1 or an STS48c. The column reports the width as a 1, 3, 6, 12, 48 etc. as appropriate, understood to be "STS-n."

Table 14-1 lists the column headings and the information recorded in each column.

Table 14-1 Alarms Column Descriptions

Column	Information Recorded
New	Indicates a new alarm. To change this status, click either the **Synchronize** button or the **Delete Cleared Alarms** button.
Date	Date and time of the alarm.
Node	Node where the alarm occurred (appears only in network view).
Object	TL1 access identifier (AID) for the alarmed object. For an STSmon or VTmon, the object.
Eqpt Type	Card type in this slot.
Slot	Slot where the alarm occurred (appears only in network and node view).
Port	Port where the alarm is raised. For STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Path Width	Indicates how many STSs are contained in the alarmed path. This information compliments the alarm object notation, which is explained in Table 14-3.
Sev	Severity level: CR (critical), MJ (major), MN (minor), NA (not-alarmed), NR (not-reported).
ST	Status: R (raised), C (clear).
SA	When checked, indicates a service-affecting alarm.
Cond	The error message/alarm name. These names are alphabetically defined in the "Alarm Troubleshooting" chapter of the *Cisco ONS 15454 Troubleshooting Guide.*
Description	Description of the alarm.

Table 14-1 Alarms Column Descriptions (continued)

Column	Information Recorded
Num	An incrementing count of alarm messages.
Ref	The reference number assigned to the alarm.

Table 14-2 lists the color codes for alarm and condition severities. The inherited (I) and unset (U) severities are only listed in the network view Provisioning > Alarm Profiles tab. They are not currently implemented.

Table 14-2 Color Codes for Alarm and Condition Severities

Color	Description
Red	Raised Critical (CR) alarm
Orange	Raised Major (MJ) alarm
Yellow	Raised Minor (MN) alarm
Magenta	Raised Not-Alarmed (NA) condition
Blue	Raised Not-Reported (NR) condition
White	Cleared (C) alarm or condition

In network view, CTC identifies STS and VT alarm objects using a TL1-type access identifier (AID), as shown in Table 14-3.

Table 14-3 Network View STS and Alarm Object Identification

Object	STS or VT AID	Port No.
MON object	STS-*Slot-Port-STS* For example, STS-6-1-6 VT1-*Slot-Port-STS-VT_Group-VT* For example, VT1-6-1-6-1-1	Port=1
TERM object	*Upstream_Slot-Port-STS* For example, STS-6-3-6 *Upstream_Slot-Port-STS-VT_Group-VT* For example, VT1-6-3-6-1-1	Port=1

14.4.1 Viewing Alarms With Each Node's Time Zone

By default, alarms and conditions are displayed with the time stamp of the CTC workstation where you are viewing them. But you can set the node to report alarms (and conditions) using the time zone where the node is located by clicking Edit > Preferences, and clicking the Display Events Using Each Node's Timezone check box.

14.4.2 Controlling Alarm Display

You can control the display of the alarms shown on the Alarms window. Table 14-4 shows the actions you can perform in the Alarms window.

Table 14-4 Alarm Display

Button/Check box/Tool	Action
Filter button	Allows you to change the display on the Alarms window to show only alarms that meet a certain severity level, occur in a specified time frame, and/or reflect specific conditions. For example, you can set the filter so that only critical alarms display on the window. If you enable the Filter feature by clicking the Filter icon button in one CTC view, such as node view, it is enabled in the others as well (card view and network view).
Synchronize button	Updates the alarm display. Although CTC displays alarms in real time, the Synchronize button allows you to verify the alarm display. This is particularly useful during provisioning or troubleshooting.
Delete Cleared Alarms button	Deletes alarms that have been cleared.
AutoDelete Cleared Alarms check box	If checked, CTC automatically deletes cleared alarms.
Filter tool	Enables or disables alarm filtering in the card, node, or network view. When enabled or disabled, this state applies to other views for that node and for all other nodes in the network. For example, if the Filter tool is enabled in the node (default login) view Alarms window, the network view Alarms window and card view Alarms window also show the tool enabled. All other nodes in the network also show the tool enabled.

14.4.3 Filtering Alarms

The alarm display can be filtered to prevent display of alarms with certain severities or alarms that occurred between certain dates. You can set the filtering parameters by clicking the Filter button at the bottom-left of the Alarms window. You can turn the filter on or off by clicking the Filter tool at the bottom-right of the window. CTC retains your filter activation setting. For example, if you turn the filter on and then log out, CTC keeps the filter active the next time your user ID is activated.

14.4.4 Viewing Alarm-Affected Circuits

A user can view which ONS 15454 circuits are affected by a specific alarm by positioning the cursor over the alarm in the Alarm window and right-clicking. A shortcut menu displays (Figure 14-2). When the user selects the Select Affected Circuits option, the Circuits window opens to show the circuits that are affected by the alarm (Figure 14-3).

Figure 14-2 Select Affected Circuits Option

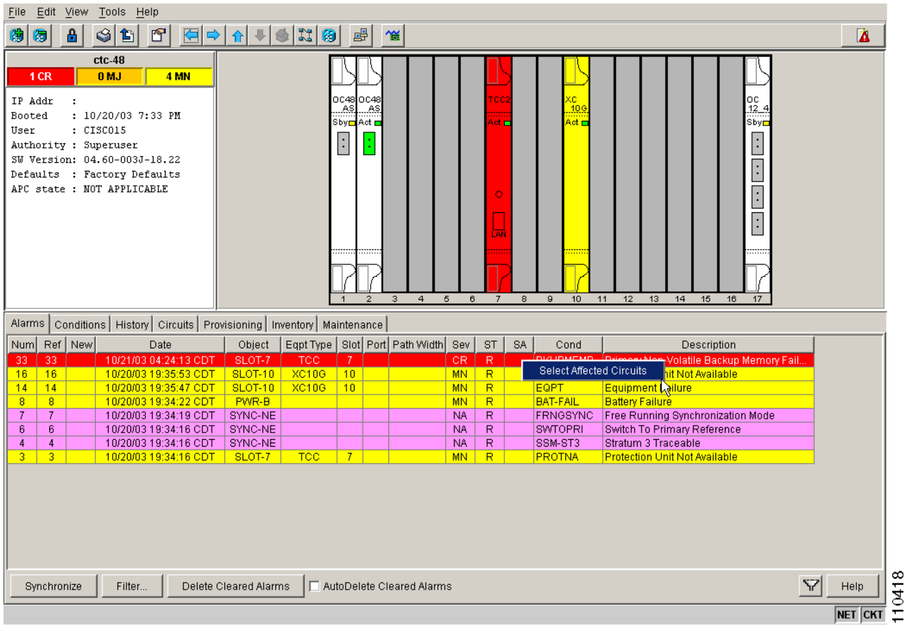
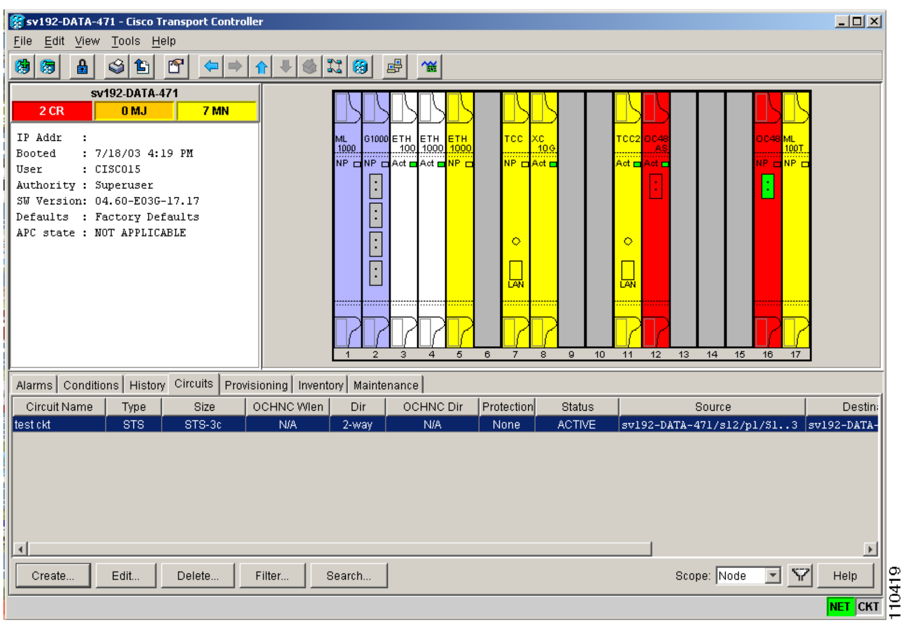


Figure 14-3 Viewing Alarm-Affected Circuits



14.4.5 Conditions Tab

The Conditions window displays retrieved fault conditions. A condition is a fault or status detected by ONS 15454 hardware or software. When a condition occurs and continues for a minimum period, CTC raises a condition, which is a flag showing that this particular condition currently exists on the ONS 15454.

The Conditions window shows all conditions that occur, including those that are superseded. For instance, if a network problem causes two alarms, such as loss of frame (LOF) and loss of signal (LOS), CTC shows both the LOF and LOS conditions in this window (even though LOS supersedes LOF). Having all conditions visible can be helpful when troubleshooting the ONS 15454. If you want to retrieve conditions that obey a root-cause hierarchy (that is, LOS supersedes and replaces LOF), you can exclude the same root causes by checking a check box in the window.

Fault conditions include reported alarms and not-reported or not-alarmed conditions. Refer to the trouble notifications information in the *Cisco ONS 15454 Troubleshooting Guide* for more information about alarm and condition classifications.

14.4.6 Controlling the Conditions Display

You can control the display of the conditions on the Conditions window. Table 14-5 shows the actions you can perform in the window.

Table 14-5 Conditions Display

Button	Action
Retrieve	Retrieves the current set of all existing fault conditions, as maintained by the alarm manager, from the ONS 15454.
Filter	Allows you to change the Conditions window display to only show the conditions that meet a certain severity level or occur in a specified time. For example, you can set the filter so that only critical conditions display on the window. There is a Filter icon button on the lower-right of the window that allows you to enable or disable the filter feature.

14.4.6.1 Retrieving and Displaying Conditions

The current set of all existing conditions maintained by the alarm manager can be seen when you click the Retrieve button. The set of conditions retrieved is relative to the view. For example, if you click the button while displaying the node view, node-specific conditions are displayed. If you click the button while displaying the network view, all conditions for the network (including ONS 15454 nodes and other connected nodes) are displayed, and the card view shows only card-specific conditions.

You can also set a node to display conditions using the time zone where the node is located, rather than the time zone of the PC where they are being viewed. See the "Viewing Alarms With Each Node's Time Zone" section on page 14-4 for more information.

14.4.6.2 Conditions Column Descriptions

Table 14-6 lists the Conditions window column headings and the information recorded in each column.

Table 14-6 Conditions Column Description

Column	Information Recorded
New	Indicates a new condition.
Date	Date and time of the condition.

Table 14-6 Conditions Column Description (continued)

Column	Information Recorded
Object	TL1 AID for the condition object. For an STSmon or VTmon, the object.
Eqpt Type	Card type in this slot.
Slot	Slot where the condition occurred (appears only in network and node view).
Port	Port where the condition occurred. For STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Sev[1]	Severity level: CR (critical), MJ (major), MN (minor), NA (not-alarmed), NR (not-reported).
SA[1]	Indicates a service-affecting alarm (when checked).
Cond	The error message/alarm name; these names are alphabetically defined in the "Alarm Troubleshooting" chapter of the *Cisco ONS 15454 Troubleshooting Guide.*
Description	Description of the condition.
Node	Node where the alarm occurred (appears only in network view).

1. All alarms, their severities, and service-affecting statuses are also displayed in the Condition tab unless you choose to filter the alarm from the display using the Filter button.

14.4.6.3 Filtering Conditions

The condition display can be filtered to prevent display of conditions (including alarms) with certain severities or that occurred between certain dates. You can set the filtering parameters by clicking the Filter button at the bottom-left of the Conditions window. You can turn the filter on or off by clicking the Filter tool at the bottom-right of the window. CTC retains your filter activation setting. For example, if you turn the filter on and then log out, CTC keeps the filter active the next time your user ID is activated.

14.4.7 Viewing History

The History window displays historic alarm or condition data for the node or for your login session. You can chose to display only alarm history, only events, or both by checking check boxes in the History > Node window. You can view network-level alarm and condition history, such as for circuits, at that level. At the node level, you can see all port (facility), card, STS, and system-level history entries. For example, protection-switching events or performance-monitoring threshold crossings appear here. If you double-click a card, you can view all port, card, and STS alarm or condition history that directly affects the card.

The ONS 15454 can store up to 640 critical alarm messages, 640 major alarm messages, 640 minor alarm messages, and 640 condition messages. When any of these limits is reached, the ONS 15454 discards the oldest events in that category.

Note In the Preference dialog General tab, the Maximum History Entries value only applies to the Session window.

Different views of CTC display different kinds of history:

- The History > Session window is shown in network view, node view, and card view. It shows alarms and conditions that occurred during the current user CTC session.

- The History > Node window is only shown in node view. It shows the alarms and conditions that occurred on the node since CTC software was operated on the node.
- The History > Card window is only shown in card view. It shows the alarms and conditions that occurred on the card since CTC software was installed on the node.

Tip Double-click an alarm in the History window to display the corresponding view. For example, double-clicking a card alarm takes you to card view. In network view, double-clicking a node alarm takes you to node view.

If you check the History window **Alarms** check box, you display the node history of alarms. If you check the **Events** check box, you display the node history of Not Alarmed and transient events (conditions). If you check both check boxes, you retrieve node history for both.

14.4.7.1 History Column Descriptions

Table 14-7 lists the History window column headings and the information recorded in each column.

Table 14-7 History Column Description

Column	Information Recorded
Date	Date and time of the condition.
Object	TL1 AID for the condition object. For an STSmon or VTmon, the object.
Sev	Severity level: critical (CR), major (MJ), minor (MN), not-alarmed (NA), not-reported (NR).
Eqpt Type	Card type in this slot (only displays in network view and node view).
ST	Status: raised (R), cleared (C), or transient (T).
Description	Description of the condition.
Port	Port where the condition occurred. For STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Cond	Condition name.
Slot	Slot where the condition occurred (only displays in network view and node view).
SA	Indicates a service-affecting alarm (when checked).

14.4.7.2 Retrieving and Displaying Alarm and Condition History

You can retrieve and view the history of alarms and conditions, as well as transients (passing notifications of processes as they occur) in the CTC history window. The information in this window is specific to the view where it is shown (that is, network history in the network view, node history in the node view, and card history in the card view).

The node and card history views are each divided into two tabs. In node view, when you click the Retrieve button, you can see the history of alarms, conditions, and transients that have occurred on the node in the History > Node window, and the history of alarms, conditions, and transients that have occurred on the node during your login session in the History > Session window. In the card-view history window, after you retrieve the card history, you can see the history of alarms, conditions, and transients on the card in the History > Card window, or a history of alarms, conditions, and transients that have occurred during your login session in the History > Session window.

You can also filter the severities and occurrence period in these history windows, but you cannot filter out not-reported conditions or transients.

14.5 Alarm Severities

ONS 15454 alarm severities follow the Telcordia GR-253 standard, so a condition maybe Alarmed—at a severity of Critical (CR), Major (MJ), or Minor (MN)—severities of Not Alarmed (NA) or Not Reported (NR). These severities are reported in the CTC software Alarms, Conditions, and History windows at all levels: network, shelf, and card.

ONS equipment provides a standard profile named "Default" listing all alarms and conditions with severity settings based on Telcordia GR-253 and other standards, but users can create their own profiles with different settings for some or all conditions and apply these wherever desired. (See the "Alarm Profiles" section on page 14-10.) For example, in a custom alarm profile, the default severity of a carrier loss (CARLOSS) alarm on an Ethernet port could be changed from major to critical. The profile allows setting to Not Reported or Not Alarmed, as well as the three alarmed severities.

Critical and Major severities are only used for service-affecting alarms. If a condition is set as Critical or Major by profile, it will raise as Minor alarm in the following situations:

- In a protection group, if the alarm is on a standby entity (side not carrying traffic)
- If the alarmed entity has no traffic provisioned on it, so no service is lost.

Because of this possibility of being raised at two different levels, the alarm profile pane shows Critical as "CR / MN" and Major as "MJ / MN."

14.6 Alarm Profiles

The alarm profiles feature allows you to change default alarm severities by creating unique alarm profiles for individual ONS 15454 ports, cards, or nodes. A created alarm profile can be applied to any node on the network. Alarm profiles can be saved to a file and imported elsewhere in the network, but the profile must be stored locally on a node before it can be applied to the node, its cards, or its cards' ports.

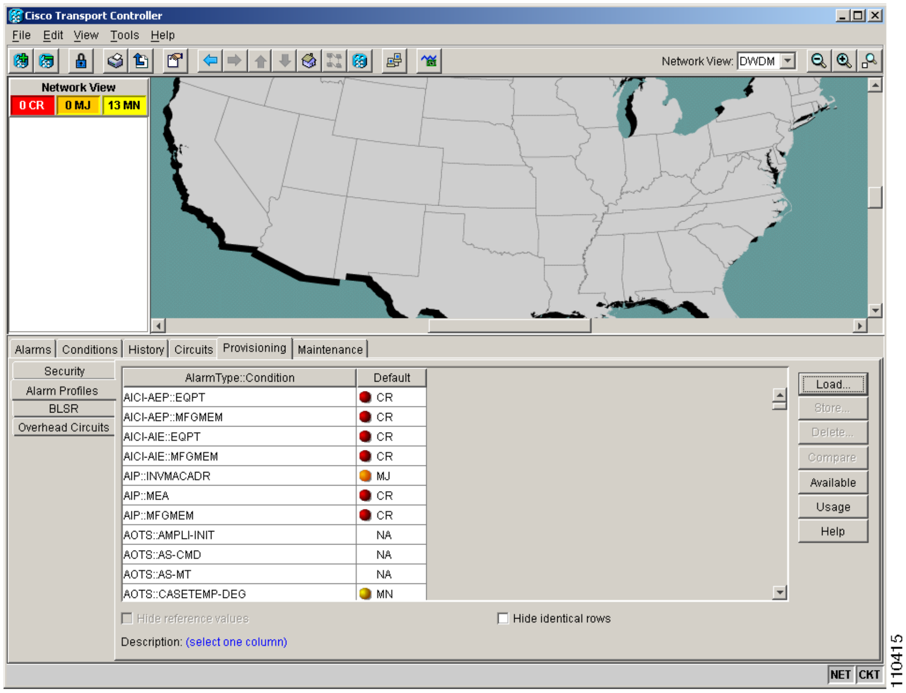
CTC can store up to ten active alarm profiles at any time to apply to the node. Custom profiles can take eight of these active profile positions, and two are reserved by CTC. The reserved Default profile contains Telcordia GR-253 severities. The reserved Inherited profile allows port alarm severities to be governed by the card-level severities, or card alarm severities to be determined by the node-level severities.

If one or more alarm profiles have been stored as files from elsewhere in the network onto the local PC or server hard drive where CTC resides, you can utilize as many profiles as you can physically store by deleting and replacing them locally in CTC so that only eight are active at any given time.

14.6.1 Creating and Modifying Alarm Profiles

Alarm profiles are created in the network view using the Provisioning > Alarm Profiles tabs. Figure 14-4 shows the default list of alarm severities. A default alarm severity following Telcordia GR-253 standards is preprovisioned for every alarm. After loading the default profile or another profile on the node, you can use the Clone feature to create custom profiles. After the new profile is created, the Alarm Profiles window shows the original profile—frequently Default—and the new profile.

Figure 14-4 Network View Alarm Profiles Window



Note The alarm profile list contains a master list of alarms that is used for a mixed node network. Some of these alarms might not be used in all ONS nodes.

Note The Default alarm profile list contains alarm and condition severities that correspond when applicable to default values established in Telcordia GR-253.

Note All default or user-defined severity settings that are Critical (CR) or Major (MJ) are demoted to Minor (MN) in non-service-affecting situations as defined in Telcordia GR-474.

Tip To see the full list of profiles including those available for loading or cloning, click the Available button. You must load a profile before you can clone it.

Note Up to 10 profiles, including the two reserved profiles — Inherited and Default — can be stored in CTC.

Wherever it is applied, the Default alarm profile sets severities to standard Telcordia GR-253 settings. In the Inherited profile, alarms inherit, or copy, severity from the next-highest level. For example, a card with an Inherited alarm profile copies the severities used by the node housing the card. If you choose the Inherited profile from the network view, the severities at the lower levels (node and card) are copied from this selection.

You do not have to apply a single severity profile to the node-, card-, and port-level alarms. Different profiles can be applied at different levels. You could use the inherited or default profile on a node and on all cards and ports, but apply a custom profile that downgrades an alarm on one particular card. For example, you might choose to downgrade an OC-N unequipped path alarm (UNEQ-P) from Critical (CR) to Not Alarmed (NA) on an optical card because this alarm raises and then clears every time you create a circuit. UNEQ-P alarms for the card with the custom profile would not display on the Alarms tab. (But they would still be recorded on the Conditions and History tabs.)

When you modify severities in an alarm profile:

- All Critical (CR) or Major (MJ) default or user-defined severity settings are demoted to Minor (MN) in Non-Service-Affecting (NSA) situations as defined in Telcordia GR-474.
- Default severities are used for all alarms and conditions until you create a new profile and apply it.
- Changing a severity to TR or U does not change its display or its default severity.

14.6.2 Alarm Profile Buttons

The Alarm Profiles window displays six buttons on the right side. Table 14-8 lists and describes each of the alarm profile buttons and their functions.

Table 14-8 Alarm Profile Buttons

Button	Description
Load	Loads a profile to a node or a file.
Store	Saves profiles on a node (or nodes) or in a file.
Delete	Deletes profiles from a node.
Compare	Displays differences between alarm profiles (for example, individual alarms that are not configured equivalently between profiles).
Available	Displays all profiles available on each node.
Usage	Displays all entities (nodes and alarm subjects) present in the network and which profiles contain the alarm. Can be printed.

14.6.3 Alarm Profile Editing

Table 14-9 lists and describes the five profile-editing options available when you right-click an alarm item in the profile column (such as Default).

Table 14-9 Alarm Profile Editing Options

Button	Description
Store	Saves a profile in a node or in a file.
Rename	Changes a profile name.
Clone	Creates a profile that contains the same alarm severity settings as the profile being cloned.
Reset	Restores a profile to its previous state or to the original state (if it has not yet been applied).
Remove	Removes a profile from the table editor.

14.6.4 Alarm Severity Options

To change or assign alarm severity, left-click the alarm severity you want to change in the alarm profile column. Seven severity levels appear for the alarm:

- Not-reported (NR)
- Not-alarmed (NA)
- Minor (MN)
- Major (MJ)
- Critical (CR)
- UNSET: Unset/Unknown (not normally used)
- Inherited (I)

Inherited and Unset only appear in alarm profiles. They do not appear when you view alarms, history, or conditions.

14.6.5 Row Display Options

In the network view, the Alarm Profiles window displays two check boxes at the bottom of the window:

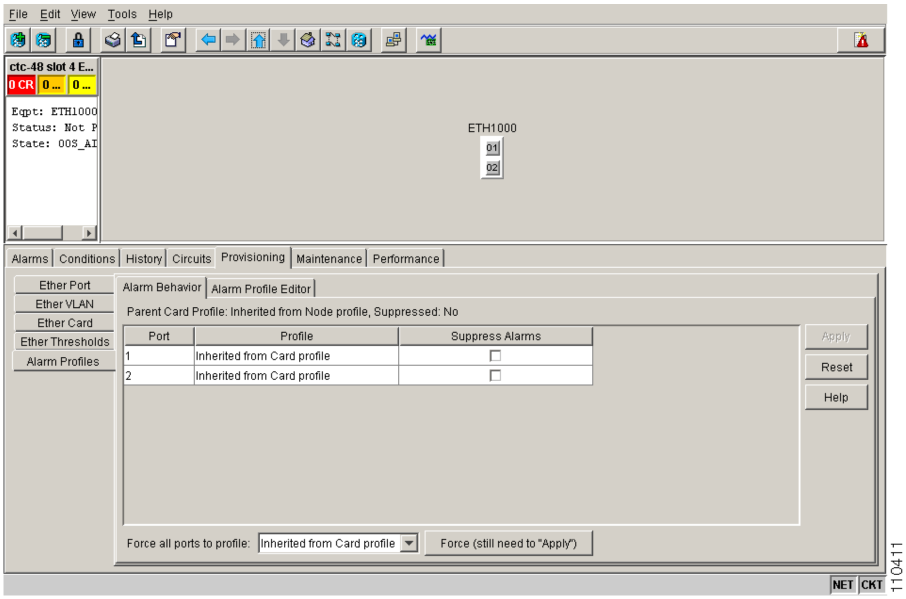
- Hide reference values—Highlights alarms with non-default severities by clearing alarm cells with default severities.
- Hide identical rows—Hides rows of alarms that contain the same severity for each profile.

14.6.6 Applying Alarm Profiles

In CTC node view, the Alarm Behavior window displays alarm profiles for the node. In card view, the Alarm Behavior window displays the alarm profiles for the selected card. Alarm profiles form a hierarchy. A node-level alarm profile applies to all cards in the node except cards that have their own profiles. A card-level alarm profile applies to all ports on the card except ports that have their own profiles.

At the node level, you can apply profile changes on a card-by-card basis or set a profile for the entire node. At the card-level view, you can apply profile changes on a port-by-port basis or set alarm profiles for all ports on that card. Figure 14-5 shows the E1000-4 card view of an alarm profile.

Figure 14-5 Card View of an E1000-4 Card Alarm Profile



14.7 Suppressing Alarms

ONS 15454 nodes have an alarm suppression option that clears raised alarm messages for the node, chassis, one or more slots (cards), or one or more ports. After they are cleared, these alarms change appearance from their normal severity color to white and they can be cleared from the display by clicking Synchronize. Alarm suppression itself raises an alarm called AS-CMD that is shown in applicable Alarms windows. Node-level suppression is shown in the node view Alarms window, and card or port-level suppression is shown in all views. The AS-CMD alarm itself is not cleared by the suppress command. Each instance of this alarm indicates its object separately in the Object column.

A suppression command applied at a higher level does not supersede a command applied at a lower level. For example, applying a node-level alarm suppression command makes all raised alarms for the node appear to be cleared, but it does not cancel out card-level or port-level suppression. Each of these conditions can exist independently and must be cleared independently.

Suppression causes the entity alarm to behave like a Not-Reported event. This means that the alarms, having been suppressed from view in the Alarms window, are now only shown in the Conditions window. The suppressed alarms are displayed with their usual visual characteristics (service-affecting status and color-coding) in the window. The alarms still appear in the History window.

Note Use alarm suppression with caution. If multiple CTC or TL1 sessions are open, suppressing the alarms in one session suppresses the alarms in all other open sessions.

14.8 Provisioning External Alarms and Controls

External alarm inputs can be provisioned on the AIC or AIC-I cards for external sensors such as an open door and flood sensors, temperature sensors, and other environmental conditions. External control outputs on these two cards allow you to drive external visual or audible devices such as bells and lights. They can control other devices such as generators, heaters, and fans.

You provision external alarms in the AIC card view Provisioning > External Alarms tab and controls in the AIC card view Provisioning > External Controls tab. Up to 4 external alarm inputs and four external controls are available with the AIC card. Up to 12 external alarm inputs and four external controls are available with the AIC-I card. If you also provision the alarm extension panel (AEP) with the AIC-I, there are 32 inputs and 16 outputs.

14.8.1 External Alarm Input

You can provision each alarm input separately. Provisionable characteristics of external alarm inputs include:

- Alarm type
- Alarm severity (CR, MJ, MN, NA, and NR)
- Alarm-trigger setting (open or closed); open means that the normal condition is no current flowing through the contact, and the alarm is generated when current does flow; closed means that normal condition is to have current flowing through the contact, and the alarm is generated with current stops flowing
- Virtual wire associated with the alarm
- CTC alarm log description (up to 63 characters)

Note If you provision an external alarm to raise upon an open contact before you physically connect to the ONS equipment, the alarm will raise until you do create the physical connection.

Note When you provision an external alarm, the alarm object is ENV-IN-nn. The variable nn refers to the external alarm's number, regardless of the name you assign.

14.8.2 External Control Output

You can provision each alarm output separately. Provisionable characteristics of alarm outputs include:

- Control type.
- Trigger type (alarm or virtual wire).
- Description for CTC display.
- Closure setting (manually or by trigger). If you provision the output closure to be triggered, the following characteristics can be used as triggers:
  - Local NE alarm severity—A chosen alarm severity (for example, major) and any higher-severity alarm (in this case, critical) causes output closure.

- Remote NE alarm severity—Similar to local NE alarm severity trigger setting, but applies to remote alarms.
- Virtual wire entities—You can provision an alarm that is input to a virtual wire to trigger an external control output.

14.9 Audit Trail

The ONS 15454 keeps a human-readable audit trail of all system actions such as circuit creation or deletion, and security events such as login and logout. You can archive this log in text form on a PC or network. You can access the log by clicking the Maintenance > Audit tabs. The log capacity is 640 entries; when this limit is reached, the oldest entries are overwritten with new events. When the log is 80 percent full, an AUD-LOG-LOW condition is raised. When the log is full and entries are being overwritten, an AUD-LOG-LOSS condition occurs.

Tip You can save the audit trail to prevent loss of information that applies to alarms.

This window contains the columns listed in

Table 14-10 Audit Trail Window Columns

Heading	Explanation
Date	Date when the action occurred.
Num	Incrementing count of actions.
User	User ID that initiated the action.
P/F	Pass/Fail (that is, whether or not the action was executed).
Operation	Action that was taken.

Performance Monitoring

Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds, and report performance data for early detection of problems. In this chapter, PM parameters and concepts are defined for electrical cards, Ethernet cards, optical cards, and dense wavelength division multiplexing (DWDM) cards in the Cisco ONS 15454.

For information about enabling and viewing PM values, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

Note For additional information regarding PM parameters, refer to Telcordia documents GR-1230-CORE, GR-820-CORE, GR-499-CORE, and GR-253-CORE and the ANSI document entitled *Digital Hierarchy - Layer 1 In-Service Digital Transmission Performance Monitoring*.

15.1 Threshold Performance Monitoring

Thresholds are used to set error levels for each PM parameter. You can set individual PM threshold values from the Cisco Transport Controller (CTC) card view Provisioning tab. For procedures on provisioning card thresholds, such as line, path, and SONET thresholds, refer to the *Cisco ONS 15454 Procedure Guide*.

During the accumulation cycle, if the current value of a performance monitoring parameter reaches or exceeds its corresponding threshold value, a threshold crossing alert (TCA) is generated by the node and displayed by CTC. TCAs provide early detection of performance degradation. When a threshold is crossed, the node continues to count the errors during a given accumulation period. If 0 is entered as the threshold value, generation of TCAs are disabled, but performance monitoring continues.

Change the threshold if the default value does not satisfy your error monitoring needs. For example, customers with a critical DS-1 installed for 911 calls must guarantee the best quality of service on the line; therefore, they lower all thresholds so that the slightest error raises a TCA.

15.2 Intermediate Path Performance Monitoring

Intermediate path performance monitoring (IPPM) allows transparent monitoring of a constituent channel of an incoming transmission signal by a node that does not terminate that channel. Many large ONS 15454 networks only use line terminating equipment (LTE), not path terminating equipment (PTE). Table 15-1 shows ONS 15454 cards that are considered LTE.

Table 15-1 Line Terminating Equipment

Electrical LTE	
EC1-12	
Optical LTE	
OC3 IR 4/STM1 SH 1310	OC3 IR/STM1 SH 1310-8
OC12 IR/STM4 SH1310	OC12 LR/STM4 LH1310
OC12 LR/STM4 LH 1550	OC12 IR/STM4 SH 1310-4
OC48 IR 1310 [1]	OC48 LR 1550
OC48 IR/STM16 SH AS 1310 [1]	OC48 LR/STM16 LH AS 1550
OC48 ELR/STM16 EH 100 GHz	OC48 ELR 200 GHz
OC192 SR/STM64 IO 1310	OC192 IR/STM64 SH 1550
OC192 LR/STM64 LH 1550	OC192 LR/STM64 LH ITU 15xx.xx
TXP_MR_10G	MXP_2.5G_10G

1. An OC-48 IR card used in a BLSR does not support IPPM during a protection switch.

Software R3.0 and higher allows LTE cards to monitor near-end PM data on individual STS payloads by enabling IPPM. After enabling IPPM provisioning on the line card, service providers can monitor large amounts of STS traffic through intermediate nodes, thus making troubleshooting and maintenance activities more efficient.

IPPM occurs only on STS paths that have IPPM enabled, and TCAs are raised only for PM parameters on the IPPM enabled paths. The monitored IPPM parameters are STS CV-P, STS ES-P, STS SES-P, STS UAS-P, and STS FC-P.

Note Far-end IPPM is not supported by all OC-N cards. It is supported by OC3-4 and EC-1 cards. However, SONET path PMs can be monitored by logging into the far-end node directly.

The ONS 15454 performs IPPM by examining the overhead in the monitored path and by reading all of the near-end path PM values in the incoming direction of transmission. The IPPM process allows the path signal to pass bidirectionally through the node completely unaltered.

For detailed information about specific IPPM parameters, locate the card name in the following sections and review the appropriate definition.

15.3 Pointer Justification Count Performance Monitoring

Pointers are used to compensate for frequency and phase variations. Pointer justification counts indicate timing errors on SONET networks. When a network is out of sync, jitter and wander occur on the transported signal. Excessive wander can cause terminating equipment to slip.

Slips cause different effects in service. Voice service has intermittent audible clicks. Compressed voice technology has short transmission errors or dropped calls. Fax machines lose scanned lines or experience dropped calls. Digital video transmission has distorted pictures or frozen frames. Encryption service loses the encryption key causing data to be transmitted again.

Pointers provide a way to align the phase variations in STS and VT payloads. The STS payload pointer is located in the H1 and H2 bytes of the line overhead. Clocking differences are measured by the offset in bytes from the pointer to the first byte of the STS synchronous payload envelope (SPE) called the J1 byte. Clocking differences that exceed the normal range of 0 to 782 can cause data loss.

There are positive (PPJC) and negative (NPJC) pointer justification count parameters. PPJC is a count of path-detected (PPJC-Pdet-P) or path-generated (PPJC-Pgen-P) positive pointer justifications. NPJC is a count of path-detected (NPJC-Pdet-P) or path-generated (NPJC-Pgen-P) negative pointer justifications depending on the specific PM name. PJCDIFF is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. PJCS-PDet-P is a count of the one-second intervals containing one or more PPJC-PDet or NPJC-PDet. PJCS-PGen-P is a count of the one-second intervals containing one or more PPJC-PGen or NPJC-PGen.

A consistent pointer justification count indicates clock synchronization problems between nodes. A difference between the counts means the node transmitting the original pointer justification has timing variations with the node detecting and transmitting this count. Positive pointer adjustments occur when the frame rate of the SPE is too slow in relation to the rate of the STS 1.

You must enable PPJC and NPJC performance monitoring parameters for LTE cards. See Table 15-1 on page 15-2 for a list of Cisco ONS 15454 LTE cards. In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the card view Provisioning tab.

For detailed information about specific pointer justification count PM parameters, locate the card name in the following sections and review the appropriate definition.

15.4 DS-1 Facility Data Link Performance Monitoring

Facility Data Link (FDL) performance monitoring enables the DS1N-14 card to calculate and report DS-1 error rate performance measured at both the near-end and far-end of the FDL. The far-end information is reported as received on the FDL in a performance report message (PRM) from an intelligent channel service unit (CSU).

To monitor DS-1 FDL PM values, the DS-1 must be set to use extended superframe (ESF) format and the FDL must be connected to an intelligent CSU. For procedures on provisioning ESF on the DS1N-14 card, refer to the *Cisco ONS 15454 Procedure Guide*.

The monitored DS-1 FDL PM parameters are CV-PFE, ES-PFE, ESA-PFE, ESB-PFE, SES-PFE, SEFS-PFE, CSS-PFE, UAS-PFE, FC-PFE, and ES-LFE. For detailed information about specific DS-1 FDL PM parameters, locate the DS1N-14 card name in the following sections and review the appropriate definition.

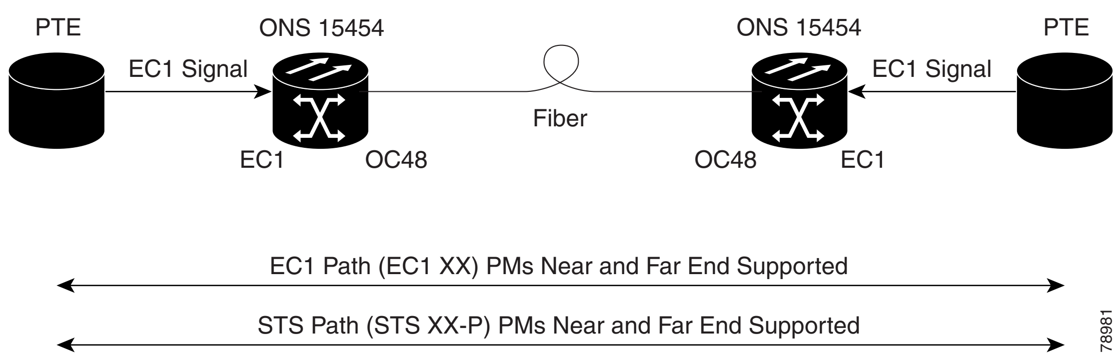
15.5 Performance Monitoring for Electrical Cards

The following sections define performance monitoring parameters for the EC1-12, DS1-14, DS1N-14, DS3-12, DS3N-12, DS3-12E, DS3N-12E, and DS3XM-6 electrical cards.

15.5.1 EC1-12 Card Performance Monitoring Parameters

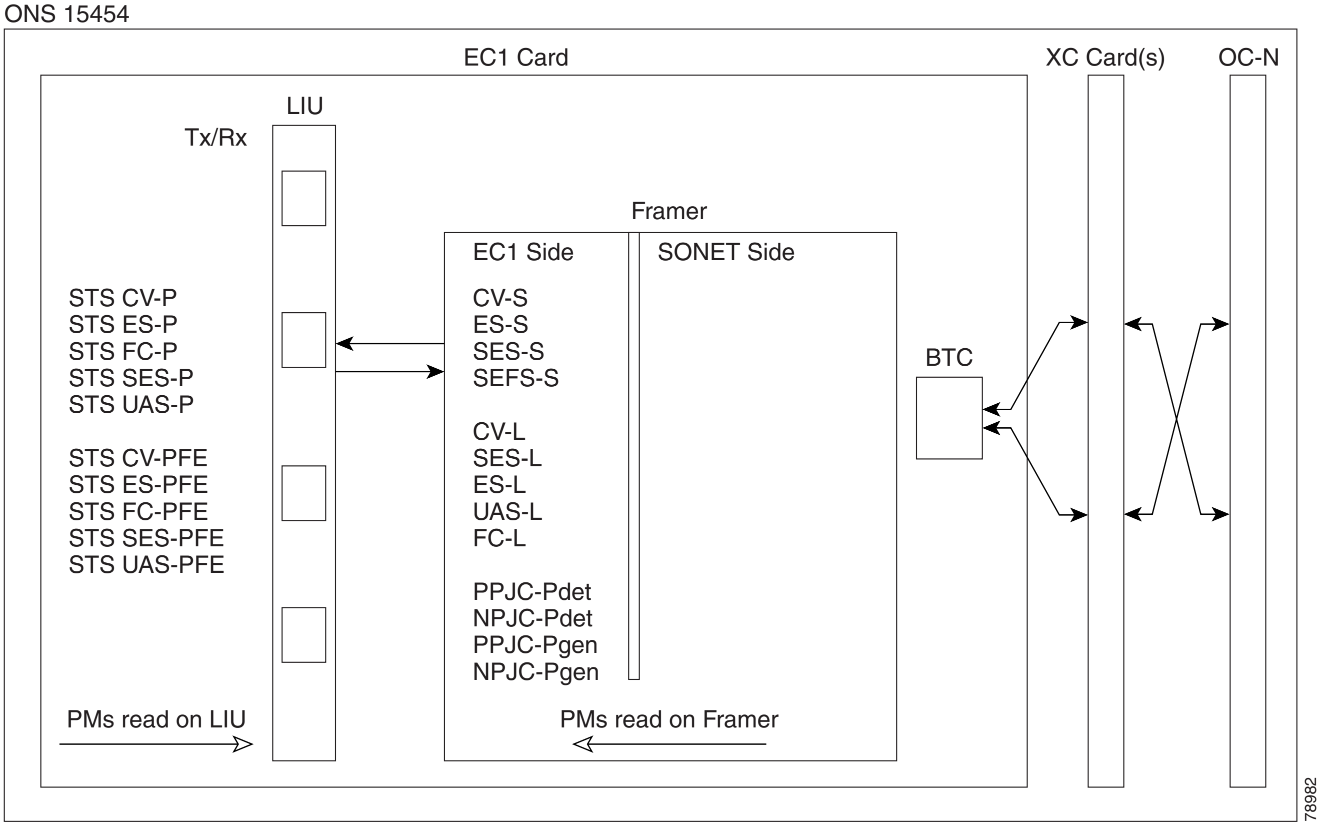
Figure 15-1 shows signal types that support near-end and far-end PMs. Figure 15-2 on page 15-5 shows where overhead bytes detected on the application specific integrated circuits (ASICs) produce performance monitoring parameters for the EC1-12 card.

Figure 15-1 Monitored Signal Types for the EC1-12 Card



Note The XX in Figure 15-1 represents all PMs listed in tables in this section with the given prefix and/or suffix.

Figure 15-2 PM Read Points on the EC1-12 Card



The PM parameters for the EC1-12 cards are described in Table 15-2 through Table 15-7 on page 15-8.

Table 15-2 Near-End Section PMs for the EC1-12 Card

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
CV-S	Section Coding Violation (CV-S) is a count of bit interleaved parity (BIP) errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or loss of signal (LOS) defect was present.

Table 15-2 Near-End Section PMs for the EC1-12 Card (continued)

Parameter	Definition
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253-CORE for value) or more section-layer BIP errors were detected or a severely errored frame (SEF) or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected during most seconds where an LOS or loss of frame (LOF) defect is present. However, there might be situations when that is not the case, and the SEFS-S parameter is only incremented based on the presence of the SEF defect.

Table 15-3 Near-End Line Layer PMs for the EC1-12 Card

Parameter	Definition
CV-L	Near-End Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame, with each error incrementing the current CV-L second register.
ES-L	Near-End Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an alarm indication signal-line (AIS-L) defect was present.
SES-L	Near-End Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Near-End Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and the line continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Near-End Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer, traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Table 15-4 Near-End SONET Path PMs for the EC1-12 Card

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
STS CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.

Table 15-4 Near-End SONET Path PMs for the EC1-12 Card (continued)

Parameter	Definition
STS ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. STS ES-P can also be caused by a Path Alarm Indicator Signal (AIS-P) defect (or a lower-layer, traffic-related, near-end defect) or a Path Loss of Pointer (LOP-P) defect.
STS FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, an unequipped path (UNEQ-P) or a trace identifier mismatch (TIM-P) failure is declared. A failure event also begins if the STS PTE monitoring the path supports path enhanced remote defect indicator (ERDI-P) for that path. The failure event ends when these failures are cleared.
STS SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. STS SES-P can also be caused by an AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect.
STS UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-5 Near-End SONET Path BIP PMs for the EC1-12 Card

Parameter	Definition
Note In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the card view Provisioning tab.	
PPJC-Pdet-P	Positive Pointer Justification Count, STS Path Detected (PPJC-Pdet-P) is a count of the positive pointer justifications detected on a particular path in an incoming SONET signal.
NPJC-Pdet-P	Negative Pointer Justification Count, STS Path Detected (NPJC-Pdet-P) is a count of the negative pointer justifications detected on a particular path in an incoming SONET signal.
PPJC-Pgen-P	Positive Pointer Justification Count, STS Path Generated (PPJC-Pgen-P) is a count of the positive pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
NPJC-Pgen-P	Negative Pointer Justification Count, STS Path Generated (NPJC-Pgen-P) is a count of the negative pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
PJCDIFF-P	Pointer Justification Count Difference, STS Path (PJCDIFF-P) is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. That is, PJCDiff-P is equal to (PPJC-PGen – NPJC-PGen) – (PPJC-PDet – NPJC-PDet).

Table 15-5 Near-End SONET Path BIP PMs for the EC1-12 Card (continued)

Parameter	Definition
PJCS-PDet-P	Pointer Justification Count Seconds, STS Path Detect (PJCS-PDet-P) is a count of the one-second intervals containing one or more PPJC-PDet or NPJC-PDet.
PJCS-PGen-P	Pointer Justification Count Seconds, STS Path Generate (PJCS-PGen-P) is a count of the one-second intervals containing one or more PPJC-PGen or NPJC-PGen.

Table 15-6 Far-End Line Layer PMs for the EC1-12 Card

Parameter	Definition
CV-L	Far-End Line Code Violation (CV-L) is a count of BIP errors detected by the far-end LTE and reported back to the near-end LTE using the REI-L indication in the line overhead. For SONET signals at rates below OC-48, up to 8 x N BIP errors per STS-N frame can be indicated using the remote error indicator (REI-L). For OC-48 signals, up to 255 BIP errors per STS-N frame can be indicated. The current CV-L second register is incremented for each BIP error indicated by the incoming REI-L.
ES-L	Far-End Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was reported by the far-end LTE or an line remote defect indicator (RDI-L) defect was present.
SES-L	Far-End Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253-CORE for values) or more line-layer BIP errors were reported by the far-end LTE or an RDI-L defect was present.
UAS-L	Far-End Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable at the far end. A line becomes unavailable at the far end when ten consecutive seconds occur that qualify as SES-LFEs and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-LFEs.
FC-L	Far-End Line Failure Count (FC-L) is a count of the number of far-end line failure events. A failure event begins when line remote fault indicator (RFI-L) failure is declared, and it ends when the RFI-L failure clears. A failure event that begins in one period and ends in another period is counted only in the period where it began.

Table 15-7 Far-End SONET Path PMs for the EC1-12 Card

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
STS CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-PFE second register.

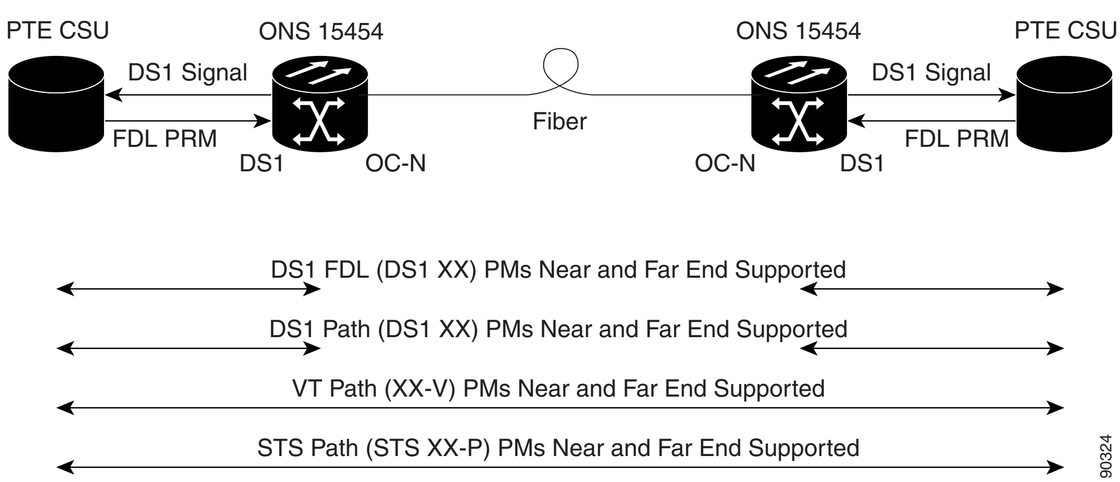
Table 15-7 Far-End SONET Path PMs for the EC1-12 Card (continued)

Parameter	Definition
STS ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when at least one STS path BIP error was detected. STS ES-PFE can also be caused by an AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect.
STS FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of far-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, an unequipped path (UNEQ-P) or a trace identifier mismatch (TIM-P) failure is declared. A failure event also begins if the STS PTE monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
STS SES-PFE	Far-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. STS SES-PFE can also be caused by an AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect.
STS UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

15.5.2 DS1-14 and DS1N-14 Card Performance Monitoring Parameters

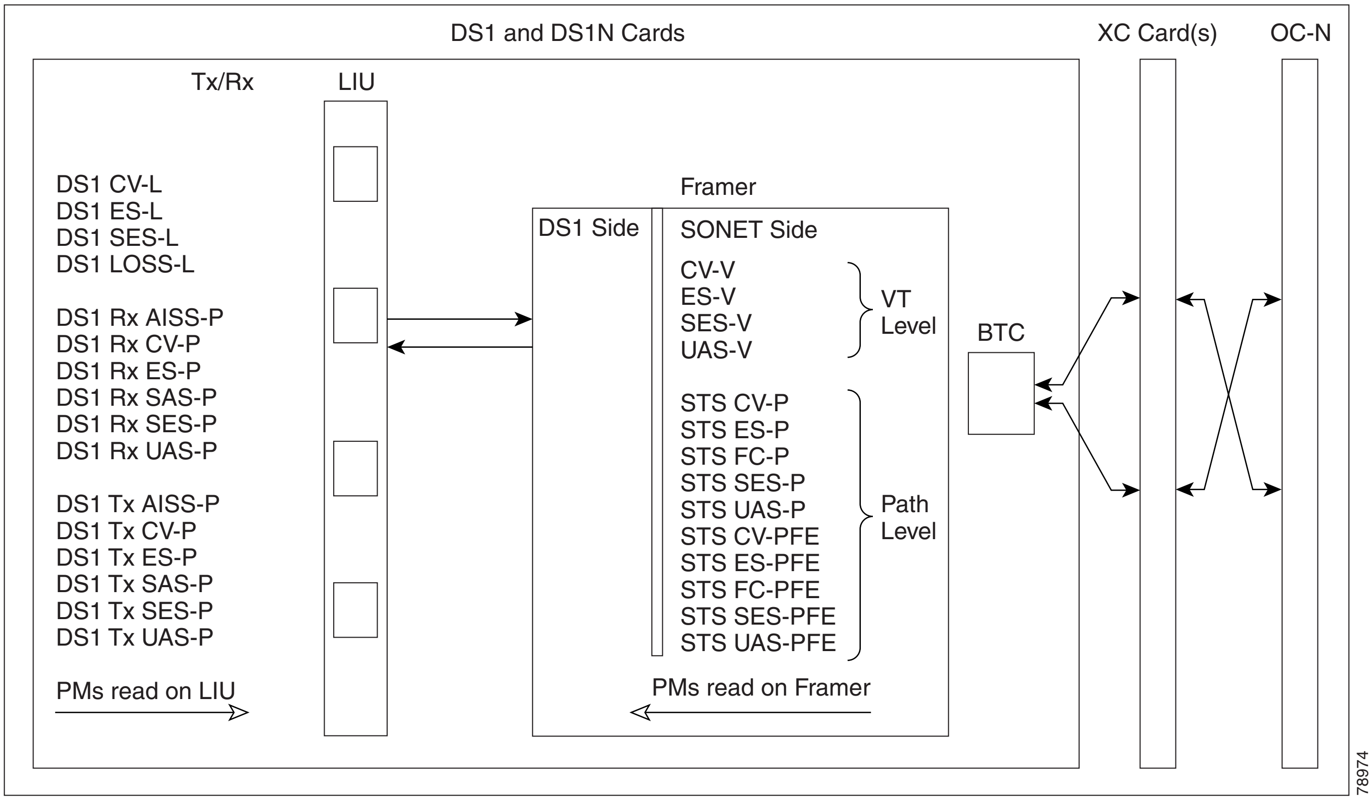
Figure 15-3 shows the signal types that support near-end and far-end PMs. Figure 15-4 on page 15-10 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the DS1-14 and DS1N-14 cards.

Figure 15-3 Monitored Signal Types for the DS1-14 and DS1N-14 Cards



Note The XX in Figure 15-3 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-4 PM Read Points on the DS1-14 and DS1N-14 Cards



The PM parameters for the DS1-14 and DS1N-14 cards are described in Table 15-8 through Table 15-15 on page 15-15.

Table 15-8 DS-1 Line PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
DS1 CV-L	Line Code Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
DS1 ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (loss of signal) on the line.
DS1 SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ $\geq$ 1544) and/or defects on the line.
DS1 LOSS-L	Line Loss of Signal Seconds (LOSS-L) is a count of one-second intervals containing one or more LOS defects.

Table 15-9 DS-1 Receive Path PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
Note Under the Provisioning > Threshold tab, the DS1-14 and DS1N-14 cards have user-defined thresholds for the DS1 receive (Rx) path PMs. In the Threshold tab they are displayed as CV, ES, SES, UAS, AISS, and SAS without the Rx prefix.	
DS1 Rx AISS-P	Receive Path Alarm Indication Signal (Rx AIS-P) means an alarm indication signal occurred on the receive end of the path. This parameter is a count of seconds containing one or more AIS defects.
DS1 Rx CV-P	Receive Path Code Violation (Rx CV-P) means a coding violation occurred on the receive end of the path. For DS1-ESF paths, this parameter is a count of detected CRC-6 errors. For the DS1-SF paths, the Rx CV-P parameter is a count of detected frame bit errors (FE).
DS1 Rx ES-P	Receive Path Errored Seconds (Rx ES-P) is a count of the seconds containing one or more anomalies and/or defects for paths on the receive end of the signal. For DS1-ESF paths, this parameter is a count of one-second intervals containing one or more CRC-6 errors, or one or more convergence sublayer (CS) events, or one or more SEF or AIS defects. For DS1-SF paths, the Rx ES-P parameter is a count of one-second intervals containing one or more FE events, or one or more CS events, or one or more SEF or AIS defects.
DS1 Rx SAS-P	Receive Path Severely Errored Seconds Frame/Alarm Indication Signal (Rx SAS-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the receive end of the signal.
DS1 Rx SES-P	Receive Path Severely Errored Seconds (Rx SES-P) is a count of the seconds containing more than a particular quantity of anomalies and/or defects for paths on the receive end of the signal. For the DS1-ESF paths, this parameter is a count of seconds when 320 or more CRC-6 errors or one or more SEF or AIS defects occurred. For DS1-SF paths, an SES is a second containing either the occurrence of four FEs or one or more SEF or AIS defects.
DS1 Rx UAS-P	Receive Path Unavailable Seconds (Rx UAS-P) is a count of one-second intervals when the DS-1 path is unavailable on the receive end of the signal. The DS-1 path is unavailable when ten consecutive SESs occur. The ten SESs are included in unavailable time. After the DS-1 path becomes unavailable, it becomes available again when ten consecutive seconds occur with no SESs. The ten seconds with no SESs are excluded from unavailable time.
DS1 Rx CSS-P	Receive Path Controlled Slip Seconds (Rx CSS-P) is a count of seconds during which a controlled slip has occurred. Counts of controlled slips can be accurately made only in the path terminating NE of the DS-1 signal where the controlled slip takes place.
DS1 Rx ESA-P	Receive Path Errored Seconds-A (Rx ESA-P) is a count of 1 second intervals with exactly one CRC-6 error and no AIS or SEF.

Table 15-9 DS-1 Receive Path PMs for the DS1-14 and DS1N-14 Cards (continued)

Parameter	Definition
DS1 Rx ESB-P	Receive Path Errored Seconds-B (Rx ESB-P) is a count of 1 second intervals with CRC-6 errors between 2 and 319 and no AIS or SEF.
DS1 Rx SEFS-P	Receive Path Severely Errored Frame-Path (SEFS-P) is a count of 1-second performance report message (PRM) intervals containing an SE=1.

Table 15-10 DS-1 Transmit Path PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
Note Under the Performance tab, the displayed DS-1 Tx path PM values are based on calculations performed by the card and therefore have no user-defined thresholds.	
DS1 Tx AISS-P	Transmit Path Alarm Indication Signal (Tx AIS-P) means an alarm indication signal occurred on the transmit end of the path. This parameter is a count of seconds containing one or more AIS defects.
DS1 Tx CV-P	Transmit Path Code Violation (Tx CV-P) means a coding violation occurred on the transmit end of the path. For DS1-ESF paths, this parameter is a count of detected CRC-6 errors. For the DS1-SF paths, the Tx CV-P parameter is a count of detected FEs.
DS1 Tx ES-P	Transmit Path Errored Seconds (Tx ES-P) is a count of the seconds containing one or more anomalies and/or defects for paths on the transmit end of the signal. For DS1-ESF paths, this parameter is a count of one-second intervals containing one or more CRC-6 errors, or one or more CS events, or one or more SEF or AIS defects. For DS1-SF paths, the Tx ES-P parameter is a count of one-second intervals containing one or more FE events, or one or more CS events, or one or more SEF or AIS defects.
DS1 Tx SAS-P	Transmit Path Severely Errored Seconds Frame/Alarm Indication Signal (Tx SAS-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the receive end of the signal.
DS1 Tx SES-P	Transmit Path Severely Errored Seconds (Tx SES-P) is a count of the seconds containing more than a particular quantity of anomalies and/or defects for paths on the transmit end of the signal. For the DS1-ESF paths, this parameter is a count of seconds when 320 or more CRC-6 errors or one or more SEF or AIS defects occurred. For DS1-SF paths, an SES is a second containing either the occurrence of four FEs or one or more SEF or AIS defects.
DS1 Tx UAS-P	Transmit Path Unavailable Seconds (Tx UAS-P) is a count of one-second intervals when the DS-1 path is unavailable on the transmit end of the signal. The DS-1 path is unavailable when ten consecutive SESs occur. The ten SESs are included in unavailable time. After the DS-1 path becomes unavailable, it becomes available again when ten consecutive seconds occur with no SESs. The ten seconds with no SESs are excluded from unavailable time.

Table 15-11 VT Path PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
CV-V	Code Violation VT Layer (CV-V) is a count of the BIP errors detected at the VT path layer. Up to two BIP errors can be detected per VT superframe, with each error incrementing the current CV-V second register.
ES-V	Errored Seconds VT Layer (ES-V) is a count of the seconds when at least one VT Path BIP error was detected. An AIS-V defect (or a lower-layer, traffic-related, near-end defect) or an LOP-V defect can also cause an ES-V.
SES-V	Severely Errored Seconds VT Layer (SES-V) is a count of seconds when K (600) or more VT Path BIP errors were detected. SES-V can also be caused by an AIS-V defect (or a lower-layer, traffic-related, near-end defect) or an LOP-V defect.
UAS-V	Unavailable Second VT Layer (UAS-V) is a count of the seconds when the VT path was unavailable. A VT path becomes unavailable when ten consecutive seconds occur that qualify as SES-Vs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Vs.

Table 15-12 Near-End SONET Path PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
STS CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame, with each error incrementing the current CV-P second register.
STS ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS ES-P.
STS FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
STS SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS SES-P.
STS UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-13 Far-End SONET Path PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
STS CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame, with each error incrementing the current CV-PFE second register.
STS ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS ES-PFE.
STS FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of far-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
STS SES-PFE	Far-End STS Path Severely Errored Seconds (SES-PFE) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS SES-PFE.
STS UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

Table 15-14 Far-End VT Path PMs for the DS1-14 and DS1N-14 Cards

Parameter	Definition
CV-VFE	Far-End VT Path Coding Violations (CV-VFE) is a count of the number of BIP errors detected by the far-end VT path terminating equipment (PTE) and reported back to the near-end VT PTE using the REI-V indication in the VT path overhead. Only one BIP error can be indicated per VT superframe using the REI-V bit. The current CV-VFE second register is incremented for each BIP error indicated by the incoming REI-V.
ES-VFE	Far-End VT Path Errored Seconds (ES-VFE) is a count of the seconds when at least one VT path BIP error was reported by the far-end VT PTE, or a one-bit RDI-V defect was present.
SES-VFE	Far-End VT Path Severely Errored Seconds (SES-VFE) is a count of the seconds when K (600) or more VT path BIP errors were reported by the far-end VT PTE or a one-bit RDI-V defect was present.
UAS-VFE	Far-End VT Path Unavailable Seconds (UAS-VFE) is a count of the seconds when the VT path is unavailable at the far-end. A VT path is unavailable at the far-end when ten consecutive seconds occur that qualify as SES-VFEs.

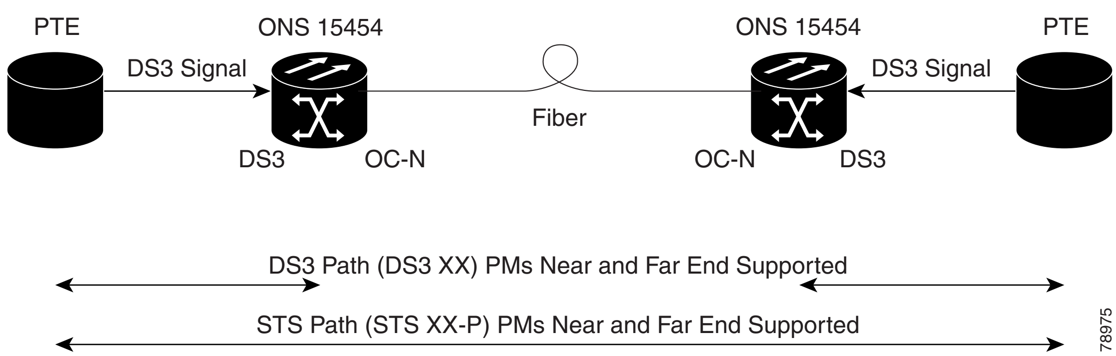
Table 15-15 DS-1 FDL PMs for the Near-End or Far-End DS1N-14 Card

Parameter	Definition
DS1 Rx CSS-P	Received FDL Path Controlled Slip Seconds (Rx CSS-P) is a count of the seconds when at least one FDL path slipped seconds error was reported by the far-end FDL PTE.
DS1 Rx ESA-P	Received FDL Path Errored Seconds type A (RX ESA-P) is a count of the seconds when at least one FDL path BIP error type A was reported by the far-end FDL PTE.
DS1 Rx ESB-P	Received FDL Path Errored Seconds type B (Rx ESB-P) is a count of the seconds when at least one FDL path BIP error type B was reported by the far-end FDL PTE.
DS1 Rx SEFS-P	Received FDL Path Severely Errored Frame Seconds (RX SEFS-P) is a count of the seconds when at least one or more severely errored frames were reported by the far-end FDL PTE.

15.5.3 DS3-12 and DS3N-12 Card Performance Monitoring Parameters

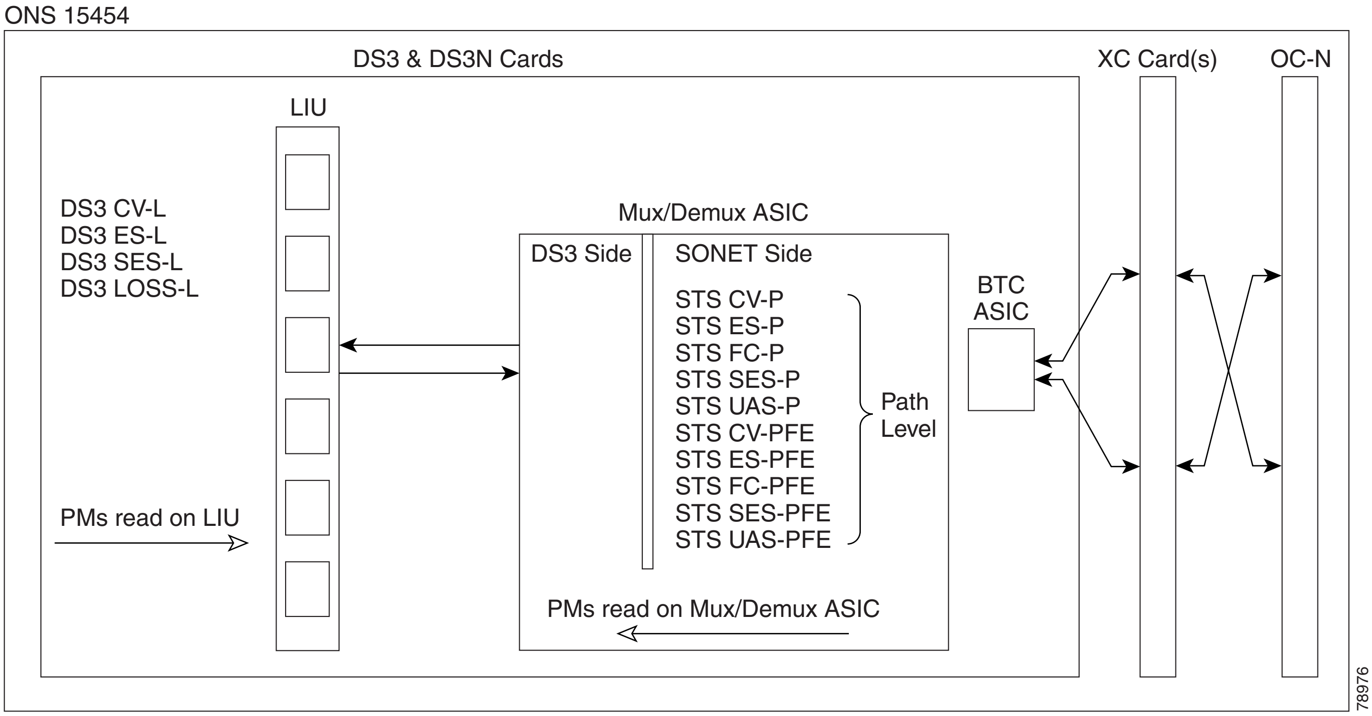
Figure 15-5 shows the signal types that support near-end and far-end PMs. Figure 15-6 on page 15-16 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the DS3-12 and DS3N-12 cards.

Figure 15-5 Monitored Signal Types for the DS3-12 and DS3N-12 Cards



Note The XX in Figure 15-5 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-6 PM Read Points on the DS3-12 and DS3N-12 Cards



The PM parameters for the DS3-12 and DS3N-12 cards are described in Table 15-16 through Table 15-18 on page 15-17.

Table 15-16 Near-End DS-3 Line PMs for the DS3-12 and DS3N-12 Cards

Parameter	Definition
DS3 CV-L	Line Code Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
DS3 ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (loss of signal) on the line.
DS3 SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ $\geq$ 44) and/or defects on the line.
DS3 LOSS-L	Line Loss of Signal (LOSS-L) is a count of one-second intervals containing one or more LOS defects.

Table 15-17 Near-End SONET Path PMs for the DS3-12 and DS3N-12 Cards

Parameter	Definition
STS CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
STS ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS ES-P.
STS FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
STS SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS SES-P.
STS UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-18 Far-End SONET Path PMs for the DS3-12 and DS3N-12 Cards

Parameter	Definition
STS CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-PFE second register.
STS ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS ES-PFE.
STS FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of far-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.

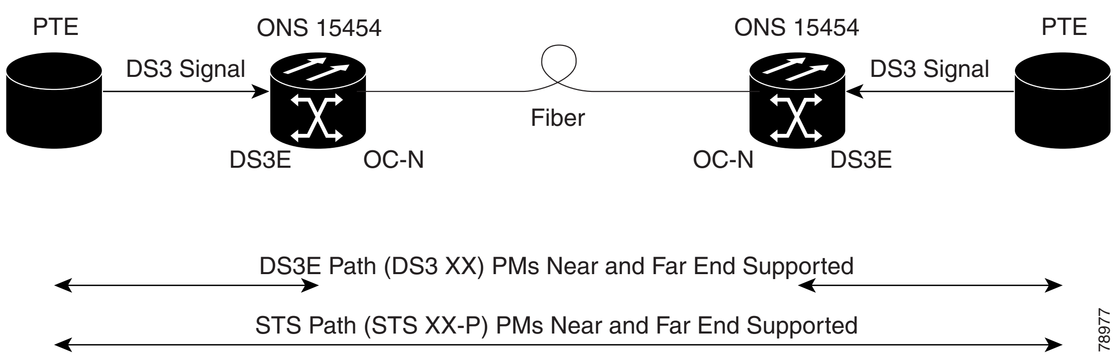
Table 15-18 Far-End SONET Path PMs for the DS3-12 and DS3N-12 Cards (continued)

Parameter	Definition
STS SES-PFE	Far-End STS Path Severely Errored Seconds (SES-PFE) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS SES-PFE.
STS UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

15.5.4 DS3-12E and DS3N-12E Card Performance Monitoring Parameters

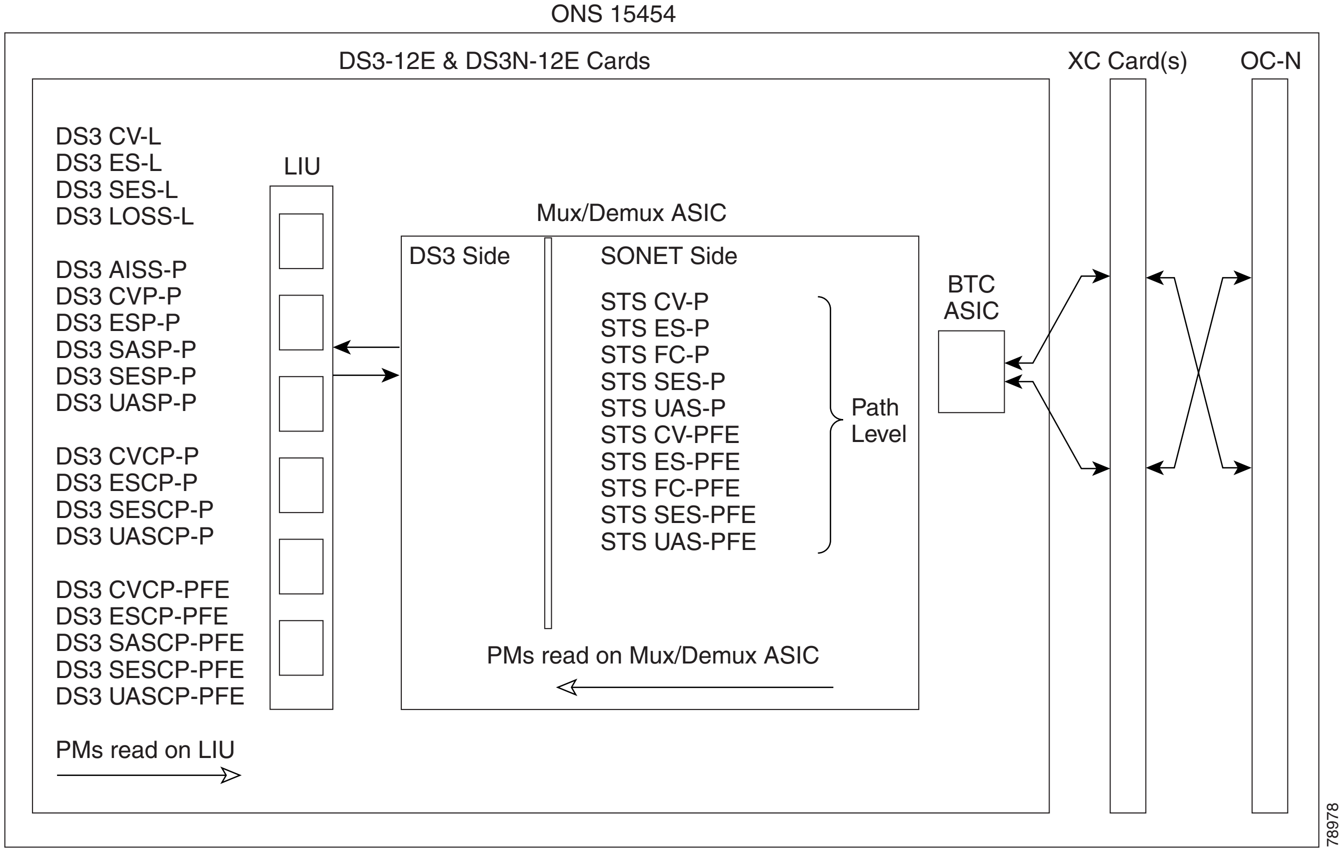
Figure 15-7 shows the signal types that support near-end and far-end PMs. Figure 15-8 on page 15-19 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the DS3-12E and DS3N-12E cards.

Figure 15-7 Monitored Signal Types for the DS3-12E and DS3N-12E Cards



Note The XX in Figure 15-7 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-8 PM Read Points on the DS3-12E and DS3N-12E Cards



The PM parameters for the DS3-12E and DS3N-12E cards are described in Table 15-19 through Table 15-24 on page 15-22.

Table 15-19 Near-End DS-3 Line PMs for the DS3-12E and DS3N-12E Cards

Parameter	Definition
DS3 CV-L	Line Code Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
DS3 ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (that is, loss of signal) on the line.
DS3 LOSS-L	Line Loss of Signal (LOSS-L) is a count of one-second intervals containing one or more LOS defects.
DS3 SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ $\geq$ 44) and/or defects on the line.

Table 15-20 Near-End P-Bit Path PMs for the DS3-12E and DS3N-12E Cards

Parameter	Definition
DS3 AISS-P	AIS Seconds Path (AISS-P) is a count of one-second intervals containing one or more AIS defects.
DS3 CVP-P	Code Violation Path (CVP-P) is a code violation parameter for M23 applications. CVP-P is a count of P-bit parity errors occurring in the accumulation period.
DS3 ESP-P	Errored Second Path (ESP-P) is a count of seconds containing one or more P-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 SASP-P	SEF/AIS Seconds Path (SASP-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the path.
DS3 SESP-P	Severely Errored Seconds Path (SESP-P) is a count of seconds containing more than 44 P-bit parity violations, one or more SEF defects, or one or more AIS defects.
DS3 UASP-P	Unavailable Second Path (UASP-P) is a count of one-second intervals when the DS-3 path is unavailable. A DS-3 path becomes unavailable when ten consecutive SESP-Ps occur. The ten SESP-Ps are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no SESP-Ps occur. The ten seconds with no SESP-Ps are excluded from unavailable time.

Table 15-21 Near-End CP-Bit Path PMs for the DS3-12E and DS3N-12E Cards

Parameter	Definition
DS3 CVCP-P	Code Violation CP-bit Path (CVCP-P) is a count of CP-bit parity errors occurring in the accumulation period.
DS3 ESCP-P	Errored Second CP-bit Path (ESCP-P) is a count of seconds containing one or more CP-bit parity errors, one or more SEF defects, or one or more AIS defects. ESCP-P is defined for the C-bit parity application.
DS3 SASCP-P	SEF/AIS Seconds CP-bit Path (SASCP-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the path.
DS3 SESCP-P	Severely Errored Seconds CP-bit Path (SESCP-P) is a count of seconds containing more than 44 CP-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 UASCP-P	Unavailable Seconds CP-bit Path (UASCP-P) is a count of one-second intervals when the DS-3 path is unavailable. A DS-3 path becomes unavailable when ten consecutive SESCP-Ps occur. The ten SESCP-Ps are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no SESCP-Ps occur. The ten seconds with no SESCP-Ps are excluded from unavailable time.

Table 15-22 Near-End SONET Path PMs for the DS3-12E and DS3N-12E Cards

Parameter	Definition
CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an ES-P.
FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an SES-P.
UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-23 Far-End CP-bit Path PMs for the DS3-12E and DS3N-12E Cards

Parameter	Definition
DS3 CVCP-PFE	Code Violation CP-bit Path (CVCP-PFE) is a parameter that is counted when the three far-end block error (FEBE) bits in a M-frame are not all collectively set to 1.
DS3 ESCP-PFE	Errored Second CP-bit Path (ESCP-PFE) is a count of one-second intervals containing one or more M-frames with the three FEBE bits not all collectively set to 1 or one or more far-end SEF/AIS defects.
DS3 SASCP-PFE	SEF/AIS Second CP-bit Path (SASCP-PFE) is a count of one-second intervals containing one or more far-end SEF/AIS defects.

Table 15-23 Far-End CP-bit Path PMs for the DS3-12E and DS3N-12E Cards (continued)

Parameter	Definition
DS3 SESCP-PFE	Severely Errored Second CP-bit Path (SESCP-PFE) is a count of one-second intervals containing one or more 44 M-frames with the three FEBE bits not all collectively set to 1 or one or more far-end SEF/AIS defects.
DS3 UASCP-PFE	Unavailable Second CP-bit Path (UASCP-PFE) is a count of one-second intervals when the DS-3 path becomes unavailable. A DS-3 path becomes unavailable when ten consecutive far-end CP-bit SESs occur. The ten CP-bit SESs are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds occur with no CP-bit SESs. The ten seconds with no CP-bit SESs are excluded from unavailable time.

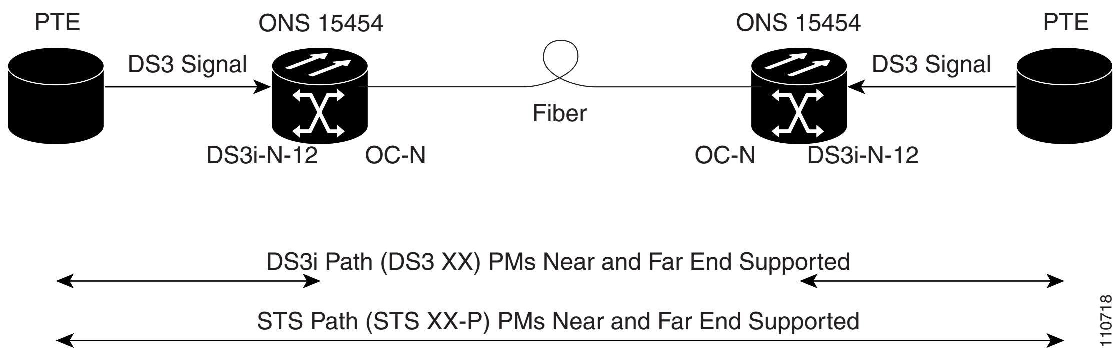
Table 15-24 Far-End SONET Path PMs for the DS3-12E and DS3N-12E Cards

Parameter	Definition
CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-PFE second register.
ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an ES-PFE.
FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-PFE	Far-End STS Path Severely Errored Seconds (SES-PFE) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an SES-PFE.
UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

15.5.5 DS3i-N-12 Card Performance Monitoring Parameters

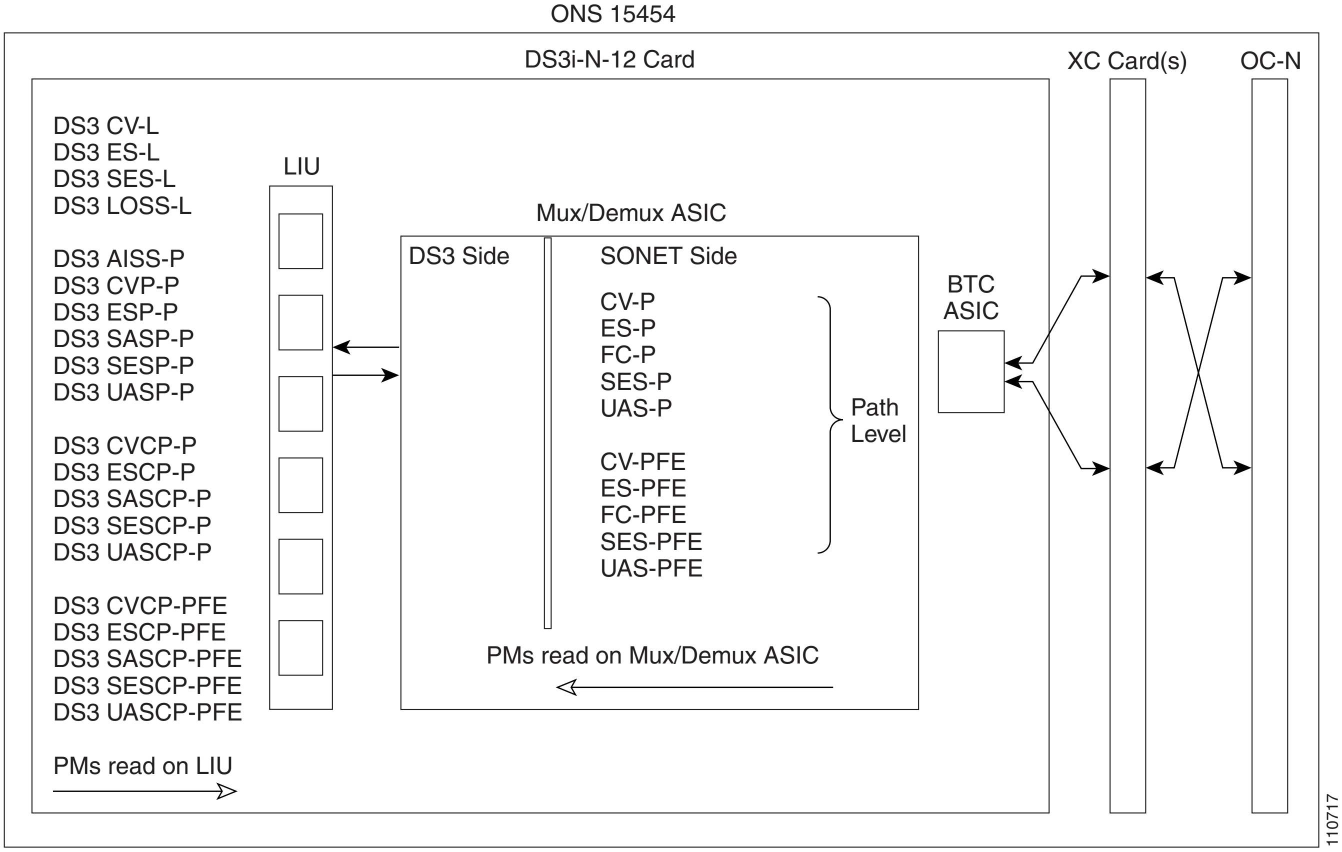
Figure 15-9 shows the signal types that support near-end and far-end PMs. Figure 15-10 on page 15-24 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the DS3i-N-12 cards.

Figure 15-9 Monitored Signal Types for the DS3i-N-12 Cards



Note The XX in Figure 15-9 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-10 PM Read Points on the DS3i-N-12 Cards



The PM parameters for the DS3i-N-12 cards are described in Table 15-25 through Table 15-30 on page 15-27.

Table 15-25 Near-End DS-3 Line PMs for the DS3i-N-12 Card

Parameter	Definition
DS3 CV-L	Line Code Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
DS3 ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (that is, loss of signal) on the line.
DS3 SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ $\geq$ 44) and/or defects on the line.
DS3 LOSS-L	Line Loss of Signal (LOSS-L) is a count of one-second intervals containing one or more LOS defects.

Table 15-26 Near-End P-Bit Path PMs for the DS3i-N-12 Card

Parameter	Definition
DS3 CVP-P	Code Violation Path (CVP-P) is a code violation parameter for M23 applications. CVP-P is a count of P-bit parity errors occurring in the accumulation period.
DS3 ESP-P	Errored Second Path (ESP-P) is a count of seconds containing one or more P-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 SESP-P	Severely Errored Seconds Path (SESP-P) is a count of seconds containing more than 44 P-bit parity violations, one or more SEF defects, or one or more AIS defects.
DS3 SASP-P	SEF/AIS Seconds Path (SASP-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the path.
DS3 UASP-P	Unavailable Second Path (UASP-P) is a count of one-second intervals when the DS-3 path is unavailable. A DS-3 path becomes unavailable when ten consecutive SESP-Ps occur. The ten SESP-Ps are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no SESP-Ps occur. The ten seconds with no SESP-Ps are excluded from unavailable time.
DS3 AISS-P	AIS Seconds Path (AISS-P) is a count of one-second intervals containing one or more AIS defects.

Table 15-27 Near-End CP-Bit Path PMs for the DS3i-N-12 Card

Parameter	Definition
DS3 CVCP-P	Code Violation CP-bit Path (CVCP-P) is a count of CP-bit parity errors occurring in the accumulation period.
DS3 ESCP-P	Errored Second CP-bit Path (ESCP-P) is a count of seconds containing one or more CP-bit parity errors, one or more SEF defects, or one or more AIS defects. ESCP-P is defined for the C-bit parity application.
DS3 SESCP-P	Severely Errored Seconds CP-bit Path (SESCP-P) is a count of seconds containing more than 44 CP-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 SASCP-P	SEF/AIS Seconds CP-bit Path (SASCP-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the path.
DS3 UASCP-P	Unavailable Seconds CP-bit Path (UASCP-P) is a count of one-second intervals when the DS-3 path is unavailable. A DS-3 path becomes unavailable when ten consecutive SESCP-Ps occur. The ten SESCP-Ps are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no SESCP-Ps occur. The ten seconds with no SESCP-Ps are excluded from unavailable time.

Table 15-28 Near-End SONET Path PMs for the DS3i-N-12 Card

Parameter	Definition
CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an ES-P.
FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an SES-P.
UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-29 Far-End CP-bit Path PMs for the DS3i-N-12 Card

Parameter	Definition
DS3 CVCP-PFE	Code Violation CP-bit Path (CVCP-PFE) is a parameter that is counted when the three far-end block error (FEBE) bits in a M-frame are not all collectively set to 1.
DS3 ESCP-PFE	Errored Second CP-bit Path (ESCP-PFE) is a count of one-second intervals containing one or more M-frames with the three FEBE bits not all collectively set to 1 or one or more far-end SEF/AIS defects.
DS3 SASCP-PFE	SEF/AIS Second CP-bit Path (SASCP-PFE) is a count of one-second intervals containing one or more far-end SEF/AIS defects.

Table 15-29 Far-End CP-bit Path PMs for the DS3i-N-12 Card (continued)

Parameter	Definition
DS3 SESCP-PFE	Severely Errored Second CP-bit Path (SESCP-PFE) is a count of one-second intervals containing one or more 44 M-frames with the three FEBE bits not all collectively set to 1 or one or more far-end SEF/AIS defects.
DS3 UASCP-PFE	Unavailable Second CP-bit Path (UASCP-PFE) is a count of one-second intervals when the DS-3 path becomes unavailable. A DS-3 path becomes unavailable when ten consecutive far-end CP-bit SESs occur. The ten CP-bit SESs are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds occur with no CP-bit SESs. The ten seconds with no CP-bit SESs are excluded from unavailable time.

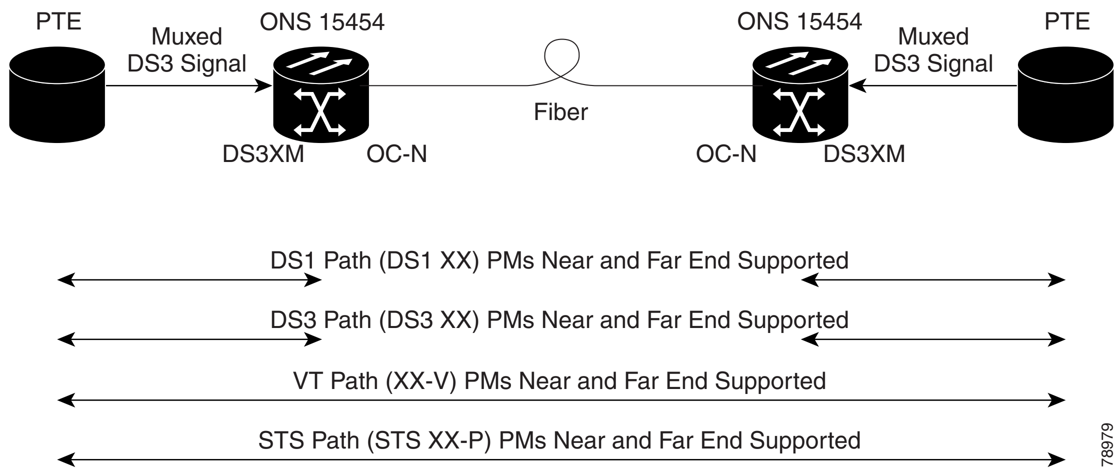
Table 15-30 Far-End SONET Path PMs for the DS3i-N-12 Card

Parameter	Definition
CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-PFE second register.
ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS ES-PFE.
FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-PFE	Far-End STS Path Severely Errored Seconds (SES-PFE) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an SES-PFE.
UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

15.5.6 DS3XM-6 Card Performance Monitoring Parameters

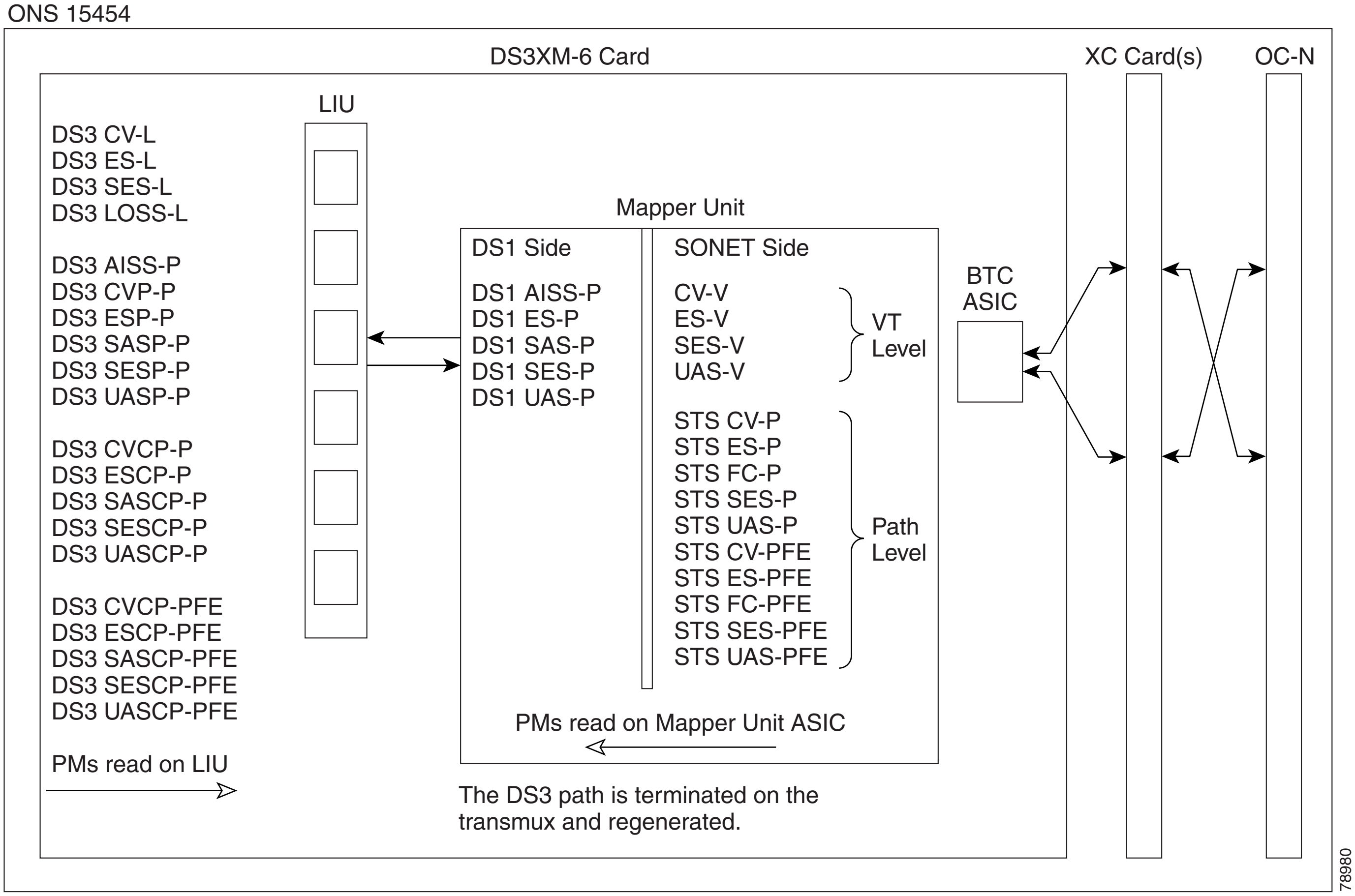
Figure 15-11 shows the signal types that support near-end and far-end PMs. Figure 15-12 on page 15-29 shows where the overhead bytes detected on the ASICs produce performance monitoring parameters for the DS3XM-6 card.

Figure 15-11 Monitored Signal Types for the DS3XM-6 Card



Note The XX in Figure 15-11 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-12 PM Read Points on the DS3XM-6 Card



The PM parameters for the DS3XM-6 cards are described in Table 15-31 through Table 15-39 on page 15-33.

Table 15-31 Near-End DS-3 Line PMs for the DS3XM-6 Card

Parameter	Definition
DS3 CV-L	Line Code Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
DS3 ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (that is, LOS) on the line.
DS3 LOSS-L	Line Loss of Signal (LOSS-L) is a count of one-second intervals containing one or more loss of signal (LOS) defects.
DS3 SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ $\geq$ 44) and/or defects on the line.

Table 15-32 Near-End P-Bit Path PMs for the DS3XM-6 Card

Parameter	Definition
DS3 AISS-P	AIS Seconds Path (AISS-P) is a count of one-second intervals containing one or more AIS defects.
DS3 CVP-P	Code Violation Path (CVP-P) is a code violation parameter for M23 applications. CVP-P is a count of P-bit parity errors occurring in the accumulation period.
DS3 ESP-P	Errored Second Path (ESP-P) is a count of seconds containing one or more P-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 SASP-P	SEF/AIS Seconds Path (SASP-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects on the path.
DS3 SESP-P	Severely Errored Seconds Path (SESP-P) is a count of seconds containing more than 44 P-bit parity violations, one or more SEF defects, or one or more AIS defects.
DS3 UASP-P	Unavailable Second Path (UASP-P) is a count of one-second intervals when the DS-3 path is unavailable. A DS-3 path becomes unavailable when ten consecutive SESP-Ps occur. The ten SESP-Ps are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no SESP-Ps occur. The ten seconds with no SESP-Ps are excluded from unavailable time.

Table 15-33 Near-End CP-Bit Path PMs for the DS3XM-6 Card

Parameter	Definition
DS3 CVCP-P	Code Violation Path (CVCP-P) is a count of CP-bit parity errors occurring in the accumulation period.
DS3 ESCP-P	Errored Second Path (ESCP-P) is a count of seconds containing one or more CP-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 SASCP-P	SEF/AIS Second (SASCP-PFE) is a count of one-second intervals containing one or more near-end SEF/AIS defects.
DS3 SESCP-P	Severely Errored Seconds Path (SESCP-P) is a count of seconds containing more than 44 CP-bit parity errors, one or more SEF defects, or one or more AIS defects.
DS3 UASCP-P	Unavailable Seconds Path (UASCP-P) is a count of one-second intervals when the DS-3 path is unavailable. A DS-3 path becomes unavailable when ten consecutive SESCP-Ps occur. The ten SESCP-Ps are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no SESCP-Ps occur. The ten seconds with no SESCP-Ps are excluded from unavailable time.

Table 15-34 Near-End DS-1 Path PMs for the DS3XM-6 Card

Parameter	Definition
DS1 AISS-P	Alarm Indication Signal Path (AIS-P) means an AIS occurred on the path. This parameter is a count of seconds containing one or more AIS defects.
DS1 ES-P	Errored Seconds Path (ES-P) is a count of the seconds containing one or more anomalies and/or defects for paths. For DS1-ESF paths, this parameter is a count of one-second intervals containing one or more CRC-6 errors, or one or more CS events, or one or more SEF or AIS defects. For DS1-SF paths, the ES-P parameter is a count of one-second intervals containing one or more FE events, or one or more CS events, or one or more SEF or AIS defects.
DS1 SAS-P	Severely Errored Seconds Path Frame/Alarm Indication Signal (SAS-P) is a count of one-second intervals containing one or more SEFs or one or more AIS defects. **Note** The DS3XM-6 card supports SAS-P only on the receive (Rx) path.
DS1 SES-P	Severely Errored Seconds Path (SES-P) is a count of the seconds containing more than a particular quantity of anomalies and/or defects for paths. For the DS1-ESF paths, this parameter is a count of seconds when 320 or more CRC-6 errors or one or more SEF or AIS defects occurs. For DS1-SF paths, an SES is a second containing either the occurrence of eight FEs, four FEs, or one or more SEF or AIS defects.
DS1 UAS-P	Unavailable Seconds Path (UAS-P) is a count of one-second intervals when the DS-1 path is unavailable. The DS-1 path is unavailable when ten consecutive SESs occur. The ten SESs are included in unavailable time. After the DS-1 path becomes unavailable, it becomes available when ten consecutive seconds occur with no SESs. The ten seconds with no SESs are excluded from unavailable time.

Table 15-35 Near-End VT PMs for the DS3XM-6 Card

Parameter	Definition
CV-V	Code Violation VT Layer (CV-V) is a count of the BIP errors detected at the VT path layer. Up to two BIP errors can be detected per VT superframe; each error increments the current CV-V second register.
ES-V	Errored Seconds VT Layer (ES-V) is a count of the seconds when at least one VT Path BIP error was detected. An AIS-V defect (or a lower-layer, traffic-related, near-end defect) or an LOP-V defect can also cause ES-V.
SES-V	Severely Errored Seconds VT Layer (SES-V) is a count of seconds when K (600) or more VT Path BIP errors were detected. An AIS-V defect (or a lower-layer, traffic-related, near-end defect) or an LOP-V defect can also cause SES-V.
UAS-V	Unavailable Seconds VT Layer (UAS-V) is a count of the seconds when the VT path was unavailable. A VT path becomes unavailable when ten consecutive seconds occur that qualify as SES-Vs and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Vs.

Table 15-36 Near-End SONET Path PMs for the DS3XM-6 Card

Parameter	Definition
STS CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
STS ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS ES-P.
STS FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
STS SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS SES-P.
STS UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-37 Far-End CP-bit Path PMs for the DS3XM-6 Card

Parameter	Definition
DS3 CVCP-PFE	Code Violation CP-bit (CVCP-PFE) is a parameter that is counted when the three FEBE bits in a M-frame are not all collectively set to 1.
DS3 ESCP-PFE	Errored Second CP-bit (ESCP-PFE) is a count of one-second intervals containing one or more M-frames with the three FEBE bits not all collectively set to 1 or one or more far-end SEF/AIS defects.
DS3 SASCP-PFE	SEF/AIS Second CP-bit (SASCP-PFE) is a count of one-second intervals containing one or more far-end SEF/AIS defects.
DS3 SESCP-PFE	Severely Errored Second CP-bit (SESCP-PFE) is a count of one-second intervals containing one or more 44 M-frames with the three FEBE bits not all collectively set to 1 or one or more far-end SEF/AIS defects.
DS3 UASCP-PFE	Unavailable Second CP-bit (UASCP-PFE) is a count of one-second intervals when the DS-3 path becomes unavailable. A DS-3 path becomes unavailable when ten consecutive far-end CP-bit SESs occur. The ten CP-bit SESs are included in unavailable time. After the DS-3 path becomes unavailable, it becomes available again when ten consecutive seconds with no CP-bit SESs occur. The ten seconds with no CP-bit SESs are excluded from unavailable time.

Table 15-38 Far-End VT PMs for the DS3XM-6 Card

Parameter	Definition
CV-VFE	Code Violation VT Layer (CV-VFE) is a count of the BIP errors detected at the VT path layer. Up to two BIP errors can be detected per VT superframe; each error increments the current CV-V second register.
ES-VFE	Errored Seconds VT Layer (ES-VFE) is a count of the seconds when at least one VT Path BIP error was detected. An AIS-V defect (or a lower-layer, traffic-related, near-end defect) or an LOP-V defect can also cause an ES-V.
SES-VFE	Severely Errored Seconds VT Layer (SES-VFE) is a count of seconds when K (600) or more VT Path BIP errors were detected. An AIS-V defect (or a lower-layer, traffic-related, near-end defect) or an LOP-V defect can also cause an SES-V.
UAS-VFE	Unavailable Second VT Layer (UAS-VFE) is a count of the seconds when the VT path was unavailable. A VT path becomes unavailable when ten consecutive seconds occur that qualify as SES-Vs and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Vs.

Table 15-39 Far-End SONET Path PMs for the DS3XM-6 Card

Parameter	Definition
STS CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-PFE second register.
STS ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS ES-PFE.
STS FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
STS SES-PFE	Far-End STS Path Severely Errored Seconds (SES-PFE) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS SES-PFE.
STS UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

15.6 Performance Monitoring for Ethernet Cards

The following sections define performance monitoring parameters and definitions for the E-Series, G-Series, and ML-Series Ethernet cards.

15.6.1 E-Series Ethernet Card Performance Monitoring Parameters

CTC provides Ethernet performance information, including line-level parameters, port bandwidth consumption, and historical Ethernet statistics. The E-Series Ethernet performance information is divided into the Statistics, Utilization, and History tabbed windows within the card view Performance tab window.

15.6.1.1 E-Series Ethernet Statistics Window

The Ethernet statistics window lists Ethernet parameters at the line level. The Statistics window provides buttons to change the statistical values shown. The Baseline button resets the displayed statistics values to zero. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs.

Table 15-40 defines the E-Series Ethernet card Statistics parameters.

Table 15-40 E-Series Ethernet Statistics Parameters

Parameter	Meaning
Link Status	Indicates whether link integrity is present; up means present, and down means not present.
Rx Packets	Number of packets received since the last counter reset.
Rx Bytes	Number of bytes received since the last counter reset.
Tx Packets	Number of packets transmitted since the last counter reset.
Tx Bytes	Number of bytes transmitted since the last counter reset.
Rx Total Errors	Total number of receive errors.
Rx FCS	Number of packets with a Frame Check Sequence (FCS) error. FCS errors indicate frame corruption during transmission.
Rx Alignment	Number of packets with alignment errors; alignment errors are received incomplete frames.
Rx Runts	Measures undersized packets with bad cyclic redundancy check (CRC) errors.
Rx Shorts	Measures undersized packets with good CRC errors.
Rx Oversized + Jabbers	Measures oversized packets and jabbers. Size is greater than 1522 errors regardless of CRC errors.
Tx Collisions	Number of transmit packets that are collisions; the port and the attached device transmitting at the same time caused collisions.

Table 15-40 E-Series Ethernet Statistics Parameters (continued)

Parameter	Meaning
Tx Late Collisions	Number of frames that were not transmitted since they encountered a collision outside of the normal collision window (late collision events should occur only rarely).
Tx Excessive Collisions	Number of consecutive collisions.
Tx Deferred	Number of packets deferred.

15.6.1.2 E-Series Ethernet Utilization Window

The Utilization window shows the percentage of transmit (Tx) and receive (Rx) line bandwidth used by the Ethernet ports during consecutive time segments. The Mode field displays the real-time mode status, such as 100 Full, which is the mode setting configured on the E-Series port. However, if the E-Series port is set to autonegotiate the mode (Auto), this field shows the result of the link negotiation between the E-Series and the peer Ethernet device attached directly to the E-Series port.

The Utilization window provides an Interval menu that enables you to set time intervals of 1 minute, 15 minutes, 1 hour, and 1 day. Line utilization is calculated with the following formulas:

Rx = (inOctets + inPkts * 20) * 8 / 100% interval * maxBaseRate

Tx = (outOctets + outPkts * 20) * 8 / 100% interval * maxBaseRate

The interval is defined in seconds. The maxBaseRate is defined by raw bits per second in one direction for the Ethernet port (that is, 1 Gbps). The maxBaseRate for E-Series Ethernet cards is shown in Table 15-41.

Table 15-41 maxBaseRate for STS Circuits

STS	maxBaseRate
STS-1	51840000
STS-3c	155000000
STS-6c	311000000
STS-12c	622000000

Note Line utilization numbers express the average of ingress and egress traffic as a percentage of capacity.

Note The E-Series Ethernet card is a Layer 2 device or switch and supports Trunk Utilization statistics. The Trunk Utilization statistics are similar to the Line Utilization statistics, but shows the percentage of circuit bandwidth used rather than the percentage of line bandwidth used. The Trunk Utilization statistics are accessed via the card view Maintenance tab.

15.6.1.3 E-Series Ethernet History Window

The Ethernet History window lists past Ethernet statistics for the previous time intervals. Depending on the selected time interval, the History window displays the statistics for each port for the number of previous time intervals as shown in Table 15-42. The listed parameters are defined in Table 15-40 on page 15-34.

Table 15-42 Ethernet History Statistics per Time Interval

Time Interval	Number of Intervals Displayed
1 minute	60 previous time intervals
15 minutes	32 previous time intervals
1 hour	24 previous time intervals
1 day (24 hours)	7 previous time intervals

15.6.2 G-Series Ethernet Card Performance Monitoring Parameters

CTC provides Ethernet performance information, including line-level parameters, port bandwidth consumption, and historical Ethernet statistics. The G-Series Ethernet performance information is divided into the Statistics, Utilization, and History tabbed windows within the card view Performance tab window.

15.6.2.1 G-Series Ethernet Statistics Window

The Ethernet statistics window lists Ethernet parameters at the line level. The Statistics window provides buttons to change the statistical values shown. The Baseline button resets the displayed statistics values to zero. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs. The G-Series Statistics window also has a Clear button. The Clear button sets the values on the card to zero, but does not reset the G-Series card.

Table 15-43 defines the G-Series Ethernet card Statistics parameters.

Table 15-43 G-Series Ethernet Statistics Parameters

Parameter	Meaning
Time Last Cleared	A time stamp indicating the last time statistics were reset.
Link Status	Indicates whether the Ethernet link is receiving a valid Ethernet signal (carrier) from the attached Ethernet device; up means present, and down means not present.
Rx Packets	Number of packets received since the last counter reset.
Rx Bytes	Number of bytes received since the last counter reset.
Tx Packets	Number of packets transmitted since the last counter reset.
Tx Bytes	Number of bytes transmitted since the last counter reset.
Rx Total Errors	Total number of receive errors.
Rx FCS	Number of packets with a FCS error. FCS errors indicate frame corruption during transmission.
Rx Alignment	Number of packets with received incomplete frames.

Table 15-43 G-Series Ethernet Statistics Parameters (continued)

Parameter	Meaning
Rx Runts	Measures undersized packets with bad CRC errors.
Rx Shorts	Measures undersized packets with good CRC errors.
Rx Jabbers	The total number of frames received that exceed the1548-byte maximum and contain CRC errors.
Rx Giants	Number of packets received that are greater than 1530 bytes in length.
Rx Pause Frames	Number of received Ethernet IEEE 802.3z pause frames.
Tx Pause Frames	Number of transmitted IEEE 802.3z pause frames.
Rx Pkts Dropped Internal Congestion	Number of received packets dropped due to overflow in G-Series frame buffer.
Tx Pkts Dropped Internal Congestion	Number of transmit queue drops due to drops in the G-Series frame buffer.
HDLC Errors	High-level data link control (HDLC) errors received from SONET/SDH (see Note).
Rx Unicast Packets	Number of unicast packets received since the last counter reset.
Tx Unicast Packets	Number of unicast packets transmitted.
Rx Multicast Packets	Number of multicast packets received since the last counter reset.
Tx Multicast Packets	Number of multicast packets transmitted.
Rx Broadcast Packets	Number of broadcast packets received since the last counter reset.
Tx Broadcast Packets	Number or broadcast packets transmitted.

Note Do not use the high level data link control (HDLC) errors counter to count the number of frames dropped because of HDLC errors, because each frame can fragment into several smaller frames during HDLC error conditions and spurious HDLC frames can also be generated. If HDLC error counters are incrementing when no SONET path problems should be present, it might indicate a problem with the quality of the SONET path. For example, a SONET protection switch generates a set of HLDC errors. But the actual values of these counters are less significant than the fact that they are changing.

15.6.2.2 G-Series Ethernet Utilization Window

The Utilization window shows the percentage of Tx and Rx line bandwidth used by the Ethernet ports during consecutive time segments. The Mode field displays the real-time mode status, such as 100 Full, which is the mode setting configured on the G-Series port. However, if the G-Series port is set to autonegotiate the mode (Auto), this field shows the result of the link negotiation between the G-Series and the peer Ethernet device attached directly to the G-Series port.

The Utilization window provides an Interval menu that enables you to set time intervals of 1 minute, 15 minutes, 1 hour, and 1 day. Line utilization is calculated with the following formulas:

Rx = (inOctets + inPkts * 20) * 8 / 100% interval * maxBaseRate

Tx = (outOctets + outPkts * 20) * 8 / 100% interval * maxBaseRate

The interval is defined in seconds. The maxBaseRate is defined by raw bits per second in one direction for the Ethernet port (that is, 1 Gbps). The maxBaseRate for G-Series Ethernet cards is shown in Table 15-44.

Table 15-44 maxBaseRate for STS Circuits

STS	maxBaseRate
STS-1	51840000
STS-3c	155000000
STS-6c	311000000
STS-12c	622000000

Note Line utilization numbers express the average of ingress and egress traffic as a percentage of capacity.

Note Unlike the E-Series, the G-Series card does not have a display of Trunk Utilization statistics, because the G-Series card is not a Layer 2 device or switch.

15.6.2.3 G-Series Ethernet History Window

The Ethernet History window lists past Ethernet statistics for the previous time intervals. Depending on the selected time interval, the History window displays the statistics for each port for the number of previous time intervals as shown in Table 15-45. The listed parameters are defined in Table 15-43 on page 15-36.

Table 15-45 Ethernet History Statistics per Time Interval

Time Interval	Number of Intervals Displayed
1 minute	60 previous time intervals
15 minutes	32 previous time intervals
1 hour	24 previous time intervals
1 day (24 hours)	7 previous time intervals

15.6.3 ML-Series Ethernet Card Performance Monitoring Parameters

CTC provides Ethernet performance information for line-level parameters and historical Ethernet statistics. The ML-Series Ethernet performance information is divided into the Ether Ports and Packet over SONET/SDH (POS) Ports tabbed windows within the card view Performance tab window.

Table 15-46 defines the ML-Series Ethernet card Ether Ports PM parameters.

Table 15-46 ML-Series Ether Ports PM Parameters

Parameter	Meaning
Rx Bytes	Number of bytes received since the last counter reset.
Rx Packets	Number of packets received since the last counter reset.
Rx Unicast Packets	Number of unicast packets received since the last counter reset.
Rx Multicast Packets	Number of multicast packets received since the last counter reset.
Rx Broadcast Packets	Number of broadcast packets received since the last counter reset.
Rx Giants	Number of packets received that are greater than 1530 bytes in length.
Rx Total Errors	Total number of receive errors.
Rx FCS Errors	Number of packets with a FCS error.
Rx Runts	Total number of frames received that are less than 64 bytes in length and have a CRC error.
Rx Jabbers	Total number of frames received that exceed the maximum 1548 bytes and contain CRC errors.
Rx Align Errors	Number of received packets with alignment errors.
Tx Bytes	Number of bytes transmitted since the last counter reset.
Tx Packets	Number of packets transmitted since the last counter reset.
Tx Unicast Packets	Number of unicast packets transmitted.
Tx Multicast Packets	Number of multicast packets transmitted.
Tx Broadcast Packets	Number or broadcast packets transmitted.
Tx Giants	Number of packets transmitted that are greater than 1548 bytes in length.
Tx Collisions	Number of transmitted packets that collided.
Port Drop Counts	Number of received frames dropped at the port level.
Rx Pause Frames	Number of received pause frames.
Rx Threshold Oversizes	Number of received packets larger than the ML-Series remote monitoring (RMON) threshold.
Rx GMAC Drop Counts	Number of received frames dropped by MAC module.
Tx Pause Frames	Number of transmitted pause frames.

Table 15-47 defines the ML-Series Ethernet card packet over SONET (POS) Ports parameters.

Table 15-47 ML-Series POS Ports Parameters

Parameter	Meaning
Rx Pre Hdlc Bytes	Number of bytes received prior to the bytes HLDC encapsulation by the policy engine.
Rx Post Hdlc Bytes	Number of bytes received after the bytes HLDC encapsulation by the policy engine.
Rx Packets	Number of packets received since the last counter reset.

Table 15-47 ML-Series POS Ports Parameters (continued)

Parameter	Meaning
Rx Normal Packets	Number of packets between the minimum and maximum packet size received.
Rx Shorts	Number of packets below the minimum packet size received.
Rx Runts	Total number of frames received that are less than 64 bytes in length and have a CRC error.
Rx Longs	Counter for the number of received frames that exceed the maximum valid packet length of 1518 bytes.
Rx Total Errors	Total number of receive errors.
Rx CRC Errors	Number of packets with a CRC error.
Rx Input Drop Packets	Number of received packets dropped before input.
Rx Input Abort Packets	Number of received packets aborted before input.
Tx Pre Hdlc Bytes	Number of bytes transmitted prior to the bytes HLDC encapsulation by the policy engine.
Tx Post Hdlc Bytes	Number of bytes transmitted after the bytes HLDC encapsulation by the policy engine.
Tx Packets	Number of packets transmitted since the last counter reset.
Port Drop Counts	Number of received frames dropped at the port level.

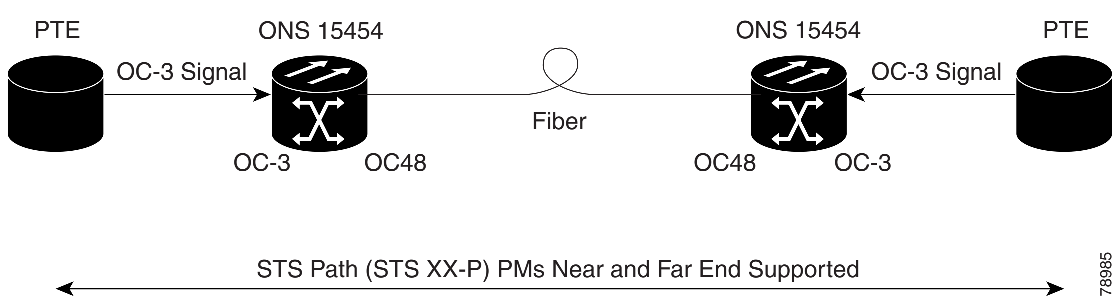
15.7 Performance Monitoring for Optical Cards

The following sections define performance monitoring parameters and definitions for the OC-3s, OC-12s, OC-48s, OC-192s, TXP_MR-10G, TXP_MR_2.5G, TXPP_MR_2.5G, and MXP_2.5G_10G, optical cards.

15.7.1 OC-3 Cards Performance Monitoring Parameters

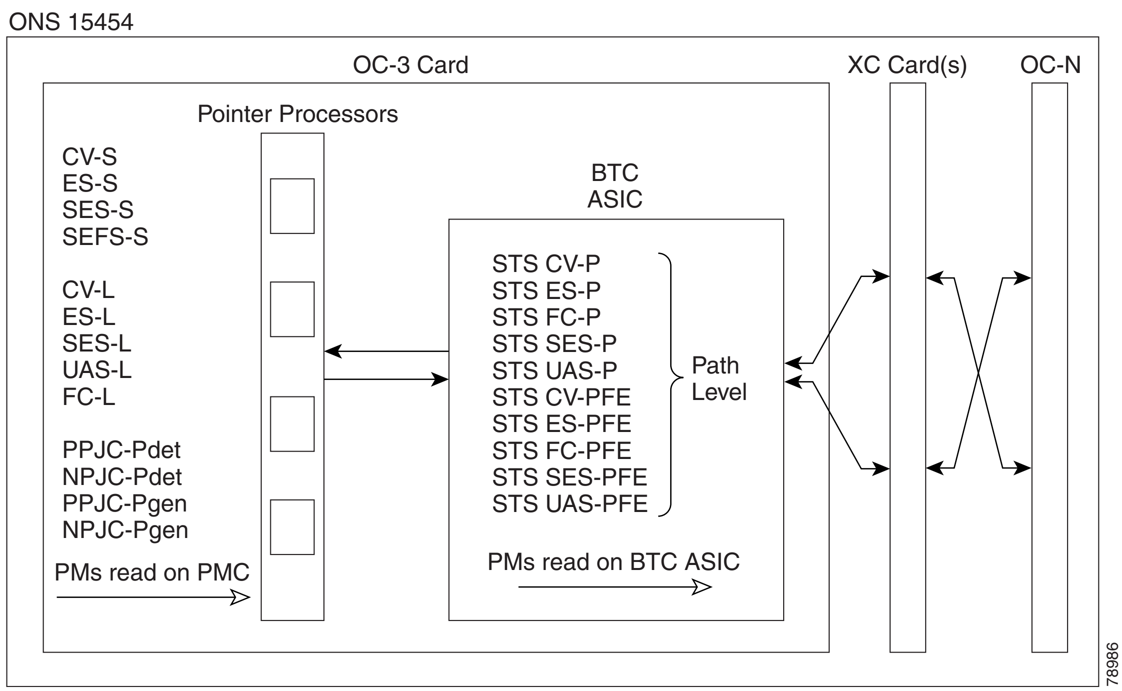
Figure 15-13 shows the signal types that support near-end and far-end PMs. Figure 15-14 on page 15-41 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the OC3 IR 4 SH 1310 and OC3 IR SH 1310-8 cards.

Figure 15-13 Monitored Signal Types for the OC-3 Cards



Note The XX in Figure 15-13 represents all PMs listed inthe tables in this section with the given prefix and/or suffix.

Figure 15-14 PM Read Points on the OC-3 Cards



Note For PM locations relating to protection switch counts, see the Telcordia GR-253-CORE document.

The PM parameters for the OC-3 cards are described in Table 15-48 through Table 15-54 on page 15-45.

Table 15-48 Near-End Section PMs for the OC-3 Cards

Parameter	**Definition**
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame, with each error incrementing the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.

Table 15-48 Near-End Section PMs for the OC-3 Cards (continued)

Parameter	Definition
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or loss of frame (LOF) defect is present. However, there can be situations when the SEFS-S parameter is only incremented based on the presence of the SEF defect.

Table 15-49 Near-End Line Layer PMs for the OC-3 Cards

Parameter	Definition
CV-L	Near-End Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Near-End Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Near-End Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253-CORE for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Near-End Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Near-End Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure is declared or when a lower-layer, traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Note For information about troubleshooting path protection switch counts, refer to the alarm troubleshooting information in the *Cisco ONS 15454 Troubleshooting Guide*. For information about creating circuits that perform a switch, see Chapter 10, "Circuits and Tunnels."

Table 15-50 Near-End Line Layer PMs for the OC-3 Cards

Parameter	Definition
PSC (1+1 protection)	In a 1 + 1 protection scheme for a working card, Protection Switching Count (PSC) is a count of the number of times service switches from a working card to a protection card plus the number of times service switches back to the working card. For a protection card, PSC is a count of the number of times service switches to a working card from a protection card plus the number of times service switches back to the protection card. The PSC PM is only applicable if revertive line-level protection switching is used. **Note** Bidirectional line switch ring (BLSR) is not supported on the OC-3 cards; therefore, the PSC-W, PSC-S, and PSC-R PMs do not increment.
PSD	Protection Switching Duration (PSD) applies to the length of time, in seconds, that service is carried on another line. For a working line, PSD is a count of the number of seconds that service was carried on the protection line. For the protection line, PSD is a count of the seconds that the line was used to carry service. The PSD PM is only applicable if revertive line-level protection switching is used. **Note** BLSR is not supported on the OC-3 cards; therefore, the PSD-W, PSD-S, and PSD-R PMs do not increment.

Table 15-51 Near-End SONET Path H-Byte PMs for the OC-3 Cards

Parameter	Definition
Note In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the Provisioning > Line tabs. See the "15.3 Pointer Justification Count Performance Monitoring" section on page 15-3.	
PPJC-Pdet-P	Positive Pointer Justification Count, STS Path Detected (PPJC-Pdet-P) is a count of the positive pointer justifications detected on a particular path in an incoming SONET signal.
NPJC-Pdet-P	Negative Pointer Justification Count, STS Path Detected (NPJC-Pdet) is a count of the negative pointer justifications detected on a particular path in an incoming SONET signal.
PPJC-Pgen-P	Positive Pointer Justification Count, STS Path Generated (PPJC-Pgen-P) is a count of the positive pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
NPJC-Pgen-P	Negative Pointer Justification Count, STS Path Generated (NPJC-Pgen-P) is a count of the negative pointer justifications generated for a particular path to reconcile the frequency of the synchronous payload envelope (SPE) with the local clock.

Table 15-51 Near-End SONET Path H-Byte PMs for the OC-3 Cards (continued)

Parameter	Definition
PJCDiff-P	Pointer Justification Count Difference, STS Path (PJCDiff-P) is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. That is, PJCDiff-P is equal to (PPJC-PGen-NPJC-PGen) – (PPJC-PDet – NPJC-PDet).
PJCS-PDet-P	Pointer Justification Count Seconds, STS Path Detect (PJCS-PDet-P) is a count of the one-second intervals containing one or more PPJC-PDet or NPJC-PDet.
PJCS-PGen-P	Pointer Justification Count Seconds, STS Path Generate (PJCS-PGen-P) is a count of the one-second intervals containing one or more PPJC-PGen or NPJC-PGen.

Table 15-52 Near-End SONET Path PMs for the OC-3 Cards

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when one or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS ES-P.
FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins with an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared, or if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an STS SES-P.
UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-53 Far-End Line Layer PMs for the OC-3 Cards

Parameter	Definition
CV-LFE	Far-End Line Code Violation (CV-LFE) is a count of BIP errors detected by the far-end line terminating equipment (LTE) and reported back to the near-end LTE using the REI-L indication in the line overhead. For SONET signals at rates below OC-48, up to 8 x N BIP errors per STS-N frame can be indicated using the REI-L. For OC-48 signals, up to 255 BIP errors per STS-N frame can be indicated. The current CV-L second register is incremented for each BIP error indicated by the incoming REI-L.
ES-LFE	Far-End Line Errored Seconds (ES-LFE) is a count of the seconds when at least one line-layer BIP error was reported by the far-end LTE or an RDI-L defect was present.
SES-LFE	Far-End Line Severely Errored Seconds (SES-LFE) is a count of the seconds when K (see Telcordia GR-253-CORE for values) or more line-layer BIP errors were reported by the far-end LTE or an RDI-L defect was present.
UAS-LFE	Far-End Line Unavailable Seconds (UAS-LFE) is a count of the seconds when the line is unavailable at the far end. A line becomes unavailable at the far end when ten consecutive seconds occur that qualify as SES-LFEs and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-LFEs.
FC-LFE	Far-End Line Failure Count (FC-LFE) is a count of the number of far-end line failure events. A failure event begins when RFI-L failure is declared, and it ends when the RFI-L failure clears. A failure event that begins in one period and ends in another period is counted only in the period where it began.

Table 15-54 Far-End SONET Path PMs for the OC-3 Cards

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
CV-PFE	Far-End STS Path Coding Violations (CV-PFE) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-PFE second register.
ES-PFE	Far-End STS Path Errored Seconds (ES-PFE) is a count of the seconds when one or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS ES-PFE.
FC-PFE	Far-End STS Path Failure Counts (FC-PFE) is a count of the number of far-end STS path failure events. A failure event begins with an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a TIM-P failure is declared, or if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.

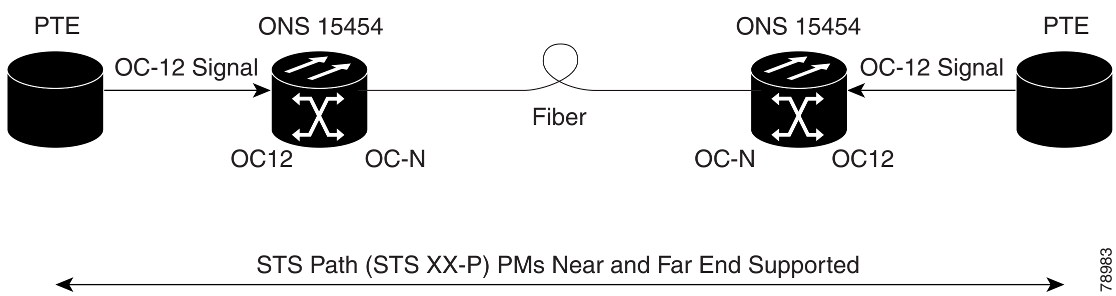
Table 15-54 Far-End SONET Path PMs for the OC-3 Cards (continued)

Parameter	Definition
SES-PFE	Far-End STS Path Severely Errored Seconds (SES-PFE) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, far-end defect) or an LOP-P defect can also cause an STS SES-PFE.
UAS-PFE	Far-End STS Path Unavailable Seconds (UAS-PFE) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-PFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-PFEs.

15.7.2 OC-12 Card Performance Monitoring Parameters

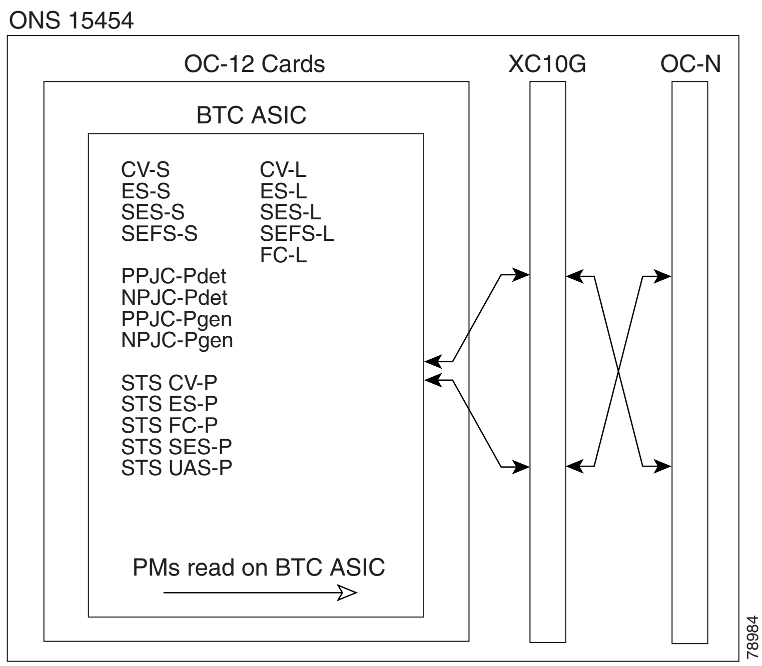
Figure 15-15 shows the signal types that support near-end and far-end PMs. Figure 15-16 on page 15-47 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the OC12 LR/STM4 LH 1310, OC12 IR/STM4 SH 1310, OC12 IR/STM4 SH 1310-4, and OC12 LR/STM4 LH 1550 cards.

Figure 15-15 Monitored Signal Types for the OC-12 Cards



Note PMs on the protect STS are not supported for bidirectional line switch ring (BLSR). The XX in Figure 15-15 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-16 PM Read Points on the OC-12 Cards



Note For PM locations relating to protection switch counts, see the Telcordia GR-1230-CORE document.

The PM parameters for the OC-12 cards are described in Table 15-55 through Table 15-60 on page 15-51.

Table 15-55 Near-End Section PMs for the OC-12 Cards

Parameter	Definition
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or LOF defect is present. However, there might be situations when the SEFS-S parameter is only incremented based on the presence of an SEF defect.

Table 15-56 Near-End Line Layer PMs for the OC-12 Cards

Parameter	Definition
CV-L	Near-End Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Near-End Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Near-End Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Near-End Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Near-End Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Table 15-57 Near-End SONET Path H-Byte PMs for the OC-12 Cards

Parameter	Definition
Note In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the Provisioning > Line tabs.	
PPJC-Pdet-P	Positive Pointer Justification Count, STS Path Detected (PPJC-Pdet-P) is a count of the positive pointer justifications detected on a particular path on an incoming SONET signal.
NPJC-Pdet-P	Negative Pointer Justification Count, STS Path Detected (NPJC-Pdet) is a count of the negative pointer justifications detected on a particular path on an incoming SONET signal.
PPJC-Pgen-P	Positive Pointer Justification Count, STS Path Generated (PPJC-Pgen-P) is a count of the positive pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
NPJC-Pgen-P	Negative Pointer Justification Count, STS Path Generated (NPJC-Pgen-P) is a count of the negative pointer justifications generated for a particular path to reconcile the frequency of the synchronous payload envelope (SPE) with the local clock.
PJCDiff-P	Pointer Justification Count Difference, STS Path (PJCDiff-P) is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. That is, PJCDiff-P is equal to (PPJC-PGen-NPJC-PGen) – (PPJC-PDet-NPJC-PDet).

Table 15-57 Near-End SONET Path H-Byte PMs for the OC-12 Cards (continued)

Parameter	Definition
PJCS-PDet-P	Pointer Justification Count Seconds, STS Path Detect (PJCS-PDet-P) is a count of the one-second intervals containing one or more PPJC-PDet or NPJC-PDet.
PJCS-PGen-P	Pointer Justification Count Seconds, STS Path Generate (PJCS-PGen-P) is a count of the one-second intervals containing one or more PPJC-PGen or NPJC-PGen.

Table 15-58 Near-End Line Layer PMs for the OC-12 Cards

Parameter	Definition
Note For information about troubleshooting path protection switch counts, refer to the alarm troubleshooting information in the *Cisco ONS 15454 Troubleshooting Guide*. For information about creating circuits that perform a switch, see Chapter 10, "Circuits and Tunnels."	
PSC (BLSR)	For a protect line in a two-fiber ring, Protection Switching Count (PSC) refers to the number of times a protection switch has occurred either to a particular span's line protection or away from a particular span's line protection. Therefore, if a protection switch occurs on a two-fiber BLSR, the PSC of the protection span to which the traffic is switched will increment, and when the switched traffic returns to its original working span from the protect span, the PSC of the protect span increments again. **Note** Four-fiber BLSR is not supported on the OC-12 card; therefore, the PSC-S and PSC-R PMs do not increment.
PSC (1+1 protection)	In a 1 + 1 protection scheme for a working card, Protection Switching Count (PSC) is a count of the number of times service switches from a working card to a protection card plus the number of times service switches back to the working card. For a protection card, PSC is a count of the number of times service switches to a working card from a protection card plus the number of times service switches back to the protection card. The PSC PM is only applicable if revertive line-level protection switching is used.
PSD	Protection Switching Duration (PSD) applies to the length of time, in seconds, that service is carried on another line. For a working line, PSD is a count of the number of seconds that service was carried on the protection line. For the protection line, PSD is a count of the seconds that the line was used to carry service. The PSD PM is only applicable if revertive line-level protection switching is used. **Note** Four-fiber BLSR is not supported on the OC-12 card; therefore, the PSD-S and PSD-R PMs do not increment.

Table 15-58 Near-End Line Layer PMs for the OC-12 Cards (continued)

Parameter	Definition
PSC-W	For a working line in a two-fiber BLSR, Protection Switching Count-Working (PSC-W) is a count of the number of times traffic switches away from the working capacity in the failed line and back to the working capacity after the failure is cleared. PSC-W increments on the failed working line and PSC increments on the active protect line.
PSD-W	For a working line in a two-fiber BLSR, Protection Switching Duration-Working (PSD-W) is a count of the number of seconds that service was carried on the protection line. PSD-W increments on the failed working line and PSD increments on the active protect line.

Table 15-59 Near-End SONET Path PMs for the OC-12 Cards

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an ES-P.
FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins with an AIS-P failure, an LOP-P failure, a UNEQ-P failure or a TIM-P failure is declared, or if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an SES-P.
UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-60 Far-End Line Layer PMs for the OC-12 Cards

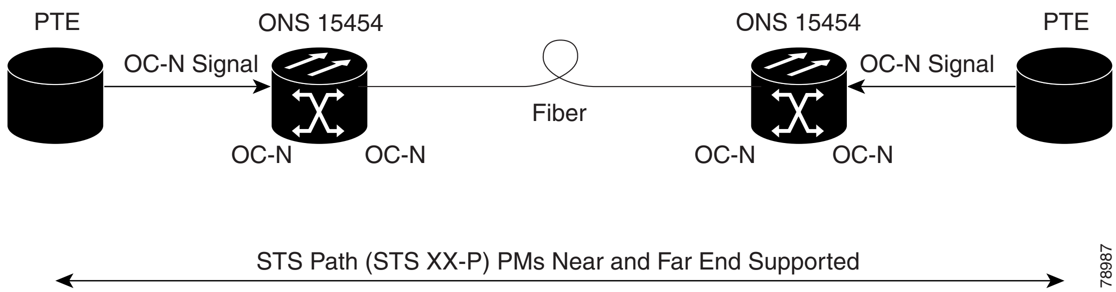
Parameter	Definition
CV-LFE	Far-End Line Code Violation (CV-LFE) is a count of BIP errors detected by the far-end line terminating equipment (LTE) and reported back to the near-end LTE using the REI-L indication in the line overhead. For SONET signals at rates below OC-48, up to 8 x N BIP errors per STS-N frame can be indicated using the REI-L. For OC-48 signals, up to 255 BIP errors per STS-N frame can be indicated. The current CV-L second register is incremented for each BIP error indicated by the incoming REI-L.
ES-LFE	Far-End Line Errored Seconds (ES-LFE) is a count of the seconds when at least one line-layer BIP error was reported by the far-end LTE or an RDI-L defect was present.
SES-LFE	Far-End Line Severely Errored Seconds (SES-LFE) is a count of the seconds when K (see Telcordia GR-253-CORE for values) or more line-layer BIP errors were reported by the far-end LTE or an RDI-L defect was present.
UAS-LFE	Far-End Line Unavailable Seconds (UAS-LFE) is a count of the seconds when the line is unavailable at the far end. A line becomes unavailable at the far end when ten consecutive seconds occur that qualify as SES-LFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-LFEs.
FC-LFE	Far-End Line Failure Count (FC-LFE) is a count of the number of far-end line failure events. A failure event begins when RFI-L failure is declared and ends when the RFI-L failure clears. A failure event that begins in one period and ends in another period is counted only in the period where it began.

Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.

15.7.3 OC-48 and OC-192 Card Performance Monitoring Parameters

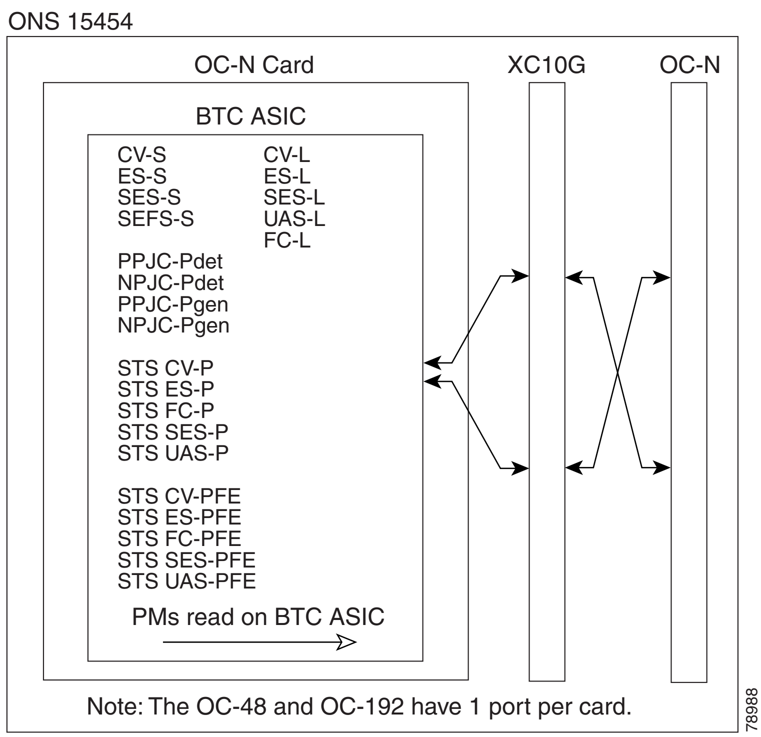
Figure 15-17 shows the signal types that support near-end and far-end PMs. Figure 15-18 on page 15-52 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the OC48 LR 1550, OC48 IR 1310, OC48 LR/STM16 LH AS 1550, OC48 IR/STM16 SH AS 1310, OC48 ELR 200 GHz, OC48 ELR/STM16 EH 100 GHz, OC192 SR/STM64 IO 1310, OC192 IR/STM64 SH 1550, OC192 LR/STM64 LH 1550, and OC192 LR/STM64 LH ITU 15xx.xx.

Figure 15-17 Monitored Signal Types for the OC-48 and OC-192 Cards



> **Note** PMs on the protect STS are not supported for BLSR. The XX in Figure 15-17 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-18 PM Read Points on the OC-48 and OC-192 Cards



> **Note** For PM locations relating to protection switch counts, see the Telcordia GR-1230-CORE document.

The PM parameters for the OC-48 and OC-192 cards are described in Table 15-61 through Table 15-66 on page 15-56.

Table 15-61 Near-End Section PMs for the OC-48 and OC-192 Cards

Parameter	Definition
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or LOF defect is present. However, there might be situations when the SEFS-S parameter is only incremented based on the presence of an SEF defect.

Table 15-62 Near-End Line Layer PMs for the OC-48 and OC-192 Cards

Parameter	Definition
CV-L	Near-End Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Near-End Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Near-End Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Near-End Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Near-End Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Note In CTC, the count fields for PPJC and NPJC PM parameters appear white and blank unless they are enabled on the Provisioning > Line tabs. See the "15.3 Pointer Justification Count Performance Monitoring" section on page 15-3.

Table 15-63 Near-End SONET Path H-byte PMs for the OC-48 and OC-192 Cards

Parameter	Definition
PPJC-Pdet-P	Positive Pointer Justification Count, STS Path Detected (PPJC-Pdet-P) is a count of the positive pointer justifications detected on a particular path on an incoming SONET signal.
NPJC-Pdet-P	Negative Pointer Justification Count, STS Path Detected (NPJC-Pdet) is a count of the negative pointer justifications detected on a particular path on an incoming SONET signal.
PPJC-Pgen-P	Positive Pointer Justification Count, STS Path Generated (PPJC-Pgen-P) is a count of the positive pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
NPJC-Pgen-P	Negative Pointer Justification Count, STS Path Generated (NPJC-Pgen-P) is a count of the negative pointer justifications generated for a particular path to reconcile the frequency of the synchronous payload envelope (SPE) with the local clock.
PJCDiff-P	Pointer Justification Count Difference, STS Path (PJCDiff-P) is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. That is, PJCDiff-P is equal to (PPJC-PGen-NPJC-PGen) – (PPJC-PDet-NPJC-PDet).
PJCS-PDet-P	Pointer Justification Count Seconds, STS Path Detect (PJCS-PDet-P) is a count of the one-second intervals containing one or more PPJC-PDet or NPJC-PDet.
PJCS-PGen-P	Pointer Justification Count Seconds, STS Path Generate (PJCS-PGen-P) is a count of the one-second intervals containing one or more PPJC-PGen or NPJC-PGen.

Table 15-64 Near-End Line Layer PMs for the OC-48 and OC-192 Cards

Parameter	Definition
Note For information about troubleshooting path protection switch counts, refer to the alarm troubleshooting information in the *Cisco ONS 15454 Troubleshooting Guide*. For information about creating circuits that perform a switch, see Chapter 10, "Circuits and Tunnels."	
PSC (BLSR)	For a protect line in a two-fiber ring, Protection Switching Count (PSC) refers to the number of times a protection switch has occurred either to a particular span's line protection or away from a particular span's line protection. Therefore, if a protection switch occurs on a two-fiber BLSR, the PSC of the protection span to which the traffic is switched will increment, and when the switched traffic returns to its original working span from the protect span, the PSC of the protect span will increment again.

Table 15-64 Near-End Line Layer PMs for the OC-48 and OC-192 Cards (continued)

Parameter	Definition
PSC (1+1 protection)	In a 1 + 1 protection scheme for a working card, Protection Switching Count (PSC) is a count of the number of times service switches from a working card to a protection card plus the number of times service switches back to the working card. For a protection card, PSC is a count of the number of times service switches to a working card from a protection card plus the number of times service switches back to the protection card. The PSC PM is only applicable if revertive line-level protection switching is used.
PSD	Protection Switching Duration (PSD) applies to the length of time, in seconds, that service is carried on another line. For a working line, PSD is a count of the number of seconds that service was carried on the protection line. For the protection line, PSD is a count of the seconds that the line was used to carry service. The PSD PM is only applicable if revertive line-level protection switching is used.
PSC-W	For a working line in a two-fiber BLSR, Protection Switching Count-Working (PSC-W) is a count of the number of times traffic switches away from the working capacity in the failed line and back to the working capacity after the failure is cleared. PSC-W increments on the failed working line and PSC increments on the active protect line. For a working line in a four-fiber BLSR, PSC-W is a count of the number of times service switches from a working line to a protection line plus the number of times it switches back to the working line. PSC-W increments on the failed line and PSC-R or PSC-S increments on the active protect line.
PSD-W	For a working line in a two-fiber BLSR, Protection Switching Duration-Workdiffing (PSD-W) is a count of the number of seconds that service was carried on the protection line. PSD-W increments on the failed working line and PSD increments on the active protect line.
PSC-S	In a four-fiber BLSR, Protection Switching Count-Span (PSC-S) is a count of the number of times service switches from a working line to a protection line plus the number of times it switches back to the working line. A count is only incremented if span switching is used.
PSD-S	In a four-fiber BLSR, Protection Switching Duration-Span (PSD-S) is a count of the seconds that the protection line was used to carry service. A count is only incremented if span switching is used.
PSC-R	In a four-fiber BLSR, Protection Switching Count-Ring (PSC-R) is a count of the number of times service switches from a working line to a protection line plus the number of times it switches back to a working line. A count is only incremented if ring switching is used.
PSD-R	In a four-fiber BLSR, Protection Switching Duration-Ring (PSD-R) is a count of the seconds that the protection line was used to carry service. A count is only incremented if ring switching is used.

Table 15-65 Near-End SONET Path PMs for the OC-48 and OC-192 Cards

Parameter	Definition
Note SONET path PMs do not increment unless IPPM is enabled. See the "15.2 Intermediate Path Performance Monitoring" section on page 15-2.	
CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an ES-P.
FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins with an AIS-P failure, an LOP-P failure, a UNEQ-P failure or a TIM-P failure is declared, or if the STS PTE that is monitoring the path supports ERDI-P for that path. The failure event ends when these failures are cleared.
SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an SES-P.
UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.

Table 15-66 Far-End Line Layer PMs for the OC-48 and OC-192 Cards

Parameter	Definition
CV-LFE	Far-End Line Code Violation (CV-LFE) is a count of BIP errors detected by the far-end line terminating equipment (LTE) and reported back to the near-end LTE using the REI-L indication in the line overhead. For SONET signals at rates below OC-48, up to 8 x N BIP errors per STS-N frame can be indicated using the REI-L. For OC-48 signals, up to 255 BIP errors per STS-N frame can be indicated. The current CV-L second register is incremented for each BIP error indicated by the incoming REI-L.
ES-LFE	Far-End Line Errored Seconds (ES-LFE) is a count of the seconds when at least one line-layer BIP error was reported by the far-end LTE or an RDI-L defect was present.
SES-LFE	Far-End Line Severely Errored Seconds (SES-LFE) is a count of the seconds when K (see Telcordia GR-253-CORE for values) or more line-layer BIP errors were reported by the far-end LTE or an RDI-L defect was present.

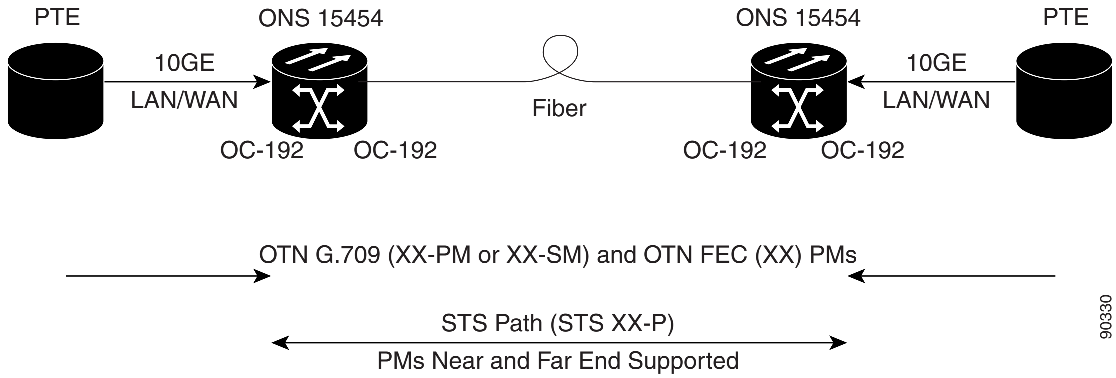
Table 15-66 Far-End Line Layer PMs for the OC-48 and OC-192 Cards (continued)

Parameter	Definition
UAS-LFE	Far-End Line Unavailable Seconds (UAS-LFE) is a count of the seconds when the line is unavailable at the far end. A line becomes unavailable at the far end when ten consecutive seconds occur that qualify as SES-LFEs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-LFEs.
FC-LFE	Far-End Line Failure Count (FC-LFE) is a count of the number of far-end line failure events. A failure event begins when RFI-L failure is declared and ends when the RFI-L failure clears. A failure event that begins in one period and ends in another period is counted only in the period where it began.

15.7.4 TXP_MR_10G Card Performance Monitoring Parameters

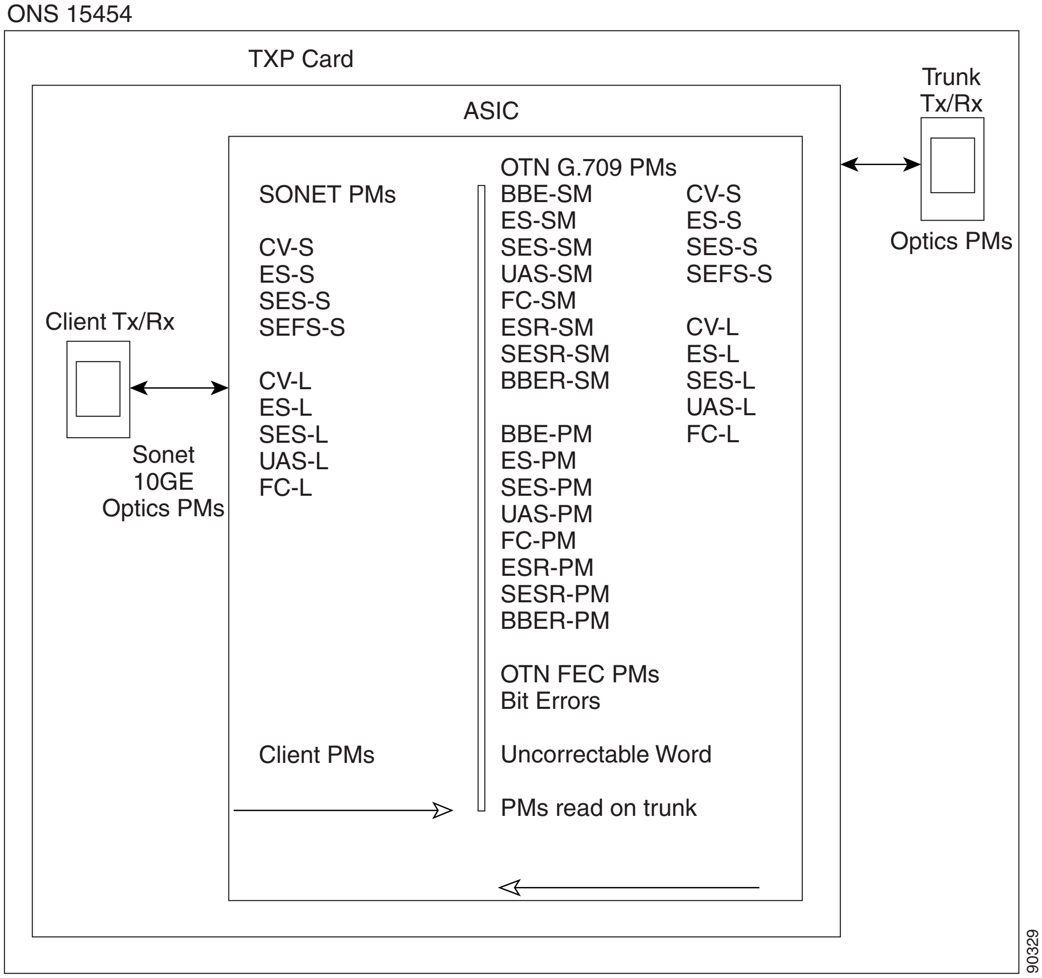
Figure 15-19 shows the signal types that support near-end and far-end PMs. Figure 15-20 on page 15-59 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the TXP_MR_10G card.

Figure 15-19 Monitored Signal Types for TXP_MR_10G Cards



Note The XX in Figure 15-19 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-20 PM Read Points on TXP_MR_10G Cards



The PM parameters for the TXP_MR_10G cards are described in Table 15-67 on page 15-59 through Table 15-72 on page 15-62.

Table 15-67 Physical Optics PM Parameters for TXP_MR_10G Cards

Parameter	Definition
Laser Bias (Min)	Minimum percentage of laser bias current (%)
Laser Bias (Avg)	Average percentage of laser bias current (%)
Laser Bias (Max)	Maximum percentage of laser bias current (%)
Rx Optical Pwr (Min)	Minimum receive optical power (dBm)
Rx Optical Pwr (Avg)	Average receive optical power (dBm)
Rx Optical Pwr (Max)	Maximum receive optical power (dBm)
Tx Optical Pwr (Min)	Minimum transmit optical power (dBm)
TX Optical Pwr (Avg)	Average transmit optical power (dBm)
Tx Optical Pwr (Max)	Maximum transmit optical power (dBm)

Table 15-68 Near-End or Far-End Section PM Parameters for TXP_MR_10G Cards

Parameter	Definition
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or LOF defect is present. However, there might be situations when the SEFS-S parameter is only incremented based on the presence of an SEF defect.

Table 15-69 Near-End or Far-End Line Layer PM Parameters for TXP_MR_10G Cards

Parameter	Definition
CV-L	Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Table 15-70 Near-End or Far-End PM Parameters for Ethernet Payloads on TXP_MR_10G Cards

Parameter	Definition
Rx Packets	Number of packets received since the last counter reset.
Rx Bytes	Number of bytes received since the last counter reset.
Tx Packets	Number of packets transmitted since the last counter reset.
Tx Bytes	Number of bytes transmitted since the last counter reset.
Rx Total Errors	Total number of receive errors.
Rx FCS	Number of packets with a FCS error.
Rx Runts	Total number of frames received that are less than 64 bytes in length and have a CRC error.
Rx Jabbers	Total number of frames received that exceed the maximum 1548 bytes and contain CRC errors.
Rx Pause Frames	Number of received pause frames.
Rx Control Frames	A count of MAC control frames passed by the MAC sublayer to the MAC control sublayer.
Rx Unknown Opcode Frames	A count of MAC control frames received that contain an opcode that is not supported by the device.

Table 15-71 Near-End or Far-End OTN G.709 PM Parameters for TXP_MR_10G Cards

Parameter	Definition
BBE-SM	Section Monitoring Background Block Errors (BBE-SM) indicates the number of background block errors recorded in the OTN section during the PM time interval.
ES-SM	Section Monitoring Errored Seconds (ES-SM) indicates the errored seconds recorded in the OTN section during the PM time interval.
SES-SM	Section Monitoring Severely Errored Seconds (SES-SM) indicates the severely errored seconds recorded in the OTN section during the PM time interval.
UAS-SM	Section Monitoring Unavailable Seconds (UAS-SM) indicates the unavailable seconds recorded in the OTN section during the PM time interval.
FC-SM	Section Monitoring Failure Counts (FC-SM) indicates the failure counts recorded in the OTN section during the PM time interval.
ESR-SM	Section Monitoring Errored Seconds Ratio (ESR-SM) indicates the errored seconds ratio recorded in the OTN section during the PM time interval.
SESR-SM	Section Monitoring Severely Errored Seconds Ratio (SESR-SM) indicates the severely errored seconds ratio recorded in the OTN section during the PM time interval.

Table 15-71 Near-End or Far-End OTN G.709 PM Parameters for TXP_MR_10G Cards (continued)

Parameter	Definition
BBER-SM	Section Monitoring Background Block Errors Ratio (BBER-SM) indicates the background block errors ratio recorded in the OTN section during the PM time interval.
BBE-PM	Path Monitoring Background Block Errors (BBE-PM) indicates the number of background block errors recorded in the OTN path during the PM time interval.
ES-PM	Path Monitoring Errored Seconds (ES-PM) indicates the errored seconds recorded in the OTN path during the PM time interval.
SES-PM	Path Monitoring Severely Errored Seconds (SES-PM) indicates the severely errored seconds recorded in the OTN path during the PM time interval.
UAS-PM	Path Monitoring Unavailable Seconds (UAS-PM) indicates the unavailable seconds recorded in the OTN path during the PM time interval.
FC-PM	Path Monitoring Failure Counts (FC-PM) indicates the failure counts recorded in the OTN path during the PM time interval.
ESR-PM	Path Monitoring Errored Seconds Ratio (ESR-PM) indicates the errored seconds ratio recorded in the OTN path during the PM time interval.
SESR-PM	Path Monitoring Severely Errored Seconds Ratio (SESR-PM) indicates the severely errored seconds ratio recorded in the OTN path during the PM time interval.
BBER-PM	Path Monitoring Background Block Errors Ratio (BBER-PM) indicates the background block errors ratio recorded in the OTN path during the PM time interval.

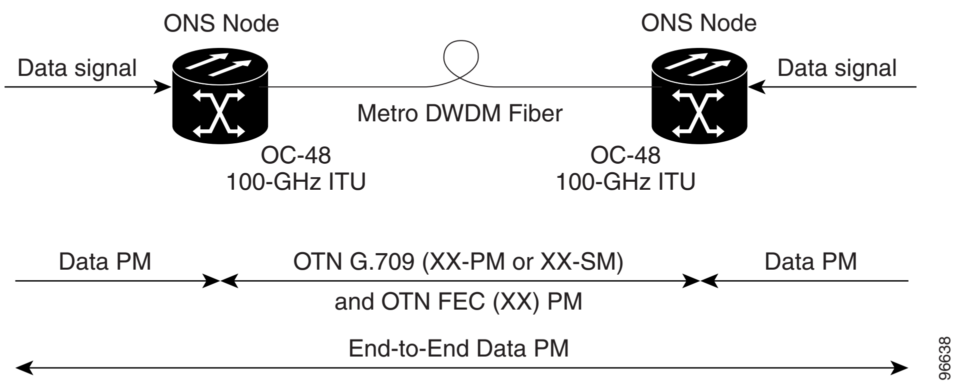
Table 15-72 Near-End or Far-End OTN FEC PM Parameters for the TXP_MR_10G Card

Parameter	Definition
Bit Errors	The number of bit errors corrected in the dense wavelength division multiplexing (DWDM) trunk line during the PM time interval.
Uncorrectable Words	The number of uncorrectable words detected in the DWDM trunk line during the PM time interval.

15.7.5 TXP_MR_2.5G and TXPP_MR_2.5G Card Performance Monitoring Parameters

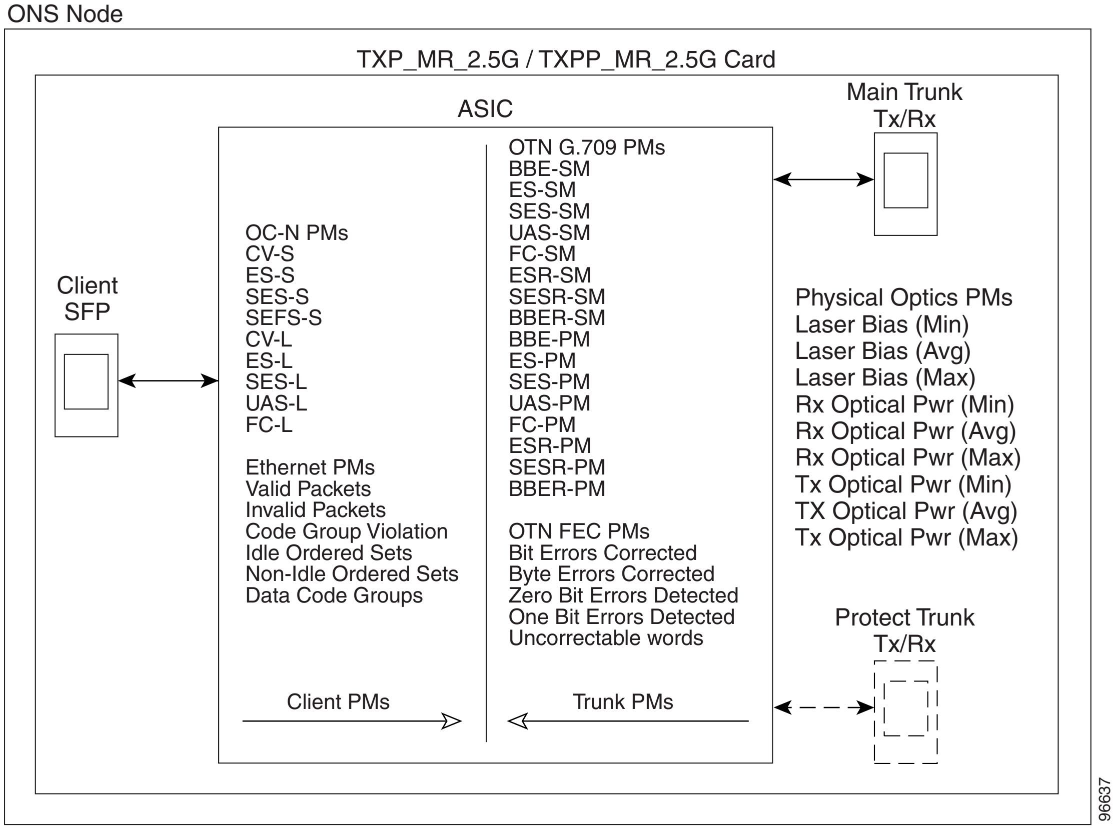
Figure 15-21 shows the signal types that support near-end and far-end PMs. Figure 15-22 on page 15-64 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Figure 15-21 Monitored Signal Types for TXP_MR_2.5G and TXPP_MR_2.5G Cards



Note The XX in Figure 15-21 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-22 PM Read Points on TXP_MR_2.5G and TXPP_MR_2.5G Cards



The PM parameters for the TXP_MR_2.5G and TXPP_MR_2.5G cards are described in Table 15-73 through Table 15-78 on page 15-67.

Table 15-73 Optical PM Parameters for TXP_MR_2.5G and TXPP_MR_2.5G Cards

Parameter	Definition
Laser Bias (Min)	Minimum percentage of laser bias current (%)
Laser Bias (Avg)	Average percentage of laser bias current (%)
Laser Bias (Max)	Maximum percentage of laser bias current (%)
Rx Optical Pwr (Min)	Minimum receive optical power (dBm)
Rx Optical Pwr (Avg)	Average receive optical power (dBm)
Rx Optical Pwr (Max)	Maximum receive optical power (dBm)
Tx Optical Pwr (Min)	Minimum transmit optical power (dBm)
Tx Optical Pwr (Avg)	Average transmit optical power (dBm)
Tx Optical Pwr (Max)	Maximum transmit optical power (dBm)

Table 15-74 Near-End or Far-End Section PM Parameters for OC-3, OC-12, and OC-48 Payloads on TXP_MR_2.5G and TXPP_MR_2.5G Cards

Parameter	Definition
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or LOF defect is present. However, there might be situations when the SEFS-S parameter is only incremented based on the presence of an SEF defect.

Table 15-75 Near-End or Far-End Line-Layer PM Parameters for OC-3, OC-12, and OC-48 Payloads on TXP_MR_2.5G TXPP_MR_2.5G Cards

Parameter	Definition
CV-L	Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Table 15-76 Near-End or Far-End PM Parameters for Ethernet and Fiber-Channel Payloads on TXP_MR_2.5G and TXPP_MR_2.5G Cards

Parameter	Definition
Valid Packets	A count of received packets that contain non-errored data code groups that have start and end delimiters.
Invalid Packets	A count of received packets that contain errored data code groups that have start and end delimiters.
Code Group Violations	A count of received code groups that do not contain a start or end delimiter.
Idle Ordered Sets	A count of received packets containing idle ordered sets.
Non-Idle Ordered Sets	A count of received packets containing non-idle ordered sets.
Data Code Groups	A count of received data code groups that do not contain ordered sets.

Note Enterprise system connection (ESCON), DV6000, SDI/D1 video, and high definition television (HDTV) client signals are unframed payload data types. If the configured payload data type is unframed, line threshold provisioning and performance monitoring are not available.

Table 15-77 Near-End or Far-End OTN G.709 PM Parameters for TXP_MR_2.5G and TXPP_MR_2.5G Cards

Parameter	Definition
BBE-SM	Section Monitoring Background Block Errors (BBE-SM) indicates the number of background block errors recorded in the OTN section during the PM time interval.
ES-SM	Section Monitoring Errored Seconds (ES-SM) indicates the errored seconds recorded in the OTN section during the PM time interval.
SES-SM	Section Monitoring Severely Errored Seconds (SES-SM) indicates the severely errored seconds recorded in the OTN section during the PM time interval.
UAS-SM	Section Monitoring Unavailable Seconds (UAS-SM) indicates the unavailable seconds recorded in the OTN section during the PM time interval.
FC-SM	Section Monitoring Failure Counts (FC-SM) indicates the failure counts recorded in the OTN section during the PM time interval.
ESR-SM	Section Monitoring Errored Seconds Ratio (ESR-SM) indicates the errored seconds ratio recorded in the OTN section during the PM time interval.
SESR-SM	Section Monitoring Severely Errored Seconds Ratio (SESR-SM) indicates the severely errored seconds ratio recorded in the OTN section during the PM time interval.
BBER-SM	Section Monitoring Background Block Errors Ratio (BBER-SM) indicates the background block errors ratio recorded in the OTN section during the PM time interval.

Table 15-77 Near-End or Far-End OTN G.709 PM Parameters for TXP_MR_2.5G and TXPP_MR_2.5G Cards (continued)

Parameter	Definition
BBE-PM	Path Monitoring Background Block Errors (BBE-PM) indicates the number of background block errors recorded in the OTN path during the PM time interval.
ES-PM	Path Monitoring Errored Seconds (ES-PM) indicates the errored seconds recorded in the OTN path during the PM time interval.
SES-PM	Path Monitoring Severely Errored Seconds (SES-PM) indicates the severely errored seconds recorded in the OTN path during the PM time interval.
UAS-PM	Path Monitoring Unavailable Seconds (UAS-PM) indicates the unavailable seconds recorded in the OTN path during the PM time interval.
FC-PM	Path Monitoring Failure Counts (FC-PM) indicates the failure counts recorded in the OTN path during the PM time interval.
ESR-PM	Path Monitoring Errored Seconds Ratio (ESR-PM) indicates the errored seconds ratio recorded in the OTN path during the PM time interval.
SESR-PM	Path Monitoring Severely Errored Seconds Ratio (SESR-PM) indicates the severely errored seconds ratio recorded in the OTN path during the PM time interval.
BBER-PM	Path Monitoring Background Block Errors Ratio (BBER-PM) indicates the background block errors ratio recorded in the OTN path during the PM time interval.

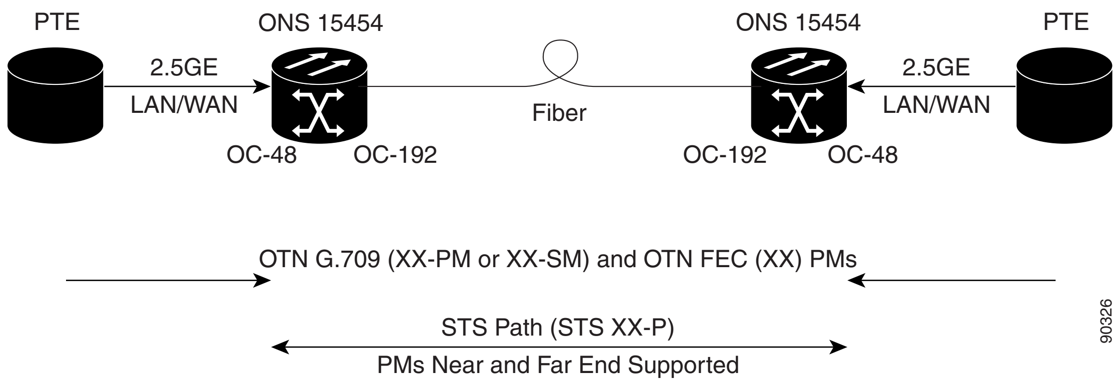
Table 15-78 Near-End or Far-End OTN FEC PM Parameters for TXP_MR_2.5G and TXPP_MR_2.5G Cards

Parameter	Definition
Bit Errors	The number of bit errors corrected in the DWDM trunk line during the PM time interval.
Uncorrectable Words	The number of uncorrectable words detected in the DWDM trunk line during the PM time interval.

15.7.6 MXP_2.5G_10G Card Performance Monitoring Parameters

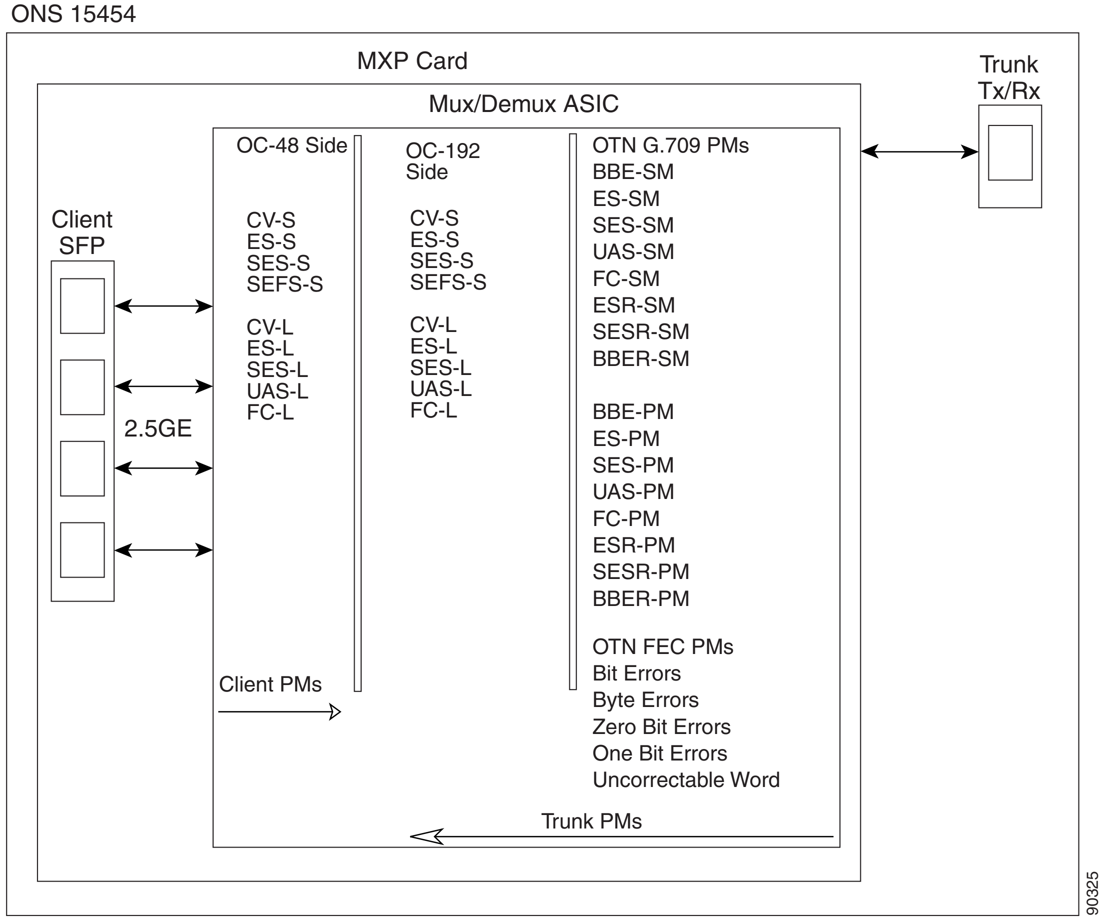
Figure 15-23 shows the signal types that support near-end and far-end PMs. Figure 15-24 on page 15-69 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the MXP_2.5G_10G card.

Figure 15-23 Monitored Signal Types for MXP_2.5G_10G Cards



Note The XX in Figure 15-23 represents all PMs listed in the tables in this section with the given prefix and/or suffix.

Figure 15-24 PM Read Points on MXP_2.5G_10G Cards



The PM parameters for the MXP_2.5G_10G cards are described in Table 15-79 on page 15-69 through Table 15-83 on page 15-72.

Table 15-79 Physical Optics PM Parameters for MXP_2.5G_10G Cards

Parameter	Definition
Laser Bias (Min)	Minimum percentage of laser bias current (%)
Laser Bias (Avg)	Average percentage of laser bias current (%)
Laser Bias (Max)	Maximum percentage of laser bias current (%)
Rx Optical Pwr (Min)	Minimum receive optical power (dBm)
Rx Optical Pwr (Avg)	Average receive optical power (dBm)
Rx Optical Pwr (Max)	Maximum receive optical power (dBm)
Tx Optical Pwr (Min)	Minimum transmit optical power (dBm)
Tx Optical Pwr (Avg)	Average transmit optical power (dBm)
Tx Optical Pwr (Max)	Maximum transmit optical power (dBm)

Table 15-80 Near-End or Far-End Section PM Parameters for MXP_2.5G_10G Cards

Parameter	Definition
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or LOF defect is present. However, there might be situations when the SEFS-S parameter is only incremented based on the presence of an SEF defect.

Table 15-81 Near-End or Far-End Line Layer PM Parameters for MXP_2.5G_10G Cards

Parameter	Definition
CV-L	Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Table 15-82 Near-End or Far-End OTN G.709 PM Parameters for MXP_2.5G_10G Cards

Parameter	Definition
BBE-SM	Section Monitoring Background Block Errors (BBE-SM) indicates the number of background block errors recorded in the OTN section during the PM time interval.
ES-SM	Section Monitoring Errored Seconds (ES-SM) indicates the errored seconds recorded in the OTN section during the PM time interval.
SES-SM	Section Monitoring Severely Errored Seconds (SES-SM) indicates the severely errored seconds recorded in the OTN section during the PM time interval.
UAS-SM	Section Monitoring Unavailable Seconds (UAS-SM) indicates the unavailable seconds recorded in the OTN section during the PM time interval.
FC-SM	Section Monitoring Failure Counts (FC-SM) indicates the failure counts recorded in the OTN section during the PM time interval.
ESR-SM	Section Monitoring Errored Seconds Ratio (ESR-SM) indicates the errored seconds ratio recorded in the OTN section during the PM time interval.
SESR-SM	Section Monitoring Severely Errored Seconds Ratio (SESR-SM) indicates the severely errored seconds ratio recorded in the OTN section during the PM time interval.
BBER-SM	Section Monitoring Background Block Errors Ratio (BBER-SM) indicates the background block errors ratio recorded in the OTN section during the PM time interval.
BBE-PM	Path Monitoring Background Block Errors (BBE-PM) indicates the number of background block errors recorded in the OTN path during the PM time interval.
ES-PM	Path Monitoring Errored Seconds (ES-PM) indicates the errored seconds recorded in the OTN path during the PM time interval.
SES-PM	Path Monitoring Severely Errored Seconds (SES-PM) indicates the severely errored seconds recorded in the OTN path during the PM time interval.
UAS-PM	Path Monitoring Unavailable Seconds (UAS-PM) indicates the unavailable seconds recorded in the OTN path during the PM time interval.
FC-PM	Path Monitoring Failure Counts (FC-PM) indicates the failure counts recorded in the OTN path during the PM time interval.
ESR-PM	Path Monitoring Errored Seconds Ratio (ESR-PM) indicates the errored seconds ratio recorded in the OTN path during the PM time interval.
SESR-PM	Path Monitoring Severely Errored Seconds Ratio (SESR-PM) indicates the severely errored seconds ratio recorded in the OTN path during the PM time interval.
BBER-PM	Path Monitoring Background Block Errors Ratio (BBER-PM) indicates the background block errors ratio recorded in the OTN path during the PM time interval.

Table 15-83 Near-End or Far-End OTN FEC PM Parameters for MXP_2.5G_10G Cards

Parameter	Definition
Bit Errors	The number of bit errors corrected in the DWDM trunk line during the PM time interval.
Uncorrectable Words	The number of uncorrectable words detected in the DWDM trunk line during the PM time interval.

15.8 Performance Monitoring for the Fiber Channel Card

The following sections define performance monitoring parameters and definitions for the FC_MR-4 card.

CTC provides FC_MR-4 performance information, including line-level parameters, port bandwidth consumption, and historical statistics. The FC_MR-4 card performance information is divided into the Statistics, Utilization, and History tabbed windows within the card view Performance tab window.

15.8.1 FC_MR-4 Statistics Window

The statistics window lists parameters at the line level. The Statistics window provides buttons to change the statistical values shown. The Baseline button resets the displayed statistics values to zero. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs. The Statistics window also has a Clear button. The Clear button sets the values on the card to zero. All counters on the card are cleared.

Table 15-84 defines the FC_MR-4 card Statistics parameters.

Table 15-84 FC_MR-4 Statistics Parameters

Parameter	Meaning
Time Last Cleared	A time stamp indicating the last time statistics were reset.
Link Status	Indicates whether the fibre channel link is receiving a valid fiber channel signal (carrier) from the attached fiber channel device; up means present, and down means not present.
Rx Frames	A count of the number of fiber channel frames received without errors.
Rx Bytes	A count of the number of bytes received without error for the fiber channel payload.
Tx Frames	A count of the number of transmitted fiber channel frames.
Tx Bytes	A count of the number of bytes transmitted from the fiber channel frame.
8b/10b Errors	A count of 10b errors received by the serial/deserializer (serdes 8b/10b).
Encoding Disparity Errors	A count of the disparity errors received by serdes.

Table 15-84 FC_MR-4 Statistics Parameters (continued)

Parameter	Meaning
Link Recoveries	A count of the FC_MR-4 software initiated link recovery attempts toward the FC line side because of SONET protection switches.
Rx Frames bad CRC	A count of the received fiber channel frames with errored CRCs.
Tx Frames bad CRC	A count of the transmitted fiber channel frames with errored CRCs.
Rx Undersized Frames	A count of the received fiber channel frames < 36 bytes including CRC, start of frame (SOF), and end of frame (EOF).
Rx Oversized Frames	A count of the received fiber channel frames > 2116 bytes of the payload. Four bytes are allowed for supporting VSAN tags sent.
GFP Rx HDR Single-bit Errors	A count of generic framing procedure (GFP) single bit errors in the core header error check (CHEC).
GFP Rx HDR Multi-bit Errors	A count of GFP multibit errors in CHEC.
GGFP Rx Frames Invalid Type	A count of GFP invalid user payload identifier (UPI) field in the type field.
GFP Rx Superblk CRC Errors	A count of superblock CRC errors in the transparent GFP frame.

15.8.2 FC_MR-4 Utilization Window

The Utilization window shows the percentage of Tx and Rx line bandwidth used by the ports during consecutive time segments. The Utilization window provides an Interval menu that enables you to set time intervals of 1 minute, 15 minutes, 1 hour, and 1 day. Line utilization is calculated with the following formulas:

Rx = (inOctets + inPkts * 24) * 8 / 100% interval * maxBaseRate

Tx = (outOctets + outPkts * 24) * 8 / 100% interval * maxBaseRate

The interval is defined in seconds. The maxBaseRate is defined by raw bits per second in one direction for the port (that is, 1 Gbps or 2 Gbps). The maxBaseRate for FC_MR-4 cards is shown in Table 15-85.

Table 15-85 maxBaseRate for STS Circuits

STS	maxBaseRate
STS-24	850000000
STS-48	850000000 x 2[1]

1. For 1 Gbps of bit rate being transported, there are only 850 Mbps of actual data because of 8b->10b conversion. Similarly, for 2 Gbps of bit rate being transported there are only 850 Mbps x 2 of actual data.

Note Line utilization numbers express the average of ingress and egress traffic as a percentage of capacity.

15.8.3 FC_MR-4 History Window

The History window lists past FC_MR-4 statistics for the previous time intervals. Depending on the selected time interval, the History window displays the statistics for each port for the number of previous time intervals as shown in Table 15-86. The listed parameters are defined in Table 15-84 on page 15-72.

Table 15-86 FC_MR-4 History Statistics per Time Interval

Time Interval	Number of Intervals Displayed
1 minute	60 previous time intervals
15 minutes	32 previous time intervals
1 hour	24 previous time intervals
1 day (24 hours)	7 previous time intervals

15.9 Performance Monitoring for DWDM Cards

The following sections define performance monitoring parameters and definitions for the OPT-PRE, OPT-BST, 32 MUX-O, 32 DMX-O, 4MD-xx.x, AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, AD-4B-xx.x, OSCM, and OSC-CSM DWDM cards.

15.9.1 Optical Amplifier Card Performance Monitoring Parameters

The PM parameters for the OPT-PRE and OPT-BST cards are described in Table 15-87 and Table 15-88.

Table 15-87 Optical Line PM Parameters for OPT-PRE and OPT-BST Cards

Parameter	Definition
Optical Pwr (Min)	Minimum received optical power (dBm)
Optical Pwr (Avg)	Average received optical power (dBm)
Optical Pwr (Max)	Maximum received optical power (dBm)

Table 15-88 Optical Amplifier Line PM Parameters for OPT-PRE and OPT-BST Cards

Parameter	Definition
Optical Pwr (Min)	Minimum transmit optical power (dBm)
Optical Pwr (Avg)	Average transmit optical power (dBm)
Optical Pwr (Max)	Maximum transmit optical power (dBm)

15.9.2 Multiplexer and Demultiplexer Card Performance Monitoring Parameters

The PM parameters for the 32 MUX-O and 32 DMX-O cards are described in Table 15-89 and Table 15-90.

Table 15-89 Optical Channel PMs for 32 MUX-O and 32 DMX-O Cards

Parameter	Definition
Optical Pwr (Min)	Minimum receive optical power (dBm)
Optical Pwr (Avg)	Average receive optical power (dBm)
Optical Pwr (Max)	Maximum receive optical power (dBm)

Table 15-90 Optical Line PMs for 32 MUX-O and 32 DMX-O Cards

Parameter	Definition
Optical Pwr (Min)	Minimum transmit optical power (dBm)
Optical Pwr (Avg)	Average transmit optical power (dBm)
Optical Pwr (Max)	Maximum transmit optical power (dBm)

15.9.3 4MD-xx.x Card Performance Monitoring Parameters

The PM parameters for the 4MD-xx.x cards are described in Table 15-91 and Table 15-92.

Table 15-91 Optical Channel PMs for 4MD-xx.x Cards

Parameter	Definition
Optical Pwr (Min)	Minimum receive optical power (dBm)
Optical Pwr (Avg)	Average receive optical power (dBm)
Optical Pwr (Max)	Maximum receive optical power (dBm)

Table 15-92 Optical Band PMs for 4MD-xx.x Cards

Parameter	Definition
Optical Pwr (Min)	Minimum transmit optical power (dBm)
Optical Pwr (Avg)	Average transmit optical power (dBm)
Optical Pwr (Max)	Maximum transmit optical power (dBm)

15.9.4 OADM Channel Filter Card Performance Monitoring Parameters

The PM parameters for the AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x cards are described in Table 15-93 and Table 15-94.

Table 15-93 Optical Channel PMs for AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x Cards

Parameter	Definition
Optical Pwr (Min)	Minimum receive optical power (dBm)
Optical Pwr (Avg)	Average receive optical power (dBm)
Optical Pwr (Max)	Maximum receive optical power (dBm)

Table 15-94 Optical Line PMs for AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x Cards

Parameter	Definition
Optical Pwr (Min)	Minimum transmit optical power (dBm)
Optical Pwr (Avg)	Average transmit optical power (dBm)
Optical Pwr (Max)	Maximum transmit optical power (dBm)

15.9.5 OADM Band Filter Card Performance Monitoring Parameters

The PM parameters for the AD-1B-xx.x and AD-4B-xx.x cards are described in Table 15-95 and Table 15-96 on page 15-76.

Table 15-95 Optical Line PMs for AD-1B-xx.x and AD-4B-xx.x Cards

Parameter	Definition
Optical Pwr (Min)	Minimum receive optical power (dBm)
Optical Pwr (Avg)	Average receive optical power (dBm)
Optical Pwr (Max)	Maximum receive optical power (dBm)

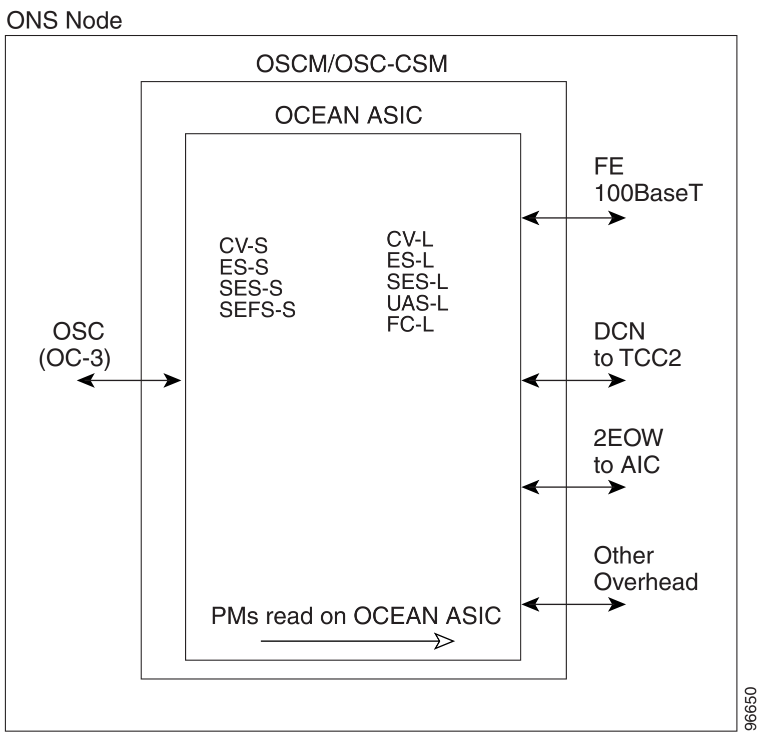
Table 15-96 Optical Band PMs for AD-1B-xx.x and AD-4B-xx.x Cards

Parameter	Definition
Optical Pwr (Min)	Minimum transmit optical power (dBm)
Optical Pwr (Avg)	Average transmit optical power (dBm)
Optical Pwr (Max)	Maximum transmit optical power (dBm)

15.9.6 Optical Service Channel Card Performance Monitoring Parameters

Figure 15-25 shows where overhead bytes detected on the ASICs produce performance monitoring parameters for the OSCM and OSC-CSM cards.

Figure 15-25 PM Read Points on OSCM and OSC-CSM Cards



The PM parameters for the OSCM and OSC-CSM cards are described in Table 15-97 through Table 15-99 on page 15-78.

Table 15-97 Optical Line PMs for OSCM and OSC-CSM Cards

Parameter	**Definition**
Optical Pwr (Min)	Minimum transmit optical power (dBm)
Optical Pwr (Avg)	Average transmit optical power (dBm)
Optical Pwr (Max)	Maximum transmit optical power (dBm)

Table 15-98 Near-End Section PM Parameters for OSCM and OSC-CSM Cards

Parameter	Definition
CV-S	Section Coding Violation (CV-S) is a count of BIP errors detected at the section-layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or LOS defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
SEFS-S	Section Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or LOF defect is present. However, there might be situations when the SEFS-S parameter is only incremented based on the presence of an SEF defect.

Table 15-99 Near-End or Far-End Line Layer PM Parameters for OSCM and OSC-CSM Cards

Parameter	Definition
CV-L	Near-End Line Code Violation (CV-L) is a count of BIP errors detected at the line-layer (that is, using the B2 bytes in the incoming SONET signal). Up to 8 x N BIP errors can be detected per STS-N frame; each error increments the current CV-L second register.
ES-L	Near-End Line Errored Seconds (ES-L) is a count of the seconds when at least one line-layer BIP error was detected or an AIS-L defect was present.
SES-L	Near-End Line Severely Errored Seconds (SES-L) is a count of the seconds when K (see Telcordia GR-253 for values) or more line-layer BIP errors were detected or an AIS-L defect was present.
UAS-L	Near-End Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Near-End Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an AIS-L failure or a lower-layer traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

CHAPTER 16

Ethernet Operation

The Cisco ONS 15454 integrates Ethernet into a SONET time-division multiplexing (TDM) platform. The ONS 15454 supports E-Series, G-Series, and ML-Series Ethernet cards. This chapter covers the operation of the E-Series and G-Series Ethernet cards.

For Ethernet card specifications, see Chapter 5, "Ethernet Cards." For information about the ML-Series cards, refer to the *Cisco ONS 15454 SONET/SDH ML-Series Multilayer Ethernet Card Software Feature and Configuration Guide.* For step-by-step Ethernet card circuit configuration procedures, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

16.1 G-Series Application

The G-Series cards (G1000-4/G1K-4) reliably transport Ethernet and IP data across a SONET backbone. The G-Series card maps up to four Gigabit Ethernet interfaces onto a SONET transport network and provides scalable and provisionable transport bandwidth at signal levels up to STS-48c per card. The G-Series card provides line rate forwarding for all Ethernet frames (unicast, multicast, and broadcast) and can be configured to support Jumbo frames (defined as a maximum of 10,000 bytes).The G-Series card incorporates features optimized for carrier-class applications such as:

- High Availability (HA), including hitless (< 50 ms) performance with software upgrades and all types of SONET/SDH equipment protection switches
- Hitless reprovisioning

- Support of Gigabit Ethernet traffic at full line rate
- Full TL1-based provisioning capability; refer to the *Cisco ONS 15454 and Cisco ONS 15327 TL1 Command Guide* for G-Series TL1 provisioning commands
- Serviceability options including enhanced port states, terminal and facility loopback, and J1 path trace
- SONET-style alarm support
- Ethernet performance monitoring (PM) and remote monitoring (RMON) functions

The G-Series card allows you to provision and manage an Ethernet private line service like a traditional SONET or SDH line. G-Series card applications include providing carrier-grade transparent LAN services (TLS), 100 Mbps Ethernet private line services (when combined with an external 100 Mb Ethernet switch with Gigabit uplinks), and high-availability transport.

The card maps a single Ethernet port to a single STS circuit. You can independently map the four ports on the G-Series card to any combination of STS-1, STS-3c, STS-6c, STS-9c, STS-12c, STS-24c, and STS-48c circuit sizes, provided that the sum of the circuit sizes that terminate on a card do not exceed STS-48c.

To support a Gigabit Ethernet port at a full line rate, an STS circuit with a capacity greater than or equal to 1 Gbps (bidirectional 2 Gbps) is needed. An STS-24c is the minimum circuit size that can support a Gigabit Ethernet port at full line rate. The G-Series card supports a maximum of two ports at full line rate.

The G-Series transmits and monitors the SONET J1 Path Trace byte in the same manner as ONS 15454 OC-N cards.

Note G-Series encapsulation is standard high level data link control (HDLC) framing over SONET/SDH as described in RFC 1622 and RFC 2615 with the point to point protocol (PPP) field set to the value specified in RFC 1841.

16.1.1 G1K-4 and G1000-4 Comparison

The G1K-4 and the G1000-4 cards comprise the ONS 15454 G-Series and are hardware equivalents.

When installed in ONS 15454s running Software Release 3.4 and earlier, both cards require the XC10G card to operate. However, when installed on an ONS 15454 running Software R4.0 and later, the G1K-4 card is not limited to installation in ONS 15454s with XC10G cards but can also be installed in ONS 15454s with XC and XCVT cards. When used with XC and XCVT cards on an ONS 15454 running Software R4.0 and later, the G1K-4 is limited to Slots 5, 6, 12, and 13.

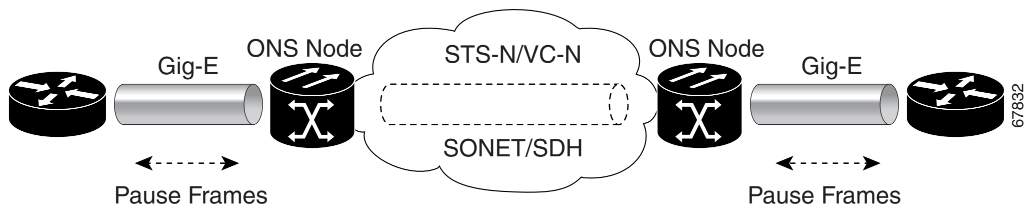
Software R4.0 and later identifies G1K-4 cards at physical installation. Software R3.4 and earlier identifies G1000-4 and G1K-4 cards as G1000-4 cards at physical installation.

These constraints do not apply to a G-Series card configured for Gigabit Ethernet Transponder Mode; see the "16.2 G-Series Gigabit Ethernet Transponder Mode" section on page 16-5 for more information.

16.1.2 G-Series Example

Figure 16-1 shows a G-Series application. In this example, data traffic from the Gigabit Ethernet port of a high-end router travels across the ONS 15454 point-to-point circuit to the Gigabit Ethernet port of another high-end router.

Figure 16-1 Data Traffic on a G-Series Point-to-Point Circuit



The G-Series card carries any Layer 3 protocol that can be encapsulated and transported over Gigabit Ethernet, such as IP or IPX. The data is transmitted on the Gigabit Ethernet fiber into the standard Cisco Gigabit Interface Converter (GBIC) on a G-Series card. The G-Series card transparently maps Ethernet frames into the SONET payload by multiplexing the payload onto a SONET OC-N card. When the SONET payload reaches the destination node, the process is reversed and the data is transmitted from the standard Cisco GBIC in the destination G-Series card onto the Gigabit Ethernet fiber.

The G-Series card discards certain types of erroneous Ethernet frames rather than transport them over SONET. Erroneous Ethernet frames include corrupted frames with cycle redundancy check (CRC) errors and under-sized frames that do not conform to the minimum 64-byte length Ethernet standard. The G-Series card forwards valid frames unmodified over the SONET network. Information in the headers is not affected by the encapsulation and transport. For example, packets with formats that include IEEE 802.1Q information will travel through the process unaffected.

16.1.3 802.3z Flow Control and Frame Buffering

The G-Series supports IEEE 802.3z flow control and frame buffering to reduce data traffic congestion. To prevent over-subscription, 512 KB of buffer memory is available for the receive and transmit channels on each port. When the buffer memory on the Ethernet port nears capacity, the ONS 15454 uses IEEE 802.3z flow control to transmit a pause frame to the source at the opposite end of the Gigabit Ethernet connection.

The pause frame instructs the source to stop sending packets for a specific period of time. The sending station waits the requested time before sending more data. Figure 16-1 illustrates pause frames being sent and received by ONS 15454s and attached switches.

The G-Series card has symmetric flow control. It proposes symmetric flow control when auto-negotiating flow control with attached Ethernet devices. Symmetric flow control allows the G-Series to respond to pause frames sent from external devices and to send pause frames to external devices. Prior to Software R4.0, flow control on the G-Series card was asymmetric, meaning the card sent pause frames and discarded received pause frames.

This flow-control mechanism matches the sending and receiving device throughput to that of the bandwidth of the STS circuit. For example, a router might transmit to the Gigabit Ethernet port on the G-Series. This particular data rate may occasionally exceed 622 Mbps, but the ONS 15454 circuit assigned to the G-Series port might be only STS-12c (622.08 Mbps). In this example, the ONS 15454 sends out a pause frame and requests that the router delay its transmission for a certain period of time. With flow control and a substantial per-port buffering capability, a private line service provisioned at less than full line rate capacity (STS-24c) is efficient because frame loss can be controlled to a large extent.

The G-Series card has flow control threshold provisioning, which allows a user to select one of three watermark (buffer size) settings: default, low latency, or custom. Default is the best setting for general use and was the only setting available prior to Software R4.1. Low latency is good for sub-rate applications, such as voice over IP (VoIP) over an STS-1. For attached devices with insufficient buffering, best effort traffic or long access line lengths, set the G-Series to a higher latency.

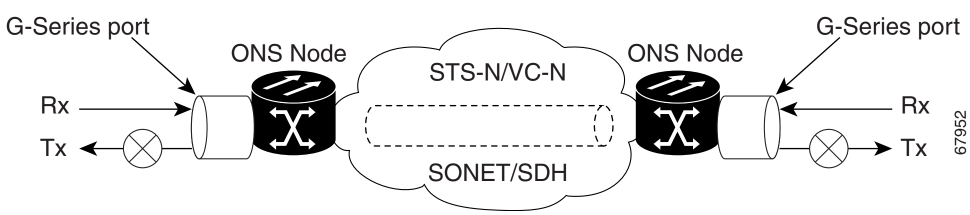
The custom setting allows you to specify an exact buffer size threshold for Flow Ctrl Lo and Flow Ctrl Hi. The flow control high setting is the watermark for sending the Pause On frame to the attached Ethernet device; this frame signals the device to temporarily stop transmitting. The flow control low setting is the watermark for sending the Pause Off frame, which signals the device to resume transmitting. With a G-Series card, you can only enable flow control on a port if autonegotiation is enabled on the device attached to that port.

Note External Ethernet devices with auto-negotiation configured to interoperate with G-Series cards running releases prior to Software R4.0 do not need to change auto-negotiation settings when interoperating with G-Series cards running Software R4.0 and later.

16.1.4 Ethernet Link Integrity Support

The G-Series supports end-to-end Ethernet link integrity (Figure 16-2). This capability is integral to providing an Ethernet private line service and correct operation of Layer 2 and Layer 3 protocols on the attached Ethernet devices. End-to-end Ethernet link integrity essentially means that if any part of the end-to-end path fails the entire path fails. Failure of the entire path is ensured by turning off the transmit lasers at each end of the path. The attached Ethernet devices recognize the disabled transmit laser as a loss of carrier and consequently an inactive link.

Figure 16-2 End-to-End Ethernet Link Integrity Support



Note Some network devices can be configured to ignore a loss of carrier condition. If a device configured to ignore a loss of carrier condition attaches to a G-Series card at one end, alternative techniques (such as use of Layer 2 or Layer 3 keep-alive messages) are required to route traffic around failures. The response time of such alternate techniques is typically much longer than techniques that use link state as indications of an error condition.

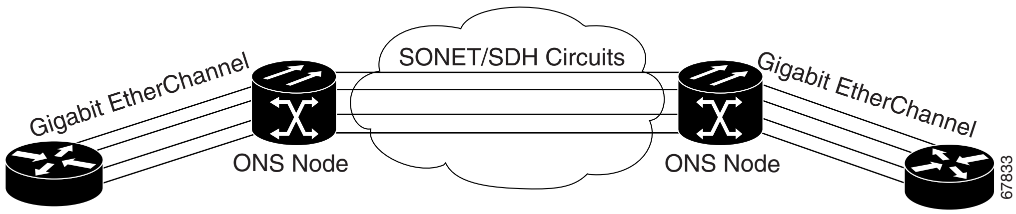
As shown in Figure 16-2, a failure at any point of the path causes the G-Series card at each end to disable its Tx transmit laser, which causes the devices at both ends to detect a link down. If one of the Ethernet ports is administratively disabled or set in loopback mode, the port is considered a “failure” for the purposes of end-to-end link integrity because the end-to-end Ethernet path is unavailable. The port “failure” also disables both ends of the path.

16.1.5 Gigabit EtherChannel/802.3ad Link Aggregation

The end-to-end Ethernet link integrity feature can be used in combination with Gigabit EtherChannel capability on attached devices. The combination provides an Ethernet traffic restoration scheme that has a faster response time than alternate techniques such as spanning tree rerouting, yet is more bandwidth efficient because spare bandwidth does not need to be reserved.

The G-Series supports all forms of link aggregation technologies including Gigabit EtherChannel (GEC), which is a Cisco proprietary standard, and the IEEE 802.3ad standard. The end-to-end link integrity feature of the G-Series allows a circuit to emulate an Ethernet link. This allows all flavors of Layer 2 and Layer 3 rerouting to work correctly with the G-Series. Figure 16-3 illustrates G-Series GEC support.

Figure 16-3 G-Series Gigabit EtherChannel (GEC) Support



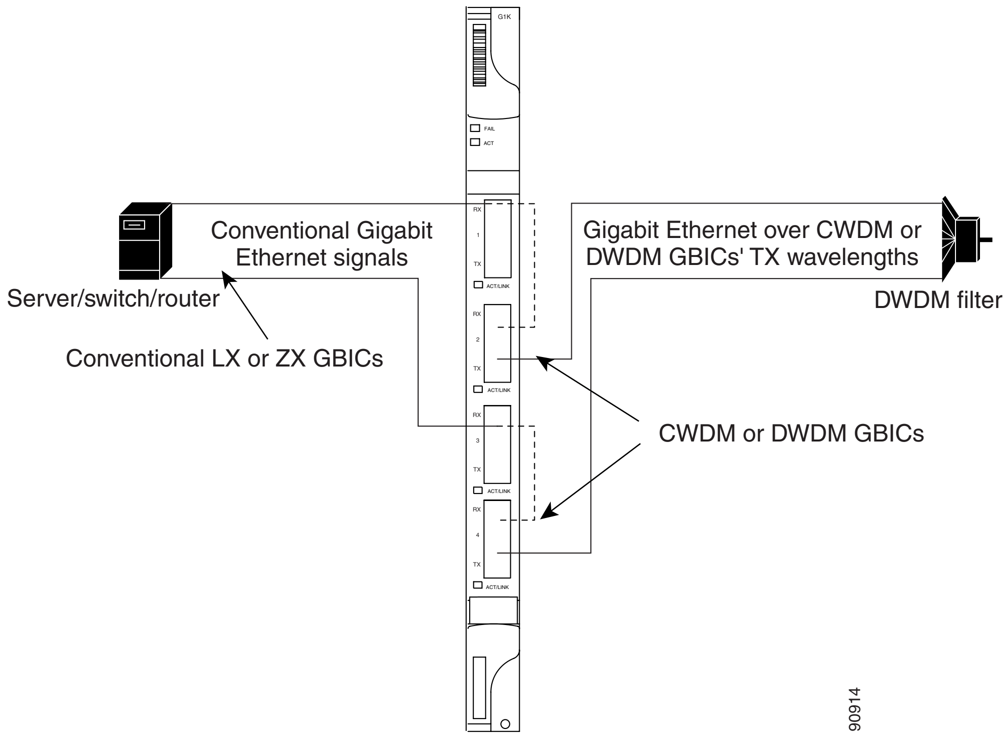
Although the G-Series card does not actively run GEC, it supports the end-to-end GEC functionality of attached Ethernet devices. If two Ethernet devices running GEC connect through G-Series cards to an ONS 15454 network, the ONS 15454 SONET side network is transparent to the EtherChannel devices. The EtherChannel devices operate as if they are directly connected to each other. Any combination of G-Series parallel circuit sizes can be used to support GEC throughput.

GEC provides line-level active redundancy and protection (1:1) for attached Ethernet equipment. It can also bundle parallel G-Series data links together to provide more aggregated bandwidth. STP operates as if the bundled links are one link and permits GEC to utilize these multiple parallel paths. Without GEC, STP permits only a single nonblocked path. GEC can also provide G-Series card-level protection or redundancy because it can support a group of ports on different cards (or different nodes) so that if one port or card has a failure, traffic is rerouted over the other port or card.

16.2 G-Series Gigabit Ethernet Transponder Mode

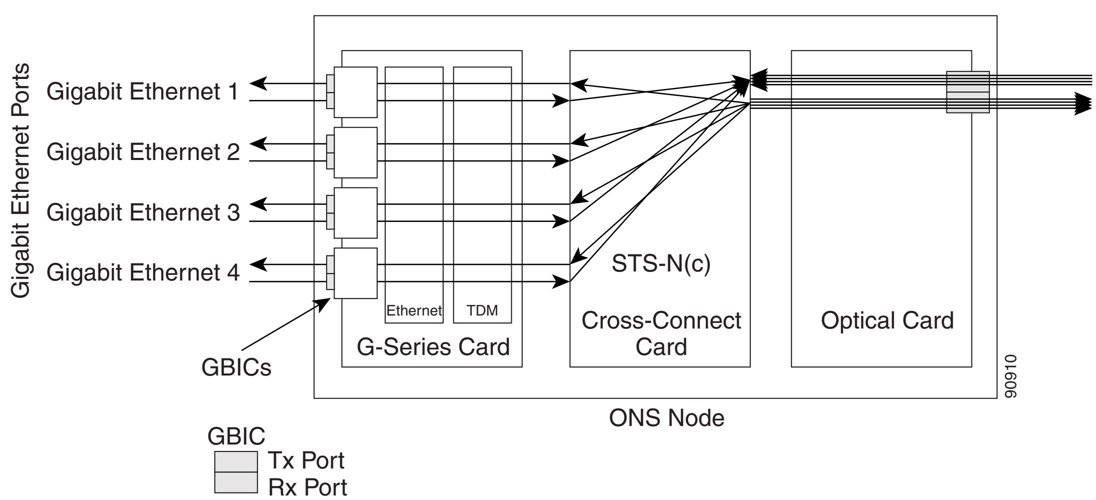
Beginning with Software R 4.1, the G-Series card can be configured as a transponder. Transponder mode can be used with any G-Series-supported GBIC (SX, LX, ZX, CWDM, or DWDM). Figure 16-4 shows a card level overview of a transponder mode application.

Figure 16-4 Card Level Overview of G-Series One-Port Transponder Mode Application



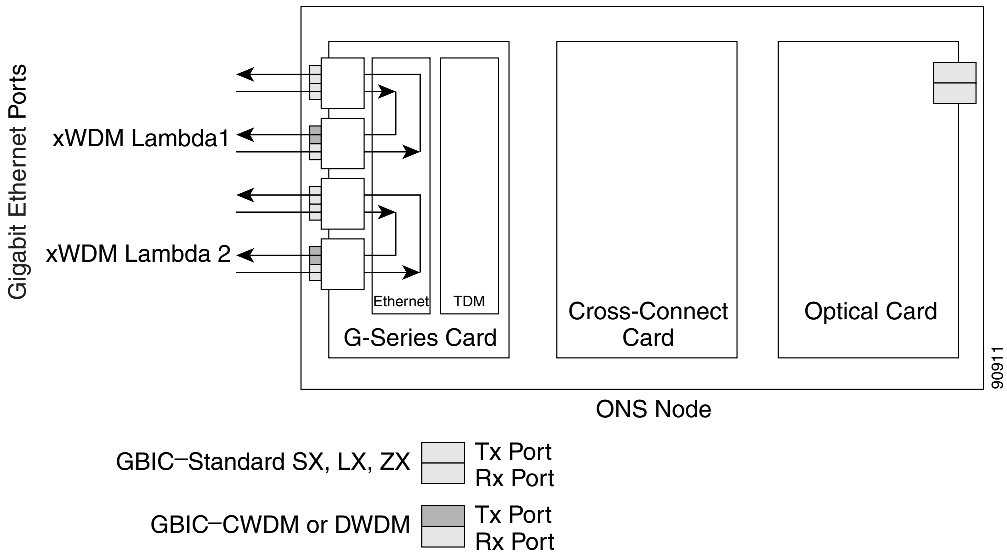
A G-Series card configured as a transponder operates quite differently than a G-Series card configured for SONET. In SONET configurations, the G-Series card receives and transmits Gigabit Ethernet traffic out the Ethernet ports and GBICs on the front of the card. This Ethernet traffic is multiplexed on and off the SONET network through the cross-connect card and the OC-N card (Figure 16-5).

Figure 16-5 G-Series in Default SONET Mode



In transponding mode, the G-Series Ethernet traffic never comes into contact with the cross-connect card or the SONET network, but stays internal to the G-Series card and is routed back to a GBIC on that card (Figure 16-6).

Figure 16-6 G-Series Card in Transponder Mode (Two-Port Bidirectional)



A G-Series card can either be configured for transponding mode or as the SONET default. When any port is provisioned in transponding mode, the card is in transponding mode and no SONET circuits can be configured until every port on the card goes back to SONET mode. To provision G-Series ports for transponder mode, refer to the *Cisco ONS 15454 Procedure Guide*.

All SONET circuits must be deleted before a G-Series card can be configured in transponding mode. An ONS 15454 can host the card in any or all of the 12 traffic slots on the ONS 15454 and supports a maximum of 24 bidirectional or 48 unidirectional lambdas.

A G-Series card configured as a transponder can be in one of three modes:

- Two-port bidirectional transponding mode
- One-port bidirectional transponding mode
- Two-port unidirectional transponding mode

16.2.1 Two-Port Bidirectional Transponder

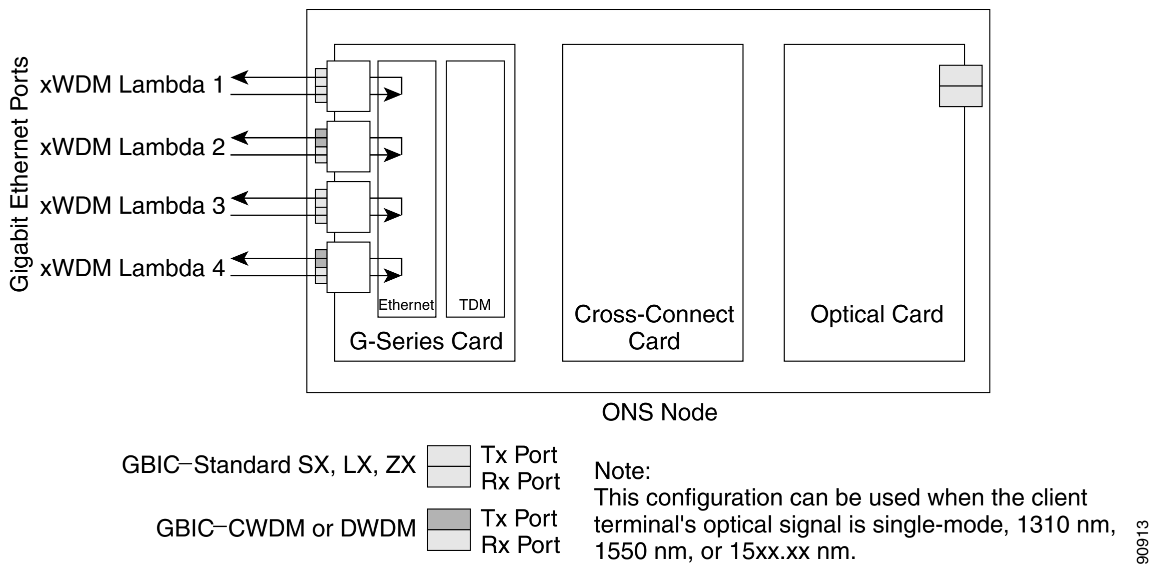
Two-port bidirectional transponder mode maps the transmitted and received Ethernet frames of one G-Series card port into the transmit and receive of another port (Figure 16-6). Transponder bidirectional port mapping can be any port to any port on the same card.

16.2.2 One-Port Bidirectional Transponder

One-port bidirectional transponder mode maps the Ethernet frames received at a port out the transmitter of the same port (Figure 16-7). This mode is similar to two-port bidirectional transponder mode except that a port is mapped only to itself instead of to another port. Although the data path of the one-port bidirectional transponder mode is identical to that of a facility loopback, the transponding mode is not a maintenance mode and does not suppress non-SONET alarms, such as loss of carrier (CARLOSS).

This mode can be used for intermediate dense wavelength division multiplexing (DWDM) signal regeneration and to take advantage of the wide band capability of the coarse wavelength division multiplexing (CWDM) and DWDM GBICs, which allows the node to receive on multiple wavelengths but transmit on a fixed wavelength.

Figure 16-7 One-Port Bidirectional Transponding Mode

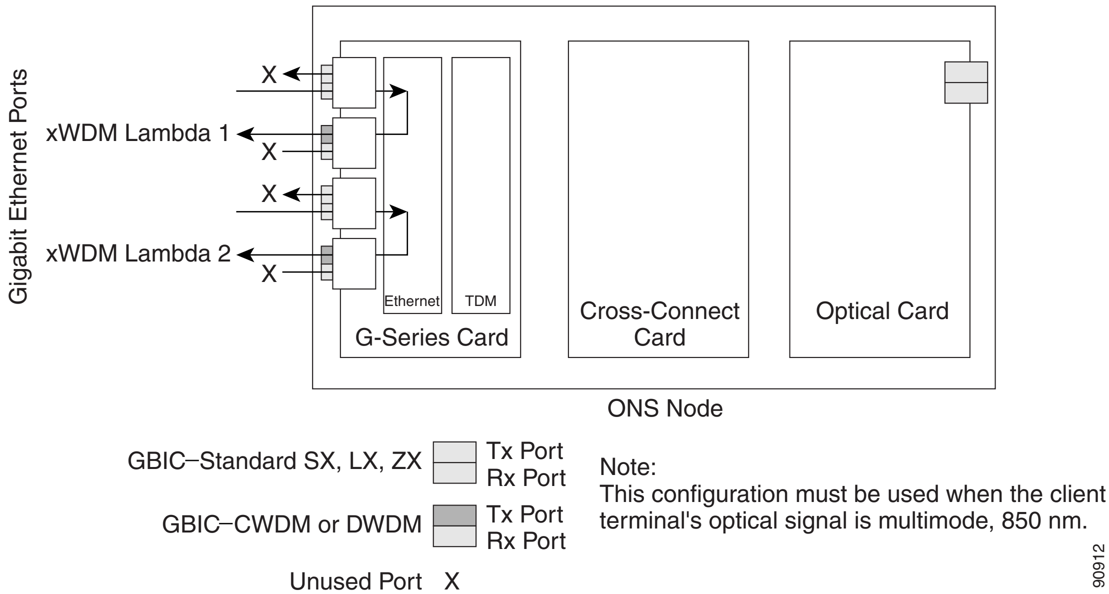


16.2.3 Two-Port Unidirectional Transponder

Ethernet frames received at one port's receiver will be transmitted out the transmitter of another port. This mode is similar to two-port bidirectional transponder mode except only one direction is used (Figure 16-8). One port has to be provisioned as unidirectional transmit only and the other port as unidirectional receive. The port configured as unidirectional transmit ignores any lack of signal on the receive port, so the receive port fiber does not need not be connected. The port configured as unidirectional receive does not turn on the transmit laser, and so the transmit port fiber does not need to be connected.

This mode can be used when only one direction needs to be transmitted over CWDM/DWDM, for example certain video on demand (VoD) applications.

Figure 16-8 Two-Port Unidirectional Transponder



16.2.4 G-Series Transponder Mode Characteristics

The operation of a G-Series card in transponder mode differs from a G-Series card in SONET mode in several ways:

- A G-Series card set to transponder mode will not show up in the CTC list of provisionable cards when the user is provisioning a SONET circuit.
- G-Series cards set to transponder mode do not require cross-connect cards (for example, XC10G), but do require a TCC2 card.

Note Software R4.5 and later support the TCC2 card, but not the TCC+ card.

- G-Series ports configured as transponders do not respond to flow control pause frames and pass the pause frames transparently through the card. In SONET mode, ports can respond to pause frames and do not pass the pause frames through the card.
- There is no TL1 provisioning support for configuring transponding mode. However, transponding mode and port information can be retrieved in the output for the TL1 command RTRV-G1000.
- All SONET related alarms are suppressed when a card is in transponding mode.
- There are no slot number or cross-connect restrictions for G1000-4 or G1K-4 cards in transponder mode.
- Facility and terminal loopbacks are not fully supported in unidirectional transponding mode, but are supported in both bidirectional transponding modes.
- Ethernet autonegotiation is not supported and cannot be provisioned in unidirectional transponding mode. Autonegotiation is supported in both bidirectional transponding modes.
- No end-to-end link integrity function is available in transponding mode.

Note In normal SONET mode the G-Series cards supports an end-to-end link integrity function. This function causes an Ethernet or SONET failure to disable and turn the transmitting laser off the corresponding mapped Ethernet port. In transponder mode, the loss of signal on an Ethernet port has no impact on the transmit signal of the corresponding mapped port.

The operation of a G-Series card in transponder mode is also similar to the operation of a G-Series card in SONET mode:

- G-Series Ethernet statistics are available for ports in both modes.
- Ethernet port level alarms and conditions are available for ports in both modes.
- Jumbo frame and non-jumbo frame operation is the same in both modes.
- Collection, reporting, and threshold crossing conditions for all existing counters and PM parameters are the same in both modes.
- SNMP and RMON support is the same in both modes.

16.3 E-Series Application

The ONS 15454 E-Series cards include the E100T-12/E100T-G and the E1000-2/E1000-2-G. An ONS 15454 supports a maximum of ten E-Series cards, and you can insert Ethernet cards in any multipurpose slot.

The E100T-G is the functional equivalent of the E100T-12. The E1000-2-G is the functional equivalent of the E1000-2. An ONS 15454 using XC10G cards requires the G versions (the E100T-G or E1000-2-G) of the E-Series Ethernet cards.

16.3.1 E-Series Modes

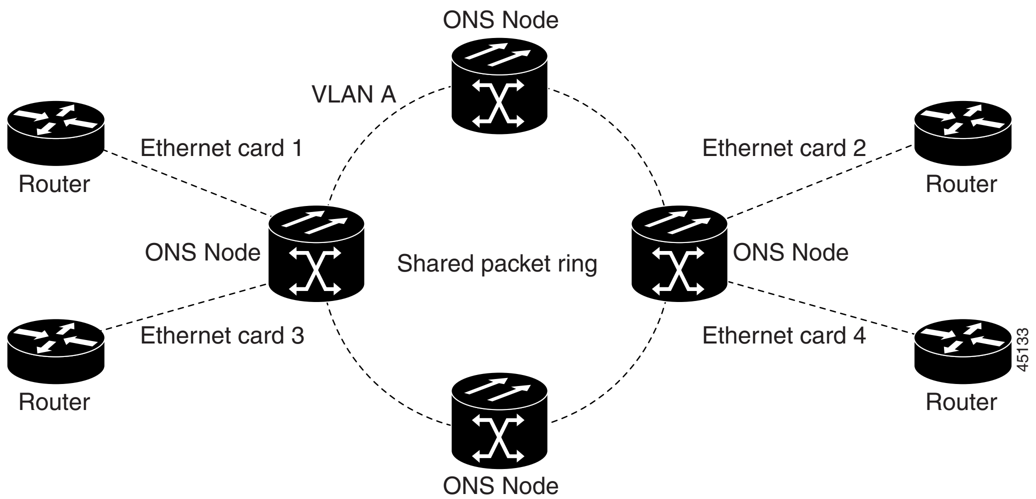
An E-Series card operates in one of three modes: multicard EtherSwitch group, single-card EtherSwitch, or port-mapped mode. E-Series cards in multicard EtherSwitch Group or single-card EtherSwitch mode support Layer 2 features, including virtual local area networks (VLANs), IEEE 802.1Q, STP, and IEEE 802.1D. Port-mapped mode configures the E-Series to operate as a straight mapper card and does not support these Layer 2 features. Within an ONS 15454 containing multiple E-Series cards, each E-Series card can operate in any of the three separate modes. At the Ethernet card view in CTC, click the Provisioning > Ether Card tabs to reveal the card modes.

Note Port-mapped mode eliminates issues inherent in other E-Series modes and is detailed in the field notice, "E-Series Ethernet Line Card Packet Forwarding Limitations."

16.3.1.1 E-Series Multicard EtherSwitch Group

Multicard EtherSwitch Group provisions two or more Ethernet cards to act as a single Layer 2 switch. It supports one STS-6c circuit, two STS-3c circuits, or six STS-1 circuits. Each multicard switch can connect up to a total of STS-6c in SONET circuits. When provisioned as an add or drop node of a shared packet ring circuit, the effective bandwidth doubles, supporting STS-6c in each direction of the ring. Figure 16-9 illustrates a multicard EtherSwitch configuration.

Figure 16-9 Multicard EtherSwitch Configuration

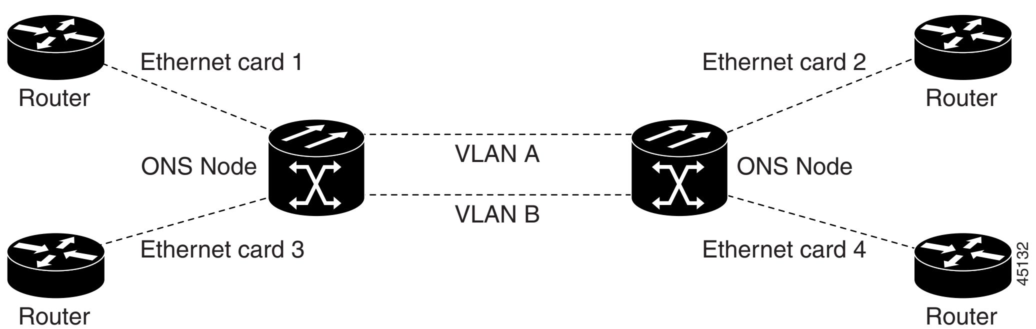


Caution If you terminate two STS-3c multicard EtherSwitch circuits on an Ethernet card and later delete the first circuit, also delete the remaining STS-3c circuit before you provision an STS-1 circuit to the card. If you attempt to create an STS-1 circuit after only deleting the first STS-3c circuit, the STS-1 circuit will not work and no alarms will indicate this condition. To avoid this situation, delete the second STS-3c before creating an STS-1 circuit.

16.3.1.2 E-Series Single-Card EtherSwitch

Single-card EtherSwitch allows each Ethernet card to remain a single switching entity within the ONS 15454 shelf. This option allows STS-12c worth of bandwidth between two Ethernet circuit endpoints. Figure 16-10 illustrates a single-card EtherSwitch configuration.

Figure 16-10 Single-Card EtherSwitch Configuration

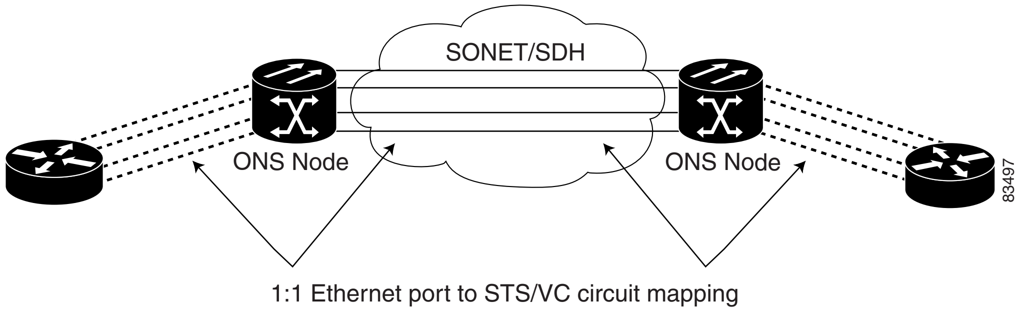


16.3.1.3 Port-Mapped (Linear Mapper)

Port-mapped mode, also referred to as linear mapper, configures the E-Series card to map a specific E-Series Ethernet port to one of the card's specific STS circuits (Figure 16-11). Port-mapped mode ensures that Layer 1 transport has low latency for unicast, multicast, and mixed traffic. Ethernet and Fast

Ethernet on the E100T-G card operate at line-rate speed. Gigabit Ethernet transport is limited to a maximum of 600 Mbps because the E1000-2-G card has a maximum bandwidth of STS-12c. Ethernet frame sizes up to 1522 bytes are also supported, which allow transport of IEEE 802.1Q tagged frames. The larger maximum frame size of Q-in-Q frames (IEEE 802.1Q in IEEE 802.1Q wrapped frames) are not supported.

Figure 16-11 E-Series Mapping Ethernet Ports to SONET STS Circuits



Port-mapped mode disables Layer 2 functions supported by the E-Series in single-card and multicard mode, including STP, VLANs, and MAC address learning. It significantly reduces the service-affecting time for cross-connect and TCC2 card switches.

Port-mapped mode does not support VLANs in the same manner as multicard and single-card mode. The ports of E-Series cards in multicard and single-card mode can join specific VLANs. E-Series cards in port-mapped mode do not have this Layer 2 capability and only transparently transport external VLANs over the mapped connection between ports. An E-Series card in port-mapped mode does not inspect the tag of the transported VLAN, so a VLAN range of 1 through 4096 can be transported in port-mapped mode.

Port-mapped mode does not perform any inspection or validation of the Ethernet frame header. The Ethernet Cyclic Redundancy Check (CRC) is validated, and any frame with an invalid Ethernet CRC is discarded.

Port-mapped mode also allows the creation of STS circuits between any two E-Series cards, including the E100T-G, E1000-G, or the E10/100-4 (the ONS 15327 E-Series card). Port-mapped mode does not allow E-Series cards to connect to the ML-Series or G-Series cards.

16.3.2 E-Series IEEE 802.3z Flow Control

The E100T-G in any mode and the E1000-G in port-mapped mode support IEEE 802.3z symmetrical flow control and propose symmetric flow control when auto-negotiating with attached Ethernet devices. For flow control to operate, both the E-Series port and the attached Ethernet device must be set to auto-negotiation (AUTO) mode. The attached Ethernet device may also need to have flow control enabled. The flow-control mechanism allows the E-Series to respond to pause frames sent from external devices and send pause frames to external devices.

Flow control matches the sending and receiving device throughput to that of the bandwidth of the STS circuit. For example, a router might transmit to the Gigabit Ethernet port on the E-Series in port mapped mode. The data rate transmitted by the router may occasionally exceed 622 Mbps, but the ONS 15454 circuit assigned to the E-Series port in port-mapped mode is a maximum of STS-12c (622.08 Mbps). In this scenario, the ONS 15454 sends out a pause frame and requests that the router delay its transmission for a certain period of time.

> **Note** To enable flow control between an E-Series in port mapped mode and a SmartBits test set, manually set bit 5 of the MII register to 0 on the SmartBits test set. To enable flow control between an E-Series in port mapped mode and an Ixia test set, select Enable the Flow Control in the properties menu of the attached Ixia port.

16.3.3 E-Series VLAN Support

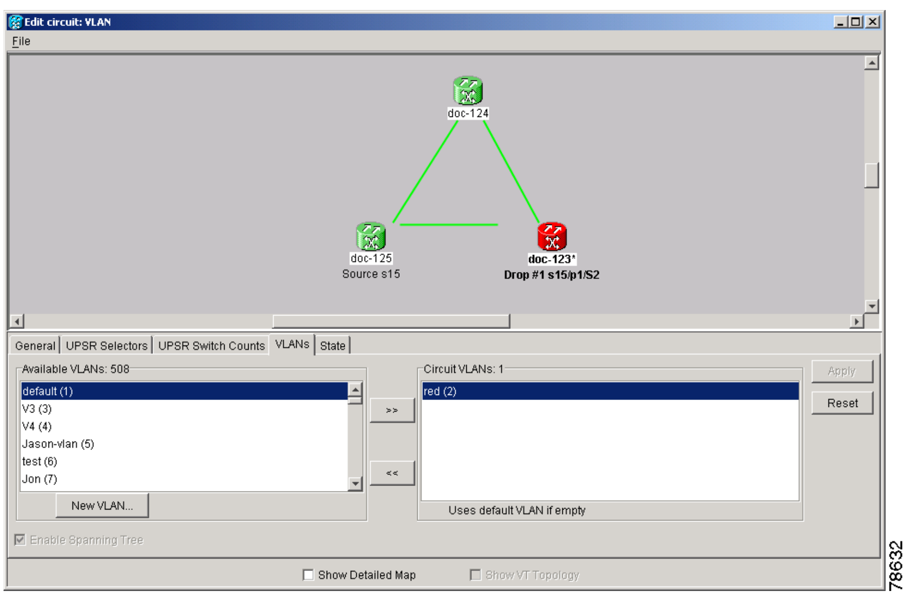
You can provision up to 509 VLANs per network with the CTC software. Specific sets of ports define the broadcast domain for the ONS 15454. The definition of VLAN ports includes all Ethernet and packet-switched SONET port types. All VLAN IP address discovery, flooding, and forwarding is limited to these ports.

The ONS 15454 IEEE 802.1Q-based VLAN mechanism provides logical isolation of subscriber LAN traffic over a common SONET transport infrastructure. Each subscriber has an Ethernet port at each site, and each subscriber is assigned to a VLAN. Although the subscriber's VLAN data flows over shared circuits, the service appears to the subscriber as a private data transport.

> **Note** Port-mapped mode does not support VLANs.

The number of VLANs used by circuits and the total number of VLANs available for use appears in CTC on the VLAN counter (Figure 16-12).

Figure 16-12 Edit Circuit Dialog Featuring Available VLANs



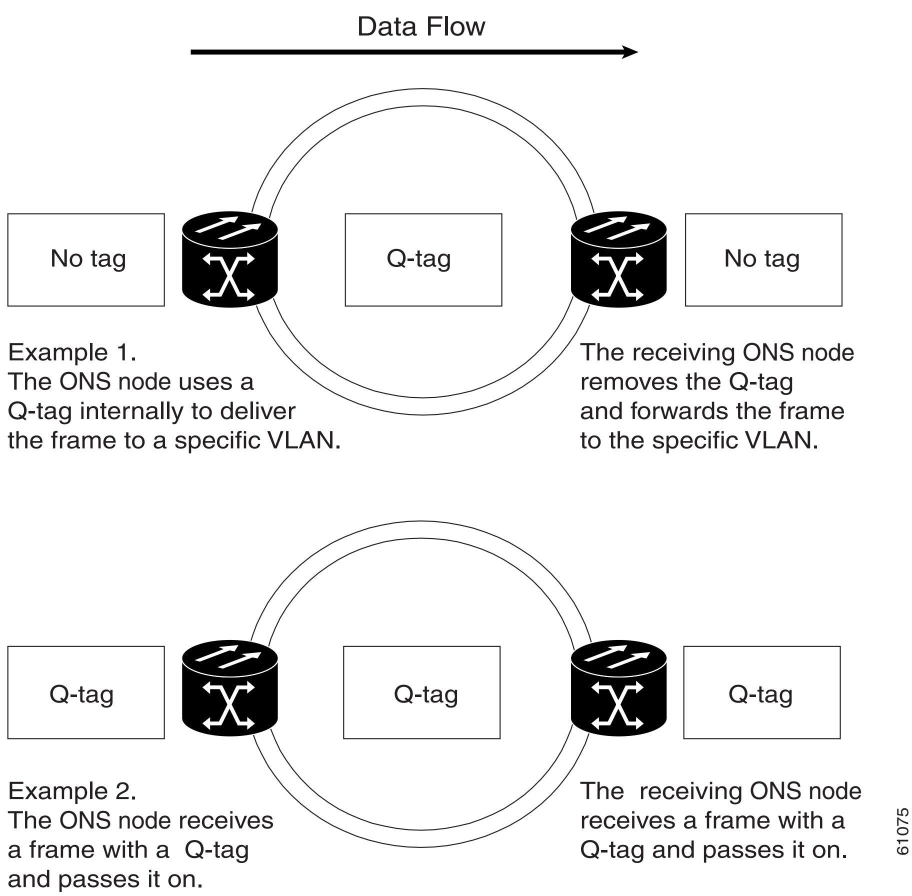
16.3.4 E-Series Q-Tagging (IEEE 802.1Q)

E-Series cards in single-card and multicard mode support IEEE 802.1Q. IEEE 802.1Q allows the same physical port to host multiple 802.1Q VLANs. Each 802.1Q VLAN represents a different logical network. E-Series cards in port-mapped mode transport IEEE 802.1Q tags (Q-tags), but do not remove or add these tags.

The ONS 15454 works with Ethernet devices that support IEEE 802.1Q and those that do not support IEEE 802.1Q. If a device attached to an ONS 15454 Ethernet port does not support IEEE 802.1Q, the ONS 15454 uses Q-tags internally only. The ONS 15454 associates these Q-tags with specific ports.

With Ethernet devices that do not support IEEE 802.1Q, the ONS 15454 takes non-tagged Ethernet frames that enter the ONS network and uses a Q-tag to assign the packet to the VLAN associated with the ONS network's ingress port. The receiving ONS node removes the Q-tag when the frame leaves the ONS network (to prevent older Ethernet equipment from incorrectly identifying the 8021.Q packet as an illegal frame). The ingress and egress ports on the ONS network must be set to Untag for the removal to occur. Untag is the default setting for ONS ports. Example 1 in Figure 16-13 illustrates Q-tag use only within an ONS network.

Figure 16-13 Q-tag Moving Through VLAN



The ONS 15454 uses the Q-tag attached by the external Ethernet devices that support IEEE 802.1Q. Packets enter the ONS network with an existing Q-tag; the ONS 15454 uses this same Q-tag to forward the packet within the ONS network and leaves the Q-tag attached when the packet leaves the ONS network. The entry and egress ports on the ONS network must be set to Tagged for this process to occur. Example 2 in Figure 16-13 on page 16-14 illustrates the handling of packets that both enter and exit the ONS network with a Q-tag.

For more information about setting ports to Tagged and Untag, refer to the *Cisco ONS 15454 Procedure Guide*.

Caution ONS 15454s propagate VLANs whenever a node appears on the network view of another node, regardless of whether the nodes are in the same SONET network or connect through DCC. For example, if two ONS 15454s without DCC connectivity belong to the same login node group, VLANs propagate between the two ONS 15454s. VLAN propagation happens even though the ONS 15454s do not belong to the same SONET ring.

16.3.5 E-Series Priority Queuing (IEEE 802.1Q)

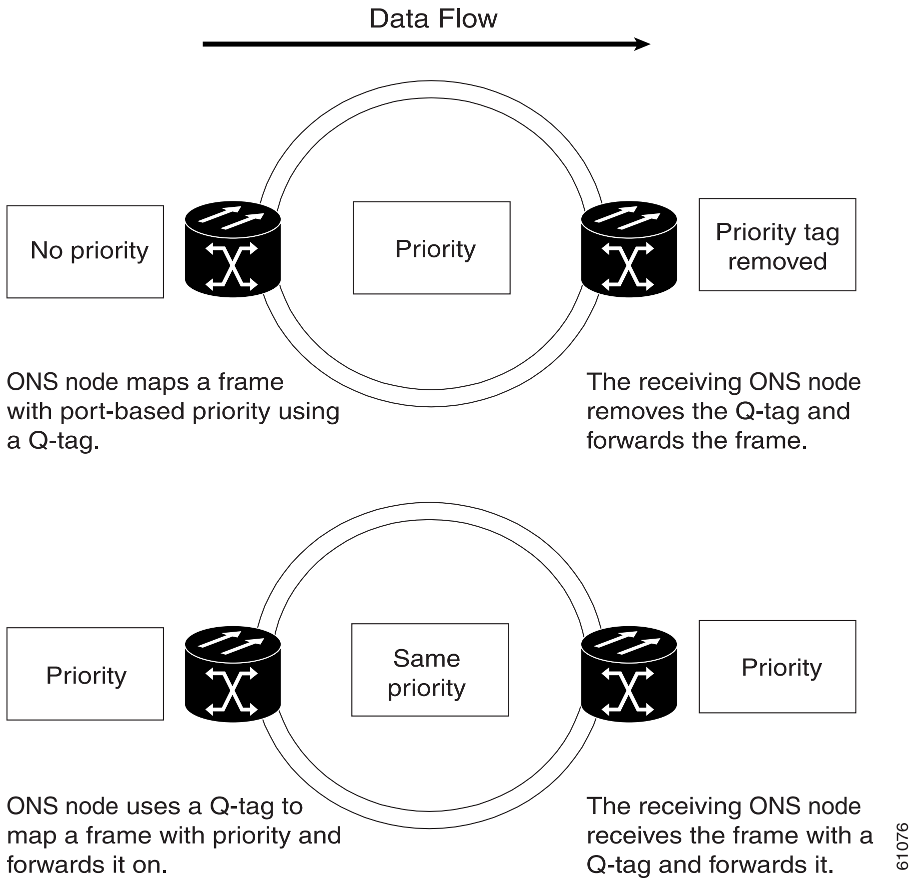
Networks without priority queuing handle all packets on a first-in-first-out basis. Priority queuing reduces the impact of network congestion by mapping Ethernet traffic to different priority levels. The ONS 15454 supports priority queuing. The ONS 15454 maps the eight priorities specified in IEEE 802.1Q to two queues, low priority and high priority (Table 16-1).

Table 16-1 Priority Queuing

User Priority	Queue	Allocated Bandwidth
0,1,2,3	Low	30%
4,5,6,7	High	70%

Q-tags carry priority queuing information through the network (Figure 16-14).

Figure 16-14 Priority Queuing Process



The ONS 15454 uses a "leaky bucket" algorithm to establish a weighted priority. A weighted priority, as opposed to a strict priority, gives high-priority packets greater access to bandwidth, but does not totally preempt low-priority packets. During periods of network congestion, about 70 percent of bandwidth goes to the high-priority queue and the remaining 30 percent goes to the low-priority queue. A network that is too congested will drop packets.

Note IEEE 802.1Q was formerly IEEE 802.1P.

Note E-Series cards in port-mapped mode and G-Series cards do not support priority queing (IEEE 8021.Q).

16.3.6 E-Series Spanning Tree (IEEE 802.1D)

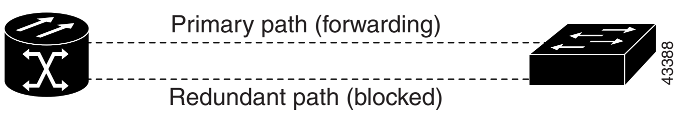
The ONS 15454 operates Spanning Tree Protocol (STP) according to IEEE 802.1D when an Ethernet card is installed. The E-Series card supports common STPs on a per circuit basis up to a total of eight STP instances. It does not support per-VLAN STP. In single-card mode, STP can be disabled or enabled on a per circuit basis during circuit creation. Disabling STP will preserve the number of available STP instances.

STP operates over all packet-switched ports including Ethernet and OC-N ports. On Ethernet ports, STP is enabled by default but can be disabled. A user can also disable or enable STP on a circuit-by-circuit basis on unstitched Ethernet cards in a point-to-point configuration. However, turning off STP protection on a circuit-by-circuit basis means that the ONS 15454 system is not protecting the Ethernet traffic on this circuit, and the Ethernet traffic must be protected by another mechanism in the Ethernet network. On OC-N interface ports, the ONS 15454 activates STP by default, and STP cannot be disabled.

The Ethernet card can enable STP on the Ethernet ports to create redundant paths to the attached Ethernet equipment. STP connects cards so that both equipment and facilities are protected against failure.

STP detects and eliminates network loops. When STP detects multiple paths between any two network hosts, STP blocks ports until only one path exists between any two network hosts (Figure 16-15). The single path eliminates possible bridge loops. This is crucial for shared packet rings, which naturally include a loop.

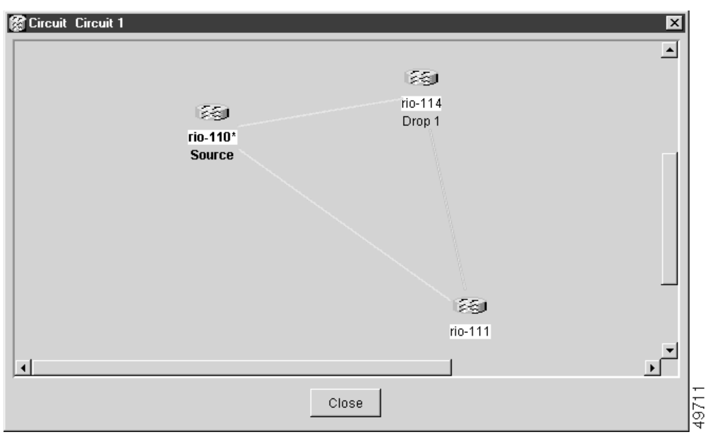
Figure 16-15 STP Blocked Path



To remove loops, STP defines a tree that spans all the switches in an extended network. STP forces certain redundant data paths into a standby (blocked) state. If one network segment in the STP becomes unreachable, the STP algorithm reconfigures the STP topology and reactivates the blocked path to reestablish the link. STP operation is transparent to end stations, which do not discriminate between connections to a single LAN segment or to a switched LAN with multiple segments. The ONS 15454 supports one STP instance per circuit and a maximum of eight STP instances per ONS 15454.

The Circuit window shows forwarding spans and blocked spans on the spanning tree map (Figure 16-16).

Figure 16-16 Spanning Tree Map on Circuit Window



Note Green represents forwarding spans and purple represents blocked (protect) spans. If you have a packet ring configuration, at least one span should be purple.

Caution Multiple circuits with STP protection enabled will incur blocking if the circuits traverse a common card and use the same VLAN.

Note E-Series port-mapped mode does not support STP (IEEE 8021.D).

16.3.6.1 E-Series Multi-Instance Spanning Tree and VLANs

The ONS 15454 can operate multiple instances of STP to support VLANs in a looped topology. You can dedicate separate circuits across the SONET ring for different VLAN groups. Each circuit runs its own STP to maintain VLAN connectivity in a multiring environment.

16.3.6.2 Spanning Tree on a Circuit-by-Circuit Basis

You can also disable or enable STP on a circuit-by-circuit basis on single-card EtherSwitch E-Series cards in a point-to-point configuration. This feature allows customers to mix spanning tree protected circuits with unprotected circuits on the same card. It also allows two single-card EtherSwitch E-Series cards on the same node to form an intranode circuit.

16.3.6.3 E-Series Spanning Tree Parameters

Default STP parameters are appropriate for most situations (Table 16-2). Contact the Cisco Technical Assistance Center (TAC) before you change the default STP parameters. See the "Obtaining Technical Assistance" section on page xliv for information on how to contact TAC.

Table 16-2 Spanning Tree Parameters

Parameter	Description
BridgeID	ONS 15454 unique identifier that transmits the configuration bridge protocol data unit (BPDU); the bridge ID is a combination of the bridge priority and the ONS 15454 MAC address
TopoAge	Amount of time in seconds since the last topology change
TopoChanges	Number of times the STP topology has been changed since the node booted up
DesignatedRoot	Identifies the STP's designated root for a particular STP instance
RootCost	Identifies the total path cost to the designated root
RootPort	Port used to reach the root
MaxAge	Maximum time that received-protocol information is retained before it is discarded
HelloTime	Time interval, in seconds, between the transmission of configuration BPDUs by a bridge that is the spanning tree root or is attempting to become the spanning tree root
HoldTime	Minimum time period, in seconds, that elapses during the transmission of configuration information on a given port
ForwardDelay	Time spent by a port in the listening state and the learning state

16.3.6.4 E-Series Spanning Tree Configuration

To view the spanning tree configuration, at the node view click the Provisioning > Etherbridge > Spanning Trees tabs (Table 16-3).

Table 16-3 Spanning Tree Configuration

Column	Default Value	Value Range
Priority	32768	0–65535
Bridge max age	20 seconds	6–40 seconds
Bridge Hello Time	2 seconds	1–10 seconds
Bridge Forward Delay	15 seconds	4–30 seconds

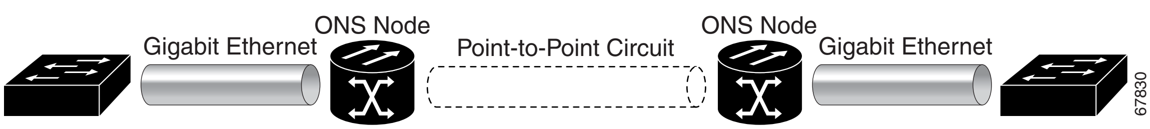
16.4 G-Series Circuit Configurations

This section explains G-Series point-to-point circuits and manual cross-connects. Ethernet manual cross-connects allow you to cross connect individual Ethernet circuits to an STS channel on the ONS 15454 optical interface and to bridge non-ONS SONET network segments.

16.4.1 G-Series Point-to-Point Ethernet Circuits

G-Series cards support point-to-point circuit configurations (Figure 16-17). Provisionable circuit sizes are STS 1, STS 3c, STS 6c, STS 9c, STS 12c, STS 24c, and STS 48c. Each Ethernet port maps to a unique STS circuit on the G-Series card.

Figure 16-17 G-Series Point-to-Point Circuit



The G-Series supports any combination of up to four circuits from the list of valid circuit sizes; however, the circuit sizes can add up to no more than 48 STSs.

Due to hardware constraints, the card imposes an additional restriction on the combinations of circuits that can be dropped onto a G-Series card. These restrictions are transparently enforced by the ONS 15454, and you do not need to keep track of restricted circuit combinations.

When a single STS-24c terminates on a card, the remaining circuits on that card can be another single STS-24c or any combination of circuits of STS-12c size or less that add up to no more than 12 STSs (that is, a total of 36 STSs on the card).

If STS-24c circuits are not being dropped on the card, the full 48 STSs bandwidth can be used with no restrictions (for example, using either a single STS-48c or 4 STS-12c circuits).

Note The STS-24c restriction applies only when a single STS-24c circuit is dropped; therefore, you can easily minimize the impact of this restriction. Group the STS-24c circuits together on a card separate from circuits of other sizes. The grouped circuits can be dropped on other G-Series cards on the ONS 15454.

Note The G-Series uses STS cross-connects only. No VT level cross-connects are used.

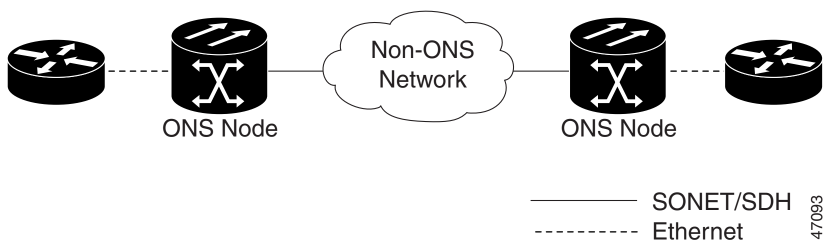
Caution G-Series cards do not connect with E-Series cards.

16.4.2 G-Series Manual Cross-Connects

ONS 15454s require end-to-end CTC visibility between nodes for normal provisioning of Ethernet circuits. When other vendors' equipment sits between ONS 15454s, OSI/TARP-based equipment does not allow tunneling of the ONS 15454 TCP/IP-based DCC. To circumvent inconsistent DCC, the Ethernet circuit must be manually cross connected to an STS channel using the non-ONS network. Manual cross-connects allow an Ethernet circuit to run from ONS node to ONS node while utilizing the non-ONS network (Figure 16-18).

Note In this chapter, "cross-connect" and "circuit" have the following meanings: Cross-connect refers to the connections that occur within a single ONS 15454 to allow a circuit to enter and exit an ONS 15454. Circuit refers to the series of connections from a traffic source (where traffic enters the ONS 15454 network) to the drop or destination (where traffic exits an ONS 15454 network).

Figure 16-18 G-Series Manual Cross-Connects



16.5 E-Series Circuit Configurations

Ethernet circuits can link ONS nodes through point-to-point (straight), shared packet ring, or hub and spoke configurations. Two nodes usually connect with a point-to-point configuration. More than two nodes usually connect with a shared packet ring configuration or a hub-and-spoke configuration. Ethernet manual cross-connects allow you to cross connect individual Ethernet circuits to an STS channel on the ONS 15454 optical interface and also to bridge non-ONS SONET network segments. To configure E-Series circuits, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide.*

16.5.1 E-Series Circuit Protection

Different combinations of E-Series circuit configurations and SONET network topologies offer different levels of E-Series circuit protection. Table 16-4 details the available protection.

Table 16-4 Protection for E-Series Circuit Configurations

Configuration	Path Protection	BLSR	1 + 1
Point-to-Point Multicard EtherSwitch	None	SONET	SONET
Point-to-Point Single-Card EtherSwitch	SONET	SONET	SONET
Point-to-Point Port-mapped Mode	SONET	SONET	SONET
Shared Packet Ring Multicard EtherSwitch	STP	SONET	SONET
Common Control Card Switch	STP	STP	STP

Note Before making Ethernet connections, choose an STS-1, STS-3c, STS-6c, or STS-12c circuit size.

Note To make an STS-12c Ethernet circuit, Ethernet cards must be configured in Single-card EtherSwitch or port-mapped mode. Multicard mode does not support STS-12c Ethernet circuits.

16.5.2 Port-Mapped Mode and Single-Card EtherSwitch Circuit Scenarios

Seven scenarios exist for provisioning circuits on an E-Series card in single-card EtherSwitch or port-mapped mode:

1. STS 12c
2. STS 6c + STS 6c
3. STS 6c + STS 3c + STS 3c
4. STS 6c + 6 STS-1s
5. STS 3c + STS 3c +STS 3c +STS 3c
6. STS 3c +STS 3c + 6 STS-1s
7. 12 STS-1s

Note When configuring Scenarios 3 and 4, the STS 6c must be provisioned before the smaller STS circuits.

16.5.3 ONS 15454 E-Series and ONS 15327 EtherSwitch Circuit Combinations

Table 16-5 shows the Ethernet circuit combinations available in ONS 15454 E-Series cards and ONS 15327 E-Series cards.

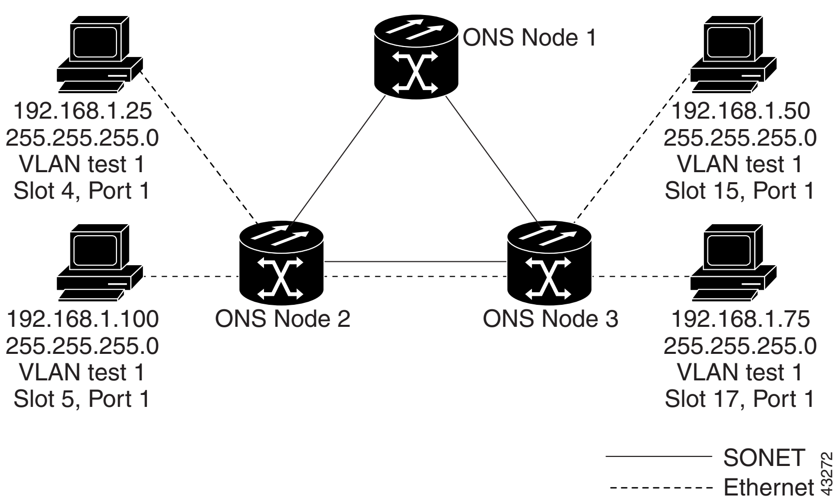
Table 16-5 ONS 15454 and ONS 15327 E-Series Ethernet Circuit Combinations

15327 E-Series Port-Mapped and Single-Card EtherSwitch	15327 E-Series Multicard EtherSwitch	15454 E-Series Port-Mapped and Single-Card EtherSwitch	15454 E-Series Multicard EtherSwitch
Six STS-1s	Three STS-1s	One STS 12c	Six STS-1s
Two STS 3cs	One STS 3c	Two STS 6cs	Two STS 3cs
One STS 6c	—	One STS 6c and two STS 3cs	One STS 6c
One STS 12c	—	One STS 6c and six STS-1s	—
—	—	Four STS 3cs	—
—	—	Two STS 3cs and six STS-1s	—
—	—	Twelve STS-1s	—

16.5.4 E-Series Point-to-Point Ethernet Circuits

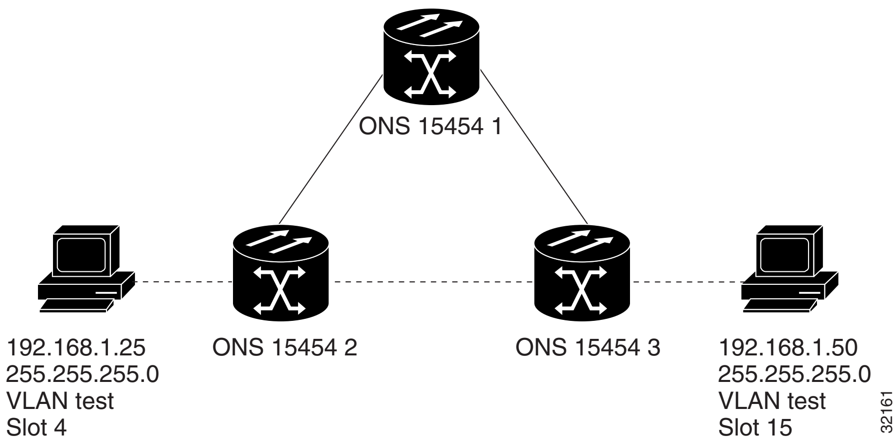
The ONS 15454 can set up a point-to-point (straight) Ethernet circuit as single-card, port-mapped, or multicard circuit. Multicard EtherSwitch limits bandwidth to STS-6c of bandwidth between two Ethernet circuit points, but allows adding nodes and cards and making a shared packet ring (Figure 16-19).

Figure 16-19 Multicard EtherSwitch Point-to-Point Circuit



Single-card EtherSwitch and port-mapped mode provide a full STS-12c of bandwidth between two Ethernet circuit endpoints (Figure 16-20).

Figure 16-20 Single-Card EtherSwitch or Port-Mapped Point-to-Point Circuit

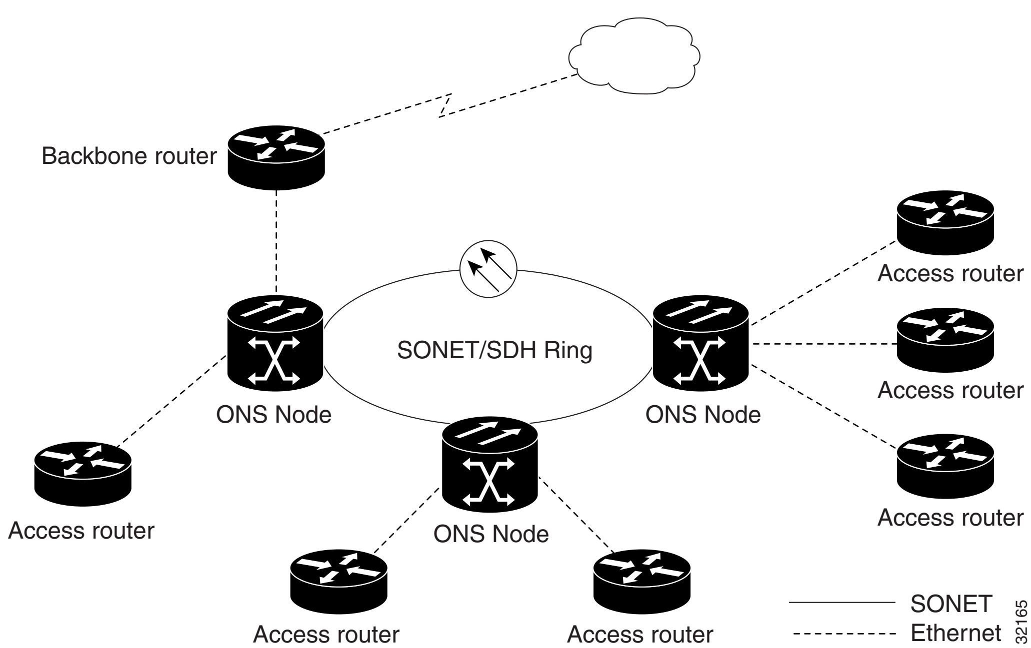


Note A port-mapped, point-to-point circuit does not contain a VLAN.

16.5.5 E-Series Shared Packet Ring Ethernet Circuits

A shared packet ring allows additional nodes, besides the source and destination nodes, access to an Ethernet STS circuit. The E-Series card ports on the additional nodes can share the circuit's VLAN and bandwidth. Figure 16-21 illustrates a shared packet ring. Your network architecture might differ from the example.

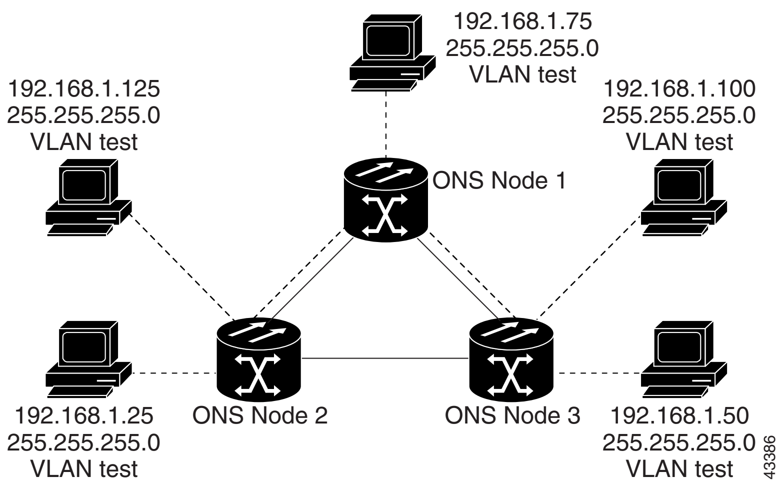
Figure 16-21 Shared Packet Ring Ethernet Circuit



16.5.6 E-Series Hub-and-Spoke Ethernet Circuit Provisioning

The hub-and-spoke configuration connects point-to-point circuits (the spokes) to an aggregation point (the hub). In many cases, the hub links to a high-speed connection and the spokes are Ethernet cards. Figure 16-22 illustrates a hub-and-spoke ring. Your network architecture may differ from the example.

Figure 16-22 Hub-and-Spoke Ethernet Circuit



16.5.7 E-Series Ethernet Manual Cross-Connects

ONS 15454s require end-to-end CTC visibility between nodes for normal provisioning of Ethernet circuits. When other vendors' equipment sits between ONS 15454s, open systems interconnection/TID address resolution protocol (OSI/TARP)-based equipment does not allow tunneling of the ONS 15454 TCP/IP-based DCC. To circumvent this inconsistent DCC, the Ethernet circuit must be manually cross connected to an STS channel using the non-ONS network. The manual cross-connect allows an Ethernet circuit to run from ONS node to ONS node utilizing the non-ONS network.

Note In this chapter, "cross-connect" and "circuit" have the following meanings: cross-connect refers to the connections that occur within a single ONS 15454 to allow a circuit to enter and exit an ONS 15454. Circuit refers to the series of connections from a traffic source (where traffic enters the ONS 15454 network) to the drop or destination (where traffic exits an ONS 15454 network).

16.6 Remote Monitoring Specification Alarm Thresholds

The ONS 15454 features remote monitoring (RMON) that allows network operators to monitor the health of the network with a network management system (NMS).

One of the ONS 15454's RMON MIBs is the Alarm group, which consists of the alarmTable. An NMS uses the alarmTable to find the alarm-causing thresholds for network performance. The thresholds apply to the current 15-minute interval and the current 24-hour interval. RMON monitors several variables, such as Ethernet collisions, and triggers an event when the variable crosses a threshold during that time interval. For example, if a threshold is set at 1000 collisions and 1001 collisions occur during the 15-minute interval, an event triggers. CTC allows you to provision these thresholds for Ethernet statistics.

Table 16-6 define the variables you can provision in CTC. For example, to set the collision threshold, choose etherStatsCollisions from the Variable menu.

Table 16-6 Ethernet Threshold Variables (MIBs)

Variable	Definition
iflnOctets	Total number of octets received on the interface, including framing octets
iflnUcastPkts	Total number of unicast packets delivered to an appropriate protocol
ifInMulticastPkts	Number of multicast frames received error free (not supported by E-Series)
ifInBroadcastPkts	Number of packets, delivered by this sublayer to a higher (sub)layer, which were addressed to a broadcast address at this sublayer (not supported by E-Series)
ifInDiscards	Number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol (not supported by E-Series)
iflnErrors	Number of inbound packets discarded because they contain errors
ifOutOctets	Total number of transmitted octets, including framing packets
ifOutUcastPkts	Total number of unicast packets requested to transmit to a single address
ifOutMulticastPkts	Number of multicast frames transmitted error free (not supported by E-Series)
ifOutBroadcastPkts	Total number of packets that higher-level protocols requested be transmitted, and which were addressed to a broadcast address at this sublayer, including those that were discarded or not sent (not supported by E-Series)
ifOutDiscards	Number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted (not supported by E-Series)
dot3statsAlignmentErrors	Number of frames with an alignment error, that is, the length is not an integral number of octets and the frame cannot pass the Frame Check Sequence (FCS) test
dot3StatsFCSErrors	Number of frames with framecheck errors, that is, there is an integral number of octets, but an incorrect FCS
dot3StatsSingleCollisionFrames	Number of successfully transmitted frames that had exactly one collision
dot3StatsMutlipleCollisionFrame	Number of successfully transmitted frames that had multiple collisions

Table 16-6 Ethernet Threshold Variables (MIBs) (continued)

Variable	Definition
dot3StatsDeferredTransmissions	Number of times the first transmission was delayed because the medium was busy
dot3StatsExcessiveCollision	Number of frames where transmissions failed because of excessive collisions
dot3StatsLateCollision	Number of times that a collision was detected later than 64 octets into the transmission (also added into collision count)
dot3StatsFrameTooLong	Number of received frames that were larger than the maximum size permitted
dot3StatsCarrierSenseErrors	Number of transmission errors on a particular interface that are not otherwise counted (not supported by E-Series)
dot3StatsSQETestErrors	Number of times that the SQE TEST ERROR message is generated by the PLS sublayer for a particular interface (not supported by E-Series)
etherStatsJabbers	Total number of Octets of data (including bad packets) received on the network
etherStatsUndersizePkts	Number of packets received with a length less than 64 octets
etherStatsFragments	Total number of packets that are not an integral number of octets or have a bad FCS, and that are less than 64 octets long
etherStatsOversizePkts	Total number of packets received that were longer than 1518 octets (excluding framing bits, but including FCS octets) and were otherwise well formed
etherStatsOctets	Total number of octets of data (including those in bad packets) received on the network (excluding framing bits but including FCS octets)
etherStatsPkts64Octets	Total number of packets received (including error packets) that were 64 octets in length
etherStatsPkts65to127Octets	Total number of packets received (including error packets) that were 65–172 octets in length
etherStatsPkts128to255Octets	Total number of packets received (including error packets) that were 128–255 octets in length
etherStatsPkts256to511Octets	Total number of packets received (including error packets) that were 256–511 octets in length
etherStatsPkts512to1023Octets	Total number of packets received (including error packets) that were 512–1023 octets in length
etherStatsPkts1024to1518Octets	Total number of packets received (including error packets) that were 1024–1518 octets in length
etherStatsJabbers	Total number of packets longer than 1518 octets that were not an integral number of octets or had a bad FCS
etherStatsCollisions	Best estimate of the total number of collisions on this segment
etherStatsCollisionFrames	Best estimate of the total number of frame collisions on this segment

Table 16-6 Ethernet Threshold Variables (MIBs) (continued)

Variable	Definition
etherStatsCRCAlignErrors	Total number of packets with a length between 64 and 1518 octets, inclusive, that had a bad FCS or were not an integral number of octets in length
receivePauseFrames	Number of received 802.x pause frames (not supported by E-Series)
transmitPauseFrames	Number of transmitted 802.x pause frames (not supported by E-Series)
receivePktsDroppedInternalCongestion	Number of received frames dropped because of frame buffer overflow and other reasons (not supported by E-Series)
transmitPktsDroppedInternalCongestion	Number of frames dropped in the transmit direction because of frame buffer overflow and other reasons (not supported by E-Series)
txTotalPkts	Total number of transmit packets (not supported by E-Series)
rxTotalPkts	Total number of receive packets (not supported by E-Series)

FC_MR-4 Operation

The FC_MR-4 is a 1.0625- or 2.125-Gbps Fibre Channel/Fiber Connectivity (FICON) card that integrates non-SONET framed protocols into a SONET time-division multiplexing (TDM) platform through virtually concatenated payloads. This chapter provides information about the FC_MR-4 card. For installation and step-by-step circuit configuration procedures, refer to the *Cisco ONS 15454 Procedure Guide*.

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

Chapter topics include:

17.1 FC_MR-4 Card Description

Warning **Class 1 (CDRH) and Class 1M (IEC) laser products.**

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.**

Warning **Use of controls, adjustments, or performing procedures other than those specified may result in hazardous radiation exposure.**

Warning **High-performance devices on this card can get hot during operation. To remove the card, hold it by the faceplate and bottom edge. Allow the card to cool before touching any other part of it or before placing it in an antistatic bag.**

Warning **Do not reach into a vacant slot or chassis while you install or remove a module or a fan. Exposed circuitry could constitute an energy hazard.**

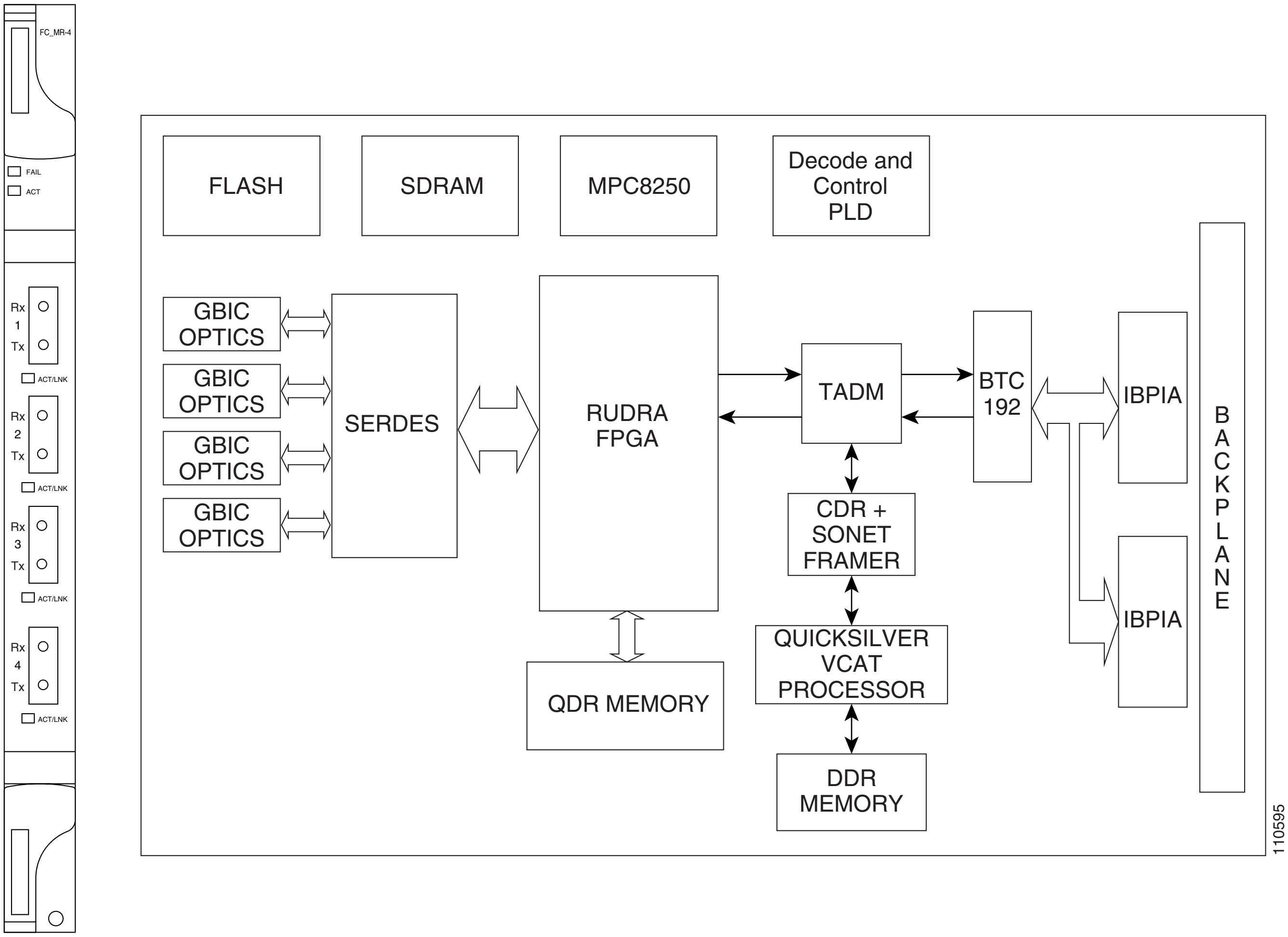
The FC_MR-4 (Fibre Channel 4-port) card uses pluggable Gigabit Interface Converters (GBICs) to transport non-SONET/SDH-framed, block-coded protocols over SONET/SDH in virtually concatenated or contiguously concatenated payloads. The FC_MR-4 can transport Fibre Channel over SONET/SDH using Fibre-Channel client interfaces and allows transport of one of the following at a time:

- Two contiguously concatenated (CCAT) STS-24c/VC4-8c circuits
- One STS-48c/VC4-16c CCAT
- Two virtually concatenated (VCAT) circuits (STC3c-8V/VC4-8v) compliant with ITU-T G.7041 GFP-T and Telcordia GR-253-CORE
- One STS-24c/VC4-8c CCAT and one STS-24c/VC4-8c VCAT

In Software Release 4.6, only two of the four ports can be active at one time.

Figure 17-1 shows the FC_MR-4 faceplate and block diagram.

Figure 17-1 FC_MR-4 Faceplate and Block Diagram



17.1.1 FC_MR-4 Card-Level Indicators

Table 17-1 describes the two card-level LEDs on the FC_MR-4 card.

Table 17-1 FC_MR-4 Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. Replace the card if the red FAIL LED persists.
Green ACT LED	If the ACT LED is green, the card is operational and ready to carry traffic.
Amber ACT LED	If the ACT LED is amber, the card is rebooting.

17.1.2 FC_MR-4 Port-Level Indicators

Each FC_MR-4 port has a corresponding ACT/LNK LED. The ACT/LNK LED is solid green if the port is available to carry traffic, is provisioned as in-service, and in the active mode. The ACT/LNK LED is flashing green if the port is carrying traffic. The ACT/LNK LED is steady amber if the port is not enabled and the link is connected, or if the port is enabled and the link is connected but there is a SONET transport error. The ACT/LNK LED is unlit if there is no link.

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. Refer to the *Cisco ONS 15454 Troubleshooting Guide* for a complete description of the alarm messages.

17.1.3 FC_MR-4 Compatibility

The FC_MR-4 cards can be installed in Slots 5, 6, 12, and 13 when used with XCVT cards. The FC_MR-4 cards can be installed in Slots 1 to 6 and 12 to 17 when used with XC10G cards. The card can be provisioned as part of any valid ONS 15454 network topology, such as path protection (CCAT circuits only), bidirectional line switched ring (BLSR), unprotected, or linear network topologies.

17.1.4 FC_MR-4 Card Specifications

The FC_MR-4 card has the following specifications:

- Environmental
  - Operating temperature

    C-Temp (15454-E100T): –5 to +55 degrees Celsius (23 to 131 degrees Fahrenheit)
  - Operating humidity: 5 to 95%, noncondensing
  - Power consumption: 60 W, 1.35 A, 221.93 BTU/hr
- Dimensions
  - Height: 321.3 mm (12.650 in.)
  - Width: 18.2 mm (0.716 in.)
  - Depth: 228.6 mm (9.000 in.)
  - Card weight: 1.17 kg (2.59 lb)
- Compliance
  - For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information*.

17.2 FC_MR-4 Application

The FC_MR-4 card reliably transports carrier-class, private-line Fibre Channel/FICON transport service. Each FC_MR-4 card can support up to two 1-Gbps circuits or a single 2-Gbps circuit. A 1-Gbps circuit is mapped to an STS-24c/VC4-8c (STS-3c-8v) and 2-Gbps circuits are mapped to an STS-48c/VC4-24c.

The FC_MR-4 card incorporates features optimized for carrier-class applications such as:

- Carrier-class Fibre Channel/FICON
- 50 ms of failover via SONET/SDH protection as specified in Telcordia GR-253CORE
- Hitless software upgrades
- Remote Fibre Channel/FICON circuit bandwidth upgrades via integrated Cisco Transport Controller (CTC)
- Multiple management options through CTC, Cisco Transport Manager (CTM), TL1 (for SONET only), and Simple Network Management Protocol (SNMP)

The FC_MR-4 payloads can be transported over the following protected circuit types, in addition to unprotected circuits:

- Path Protection (CCAT circuits only)
- Path-protected mesh network (PPMN)
- BLSR
- Protection channel access (PCA)

The FC_MR-4 card supports high-order virtual concatenation (VCAT). See the "10.14 Virtual Concatenated Circuits" section on page 10-27.

The FC_MR-4 uses pluggable GBICs for client interfaces and is compatible with the following GBIC types:

- ONS-GX-2FC-SML= (2Gb FC 1310nm Single mode with SC connectors)
- ONS-GX-2FC-MMI= (2Gb FC 850nm Multi mode with SC connectors)

CHAPTER 18

SNMP

This chapter explains Simple Network Management Protocol (SNMP) as implemented by the Cisco ONS 15454.

For SNMP setup information, refer to the *Cisco ONS 15454 Procedure Guide*.

Chapter topics include:

18.1 SNMP Overview

SNMP is an application-layer communication protocol that allows network devices to exchange management information. SNMP enables network administrators to manage network performance, find and solve network problems, and plan network growth.

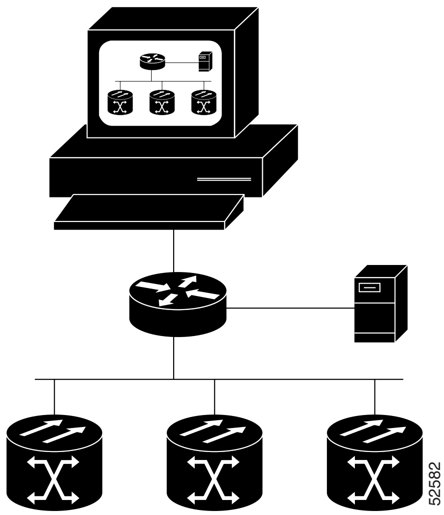
The ONS 15454 uses SNMP to provide asynchronous event notification to a network management system (NMS). ONS SNMP implementation uses standard Internet Engineering Task Force (IETF) management information bases (MIBs) to convey node-level inventory, fault, and performance management information for generic read-only management of DS-1, DS-3, SONET, and Ethernet technologies. SNMP allows limited management of the ONS 15454 by a generic SNMP manager, for example, HP OpenView Network Node Manager (NNM) or Open Systems Interconnection (OSI) NetExpert.

The Cisco ONS 15454 supports SNMP Version 1 (SNMPv1) and SNMP Version 2c (SNMPv2c). Both versions share many features, but SNMPv2c includes additional protocol operations. This chapter describes both versions and explains how to configure SNMP on the ONS 15454.

Note The CERENT-MSDWDM-MIB.mib and CERENT-FC-MIB.mib in the CiscoV2 directory support 64-bit performance monitoring counters. However, the respective SNMPv1 MIB in the CiscoV1 directory does not contain 64-bit performance monitoring counters, but supports the lower and higher word values of the corresponding 64-bit counter. The other MIB files in the CiscoV1 and CiscoV2 directories are identical in content and differ only in format.

Figure 18-1 illustrates a basic network managed by SNMP.

Figure 18-1 Basic Network Managed by SNMP

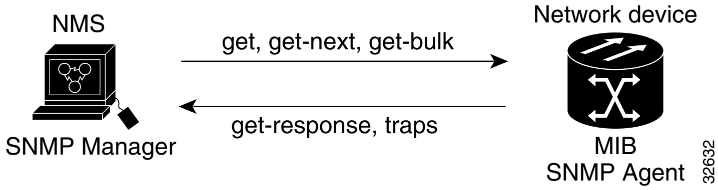


18.2 SNMP Basic Components

An SNMP-managed network consists of three primary components: managed devices, agents, and management systems. A managed device is a network node that contains an SNMP agent and resides on an SNMP-managed network. Managed devices collect and store management information and use SNMP to make this information available to management systems that use SNMP. Managed devices include routers, access servers, switches, bridges, hubs, computer hosts, and network elements such as an ONS 15454.

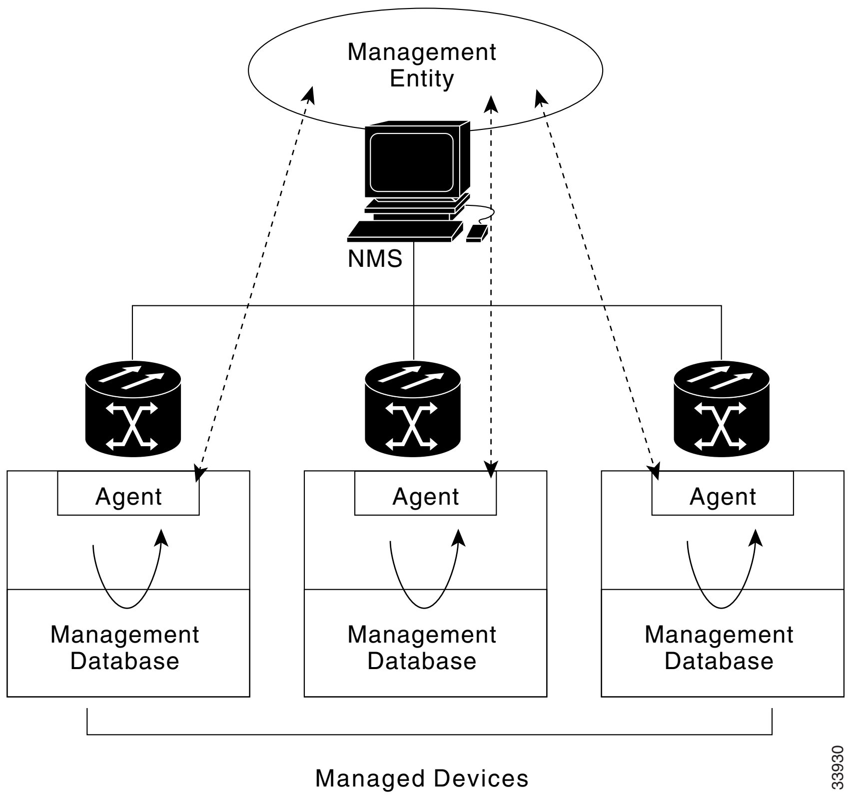
An agent is a software module that resides in a managed device. An agent has local knowledge of management information and translates that information into a form compatible with SNMP. The SNMP agent gathers data from the MIB, which is the repository for device parameter and network data. The agent can also send traps, which are notifications of certain events (such as changes), to the manager. Figure 18-2 on page 18-3 illustrates these SNMP operations.

Figure 18-2 SNMP Agent Gathering Data from a MIB and Sending Traps to the Manager



A management system such as HP OpenView executes applications that monitor and control managed devices. Management systems provide the bulk of the processing and memory resources required for network management. One or more management systems must exist on any managed network. Figure 18-3 illustrates the relationship between the three key SNMP components.

Figure 18-3 Example of the Primary SNMP Components



18.3 SNMP Proxy Support Over Firewalls

Firewalls, often used for isolating security risks inside networks or from outside, have traditionally prevented SNMP and other NMS monitoring and control applications from accessing NEs beyond a firewall.

Release 4.6 enables an application-level proxy at each firewall to transport SNMP protocol data units (PDU) between the NMS and NEs. This proxy, integrated into the firewall NE SNMP agent, exchanges requests and responses between the NMS and NEs and forwards NE autonomous messages to the NMS.

The usefulness of the proxy feature is that network operations centers (NOCs) can fetch performance monitoring data such as remote monitoring (RMON) statistics across the entire network with little provisioning at the NOC and no additional provisioning at the NEs.

The firewall proxy interoperates with common NMS such as HP-OpenView. It is intended to be used with many NEs through a single NE gateway in a gateway network element-end network element (GNE-ENE) topology. Up to 64 SNMP requests (such as get, getnext, or getbulk) are supported at any time behind single or multiple firewalls.

For security reasons, the SNMP proxy feature must be turned on at all receiving and transmitting NEs to be enabled. For instructions to do this, refer to the *Cisco ONS 15454 Procedure Guide*. The feature does not interoperate with earlier ONS 15454 releases.

18.4 SNMP Version Support

The ONS 15454 supports SNMP v1 and SNMPv2c traps and get requests. The SNMP MIBs in the ONS 15454 define alarms, traps, and status. Through SNMP, NMS applications can query a management agent using a supported MIB. The functional entities include Ethernet switches and SONET multiplexers. Refer to the *Cisco ONS 15454 Procedure Guide* for procedures to set up or change SNMP settings.

18.5 SNMP Management Information Bases

A MIB is a hierarchically organized collection of information. It consists of managed objects and is identified by object identifiers. Network-management protocols, such as SNMP, are able to access to MIBs. The ONS 15454 SNMP agent communicates with an SNMP management application using SNMP messages. Table 18-1 describes these messages.

Table 18-1 SNMP Message Types

Operation	Description
get-request	Retrieves a value from a specific variable.
get-next-request	Retrieves the value following the named variable; this operation is often used to retrieve variables from within a table. With this operation, an SNMP manager does not need to know the exact variable name. The SNMP manager searches sequentially to find the needed variable from within the MIB.
get-response	Replies to a get-request, get-next-request, get-bulk-request, or set-request sent by an NMS.
get-bulk-request	Fills the get-response with up to the max-repetition number of get-next interactions, similar to a get-next-request.
set-request	Provides remote network monitoring (RMON) MIB.
trap	Indicates that an event has occurred. An unsolicited message is sent by an SNMP agent to an SNMP manager.

A managed object (sometimes called a MIB object) is one of many specific characteristics of a managed device. Managed objects consist of one or more object instances (variables). Table 18-2 lists the IETF standard MIBs implemented in the ONS 15454 SNMP agent.

Table 18-2 IETF Standard MIBs Implemented in the ONS 15454 and ONS 15327 SNMP Agent

RFC[1] Number	Module Name	Title/Comments
—	IANAifType-MIB.mib	Internet Assigned Numbers Authority (IANA) ifType
1213	RFC1213-MIB-rfc1213.mib,	Management Information Base for Network
1907	SNMPV2-MIB-rfc1907.mib	Management of TCP/IP-based internets: MIB-II Management Information Base for Version 2 of the Simple Network Management Protocol (SNMPv2)
1253	RFC1253-MIB-rfc1253.mib	OSPF Version 2 Management Information Base
1493	BRIDGE-MIB-rfc1493.mib	Definitions of Managed Objects for Bridges (This defines MIB objects for managing MAC bridges based on the IEEE 802.1D-1990 standard between Local Area Network (LAN) segments.)
2819	RMON-MIB-rfc2819.mib	Remote Network Monitoring Management Information Base
2737	ENTITY-MIB-rfc2737.mib	Entity MIB (Version 2)
2233	IF-MIB-rfc2233.mib	Interfaces Group MIB using SMIv2
2358	EtherLike-MIB-rfc2358.mib	Definitions of Managed Objects for the Ethernet-like Interface Types
2493	PerfHist-TC-MIB-rfc2493.mib	Textual Conventions for MIB Modules Using Performance History Based on 15 Minute Intervals
2495	DS1-MIB-rfc2495.mib	Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types
2496	DS3-MIB-rfc2496.mib	Definitions of Managed Object for the DS3/E3 Interface Type
2558	SONET-MIB-rfc2558.mib	Definitions of Managed Objects for the SONET/SDH Interface Type
2674	P-BRIDGE-MIB-rfc2674.mib Q-BRIDGE-MIB-rfc2674.mib	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions

1. RFC = Request for Comment

The ONS 15454 MIBs in Table 18-3 are included on the software CD that ships with the ONS 15454. Compile these MIBs in the order listed in Table 18-2 and then Table 18-3. If you do not follow the order, one or more MIB files might not compile.

Table 18-3 ONS Proprietary MIBs

MIB Number	Module Name
1	CERENT-GLOBAL-REGISTRY.mib
2	CERENT-TC.mib
3	CERENT-454.mib (for ONS 15454 only)
4	CERENT-GENERIC.mib (for ONS 15327 only)

Table 18-3 ONS Proprietary MIBs (continued)

MIB Number	Module Name
5	CISCO-SMI.mib
6	CISCO-VOA-MIB.mib
7	CERENT-MSDWDM-MIB.mib
8	CISCO-OPTICAL-MONITOR-MIB.mib
100	CERENT-FC-MIB.mib

If you cannot compile the ONS 15454 MIBs, call the Cisco Technical Assistance Center (Cisco TAC). Contact information for Cisco TAC is listed in the "About this Manual" section on page -xxxix.

18.6 SNMP Traps

The ONS 15454 can receive SNMP requests from a number of SNMP managers and send traps to 10 trap receivers. The ONS 15454 generates all alarms and events as SNMP traps. The ONS 15454 generates traps containing an object ID that uniquely identifies the alarm. An entity identifier uniquely identifies the entity that generated the alarm (slot, port, synchronous transport signal [STS], Virtual Tributary [VT], bidirectional line switched ring [BLSR], Spanning Tree Protocol [STP], and so on). The traps give the severity of the alarm (critical, major, minor, event, and so on) and indicate whether the alarm is service affecting or non-service affecting. The traps also contain a date/time stamp that shows the date and time the alarm occurred. The ONS 15454 also generates a trap for each alarm when the alarm condition clears. Each SNMP trap contains ten variable bindings, listed in Table 18-4.

Table 18-4 SNMPv2 Trap Variable Bindings

Number	ONS 15454 Name	ONS 15327 Name	Description
1	sysUpTime	sysUpTime	The first variable binding in the variable binding list of an SNMPv2-Trap-PDU.
2	snmpTrapOID	snmpTrapOID	The second variable binding in the variable binding list of an SNMPv2-Trap-PDU.
3	cerent454NodeTime	cerentGenericNodeTime	The time that an event occurred
4	cerent454AlarmState	cerentGenericAlarmState	The alarm severity and service-affecting status. Severities are minor, major, and critical. Service- affecting statuses are service-affecting and non-service affecting.
5	cerent454AlarmObjectType	cerentGenericAlarmObjectType	The entity type that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
6	cerent454AlarmObjectIndex	cerentGenericAlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of the objects in each table; if the alarm is interface related, this is the index of the interfaces in the interface table.

Table 18-4 SNMPv2 Trap Variable Bindings (continued)

Number	ONS 15454 Name	ONS 15327 Name	Description
7	cerent454AlarmSlotNumber	cerentGenericAlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
8	cerent454AlarmPortNumber	cerentGenericAlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
9	cerent454AlarmLineNumber	cerentGenericAlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.
10	cerent454AlarmObjectName	cerentGenericAlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.

The ONS 15454 supports the generic and IETF traps listed in Table 18-5.

Table 18-5 Traps Supported in the ONS 15454

Trap	From RFC No. MIB	Description
coldStart	RFC1907-MIB	Agent up, cold start.
warmStart	RFC1907-MIB	Agent up, warm start.
authenticationFailure	RFC1907-MIB	Community string does not match.
newRoot	RFC1493/ BRIDGE-MIB	Sending agent is the new root of the spanning tree.
topologyChange	RFC1493/ BRIDGE-MIB	A port in a bridge has changed from Learning to Forwarding or Forwarding to Blocking.
entConfigChange	RFC2737/ ENTITY-MIB	The entLastChangeTime value has changed.
dsx1LineStatusChange	RFC2495/ DS1-MIB	A dsx1LineStatusChange trap is sent when the value of an instance of dsx1LineStatus changes. The trap can be used by an NMS to trigger polls. When the line status change results from a higher-level line status change (for example, a DS-3), no traps for the DS-1 are sent.
dsx3LineStatusChange	RFC2496/ DS3-MIB	A dsx3LineStatusLastChange trap is sent when the value of an instance of dsx3LineStatus changes. This trap can be used by an NMS to trigger polls. When the line status change results in a lower-level line status change (for example, a DS-1), no traps for the lower-level are sent.
risingAlarm	RFC2819/ RMON-MIB	The SNMP trap that is generated when an alarm entry crosses the rising threshold and the entry generates an event that is configured for sending SNMP traps.
fallingAlarm	RFC2819/ RMON-MIB	The SNMP trap that is generated when an alarm entry crosses the falling threshold and the entry generates an event that is configured for sending SNMP traps.

18.7 SNMP Community Names

You can provision community names for all SNMP requests from the SNMP Trap Destination dialog box in Cisco Transport Controller (CTC). In effect, SNMP considers any request valid that uses a community name matching a community name on the list of provisioned SNMP trap destinations. Otherwise, SNMP considers the request invalid and drops it.

If an SNMP request contains an invalid community name, the request silently drops and the MIB variable (snmpInBadCommunityNames) increments. All MIB variables managed by the agent grant access to all SNMP requests containing a validated community name.

18.8 SNMP Remote Network Monitoring

The ONS 15454 incorporates RMON to allow network operators to monitor the ONS 15454 Ethernet cards. This feature is not apparent to the typical CTC user, because RMON interoperates with an NMS. However, with CTC you can provision the RMON alarm thresholds. For the procedure, refer to the *Cisco ONS 15454 Procedure Guide*. CTC also monitors the five RMON groups implemented by the ONS 15454.

ONS 15454 RMON implementation is based on the IETF-standard MIB RFC2819. The ONS 15454 implements five groups from the standard MIB: Ethernet Statistics, History Control, Ethernet History, Alarm, and Event.

18.8.1 Ethernet Statistics Group

The Ethernet Statistics group contains the basic statistics for each monitored subnetwork in a single table named etherstats. The group also contains 64-bit statistics in the etherStatsHighCapacityTable.

18.8.2 History Control Group

The History Control group defines sampling functions for one or more monitor interfaces. RFC 2819 defines the historyControlTable.

18.8.3 Ethernet History Group

The ONS 15454 implements the etherHistoryTable as defined in RFC 2819, within the bounds of the historyControlTable. It also implements 64-bit Ethernet history in the etherHistoryHighCapacityTable.

18.8.4 Alarm Group

The Alarm group consists of a single alarm table. This table provides the network performance alarm thresholds for the network management application. With CTC, you can provision the thresholds in the table.

18.8.5 Event Group

The Event group consists of two tables, eventTable and logTable. The eventTable is read-only. The ONS 15454 implements the logTable as specified in RFC 2819.

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