Cisco ONS 15454 DWDM Reference Manual

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• Move the equipment to one side or the other of the television or radio.

• Move the equipment farther away from the television or radio.

• Plug the equipment into an outlet that is on a different circuit from the television or radio. (That is, make certain the equipment and the television or radio are on circuits controlled by different circuit breakers or fuses.)

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Preface

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.

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

This section provides the following information:

- Revision History
- Document Objectives
- Audience
- Document Organization
- Related Documentation
- Document Conventions
- Obtaining Optical Networking Information
- Obtaining Documentation and Submitting a Service Request

Revision History

Date	Notes
September 2007	Added this Revision History table. Incorporated the NEBS Compliance changes in Appendix-A A1.11 System Power section.
October 2007	Added note on mounting brackets in Chapter 1, Install the Shelf and Common Control Cards . Updated the receiver power range of the SFP, ONS-SE-4G-SM, in Hardware Specification appendix. Added a note in Chapter 8 Transponder and Muxponder Cards, section 8.7.4 MXP_2.5G_10E Card.

Date	Notes
November 2007	Added replacement SFPs for the EOL/EOS SFPs in Chapter 8, Transponder and Muxponder Cards and Appendix A, Hardware Specification. Added a note about managing a DWDM Ring through Telcordia OSS in the Multishelf Node Layout section of Chapter 9, Node Reference.
February 2008	Updated trunk rate for TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards in Chapter 8, Transponder and Muxponder Cards. Updated cabling details for ONS-SE-ZE-EL SFP in Chapter 8. Updated the “Computer Requirements for CTC” table in Chapter 12, Cisco Transport Controller Operation. Updated note in Table 8-40 in Chapter 8, Transponder and Muxponder Cards.
April 2008	Corrected applicable slot number for the TXP_MR_10E Card in Section 8.4 TXP_MR_10E Card. Corrected part number from 10-2193-01 to 10-2193-02 in the chapter, Transponder and Muxponder Cards. Updated Table 11-2 for ADM-10G card in Chapter 11, Optical Channel Circuits and Virtual Patchcords Reference. Added a note in chapter 8, Transponder and Muxponder Cards, section ADM-10G Card, Configuration Management.
May 2008	Added power-level LED information for TCC2 and TCC2P cards in Chapter 2, Common Control Cards. Modified Fig 7-34 in section 7.12.2 40-WXC-C Block Diagram in Chapter 7, Reconfigurable Optical Add/Drop Cards. Added autonegotiation support in ADM-10G feature list in Chapter 8, Transponder and Muxponder Cards.
June 2008	Added a note in the Key Features section of MXP_MR_10DME_C and MXP_MR_10DME_L Cards in Chapter 8, Transponder and Muxponder Cards.

Date	Notes
July 2008	Added information about the Force APC Correction button in Chapter 10, Network Reference, section Managing APC. Added operating wavelength range for the following SFPs in the SFP Specifications section of Appendix A, Hardware Specifications: • 15454-SFP3-1-IR= Intermediate Reach • 15454E-SFP-L.1.1= Short Haul • 15454-SFP12-4-IR= Intermediate Reach • 15454E-SFP-L.4.1= Short Haul • 15454-SFP-OC48-IR= Intermediate Reach • ONS-SE-2G-S1= Short Reach • 15454E-SFP-L.16.1= Short Haul • 15454-SFP-GE+-LX=/15454E-SFP-GE+-LX= Long Reach • ONS-SE-G2F-LX • ONS-SE-4G-SM • 15454-SFP-200/15454E-SFP-200 Long Reach • 15454-SFP-GEFC-SX/15454E-SFP-GEFC-S Short Reach • ONS-SE-G2F-SX • ONS-SE-4G-MM Added the following information in the section, GE_XP and 10GE_XP Cards, of chapter, Transponder and Muxponder Cards: • reduced traffic due to 10 ports in full line rate for the 10GE MXP mode. • cannot sustain full traffic with all 20 ports connected to the trunk for 20GE MXP mode. Deleted the note in the ONS 15454 ANSI Power and Ground section in Chapter 1, Shelf Assembly Hardware. Added a note in sections 7.12.1 “40-WXC-C Faceplate Ports” and 9.3.1 “Line Termination Mesh Node” of Chapter 7, Recongifurable Optical Add/Drop Crads and Chapter 9, Node Reference. Reorganized and updated the Optical Sides section in Chapter 9, Node Reference. Updated Table B-8 in Appendix B, Administrative and Service States. Deleted the note in the ONS 15454 ANSI Power and Ground section in Chapter 1, Shelf Assembly Hardware. Added information about troubleshooting the power monitoring levels of the WXC card in section 7.12.3 40-WXC-C Power Monitoring of Chapter 7, Reconfigurable Optical Add/Drop Cards.

Date	Notes
August 2008	Modified the table footnote for Table A-51 in section A-11 XFP Specifications. Modified the cell content for "Table A-18 40-WSS-C Optical Specifications" in section A.7.8 40-WSS-C Card Specifications. Updated link failure behavior of ADM-10G card in Configuration Management section of Chapter 8, Transponder and Muxponder Cards.
September 2008	Added a note in Card Default Settings and Node Default Settings section of Appendix C, Network Element Defaults. Updated the Hub Node and Terminal Node sections in Chapter 9, Node Reference.
October 2008	Added a reference to "CTC Port Numbers and TL1 Aids" section of TL1 Command Guide, in the Power Monitoring sections.
December 2008	• Updated the table "GE_XP and 10GE_XP Card Modes" in the chapter "Transponder and Muxponder Cards". • Added a note in the Client Interface section of Chapter 8, Transponder and Muxponder Cards. • Added new section on DCN Extension in Chapter 16, Management Network Connectivity. • Added a note in the "Y-Cable and Splitter Protection" section of Chapter 8, Transponder and Muxponder Cards.
March 2009	• Added a note in the "SFP Specifications" section of Appendix A, "Hardware specifications". • Added the optical module functional block diagram for the OPT-AMP-C card in the chapter, Optical Amplifier Cards. • Added a note to the section "GE_XP and 10GE_XP Cards" in the chapter, "Transponder and Muxponder Cards". • Updated details of ONS-SE-ZE-EL SFP in Chapter 8, Transponder and Muxponder Cards and Appendix A, Hardware specifications.
April 2009	Added a note in the section "Automatic Power Reduction" of chapter 10, "Network Reference".
July 2009	Updated the minimum output power (with one channel) value in the "A.5 Optical Amplifier Cards" section of Appendix A, Hardware specifications.
August 2009	Added details on how the throughput of the MXP_MR_10DME_C and MXP_MR_10DME_L cards is affected in Chapter 8, Transponder and Muxponder Cards.
September 2009	Added a new section titled "Management of Non-LAN Connected Multishelf Node" in Chapter 15, Management Network Connectivity.

Date	Notes
November 2009	• Updated the section “32WSS Block Diagram” in the chapter “Reconfigurable Optical Add/Drop Cards”. • Added a note in “GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards” section of chapter, Transponder and Muxponder Cards. • Updated the table "2R and 3R Mode and ITU-T G.709 Compliance by Client Interface" in chapter, Transponder and Muxponder Cards. • Updated the table “Card View Tabs and Subtabs” in Chapter, Cisco Transport Controller Operation. • Updated the section “Layer 2 Over DWDM Protection” in the chapter “Transponder and Muxponder Cards”.
February 2010	• Changed the BIEC parameter to BIT-EC in Chapter 17, “Performance Monitoring”. • Updated the SFP/XFP Card Compatibility table for ADM-10G card in chapter Transponder and Muxponder Cards.
March 2010	• Updated the section “Client Interface” under the section “GE_XP and 10GE_XP Cards” in the chapter “Transponder and Muxponder Cards”. • Added the section, “Mesh Patch Panel Specifications” in the appendix, Hardware Specifications. • Updated the table “Multimode Fiber SFP Port Cabling Specifications” in the appendix “Hardware Specifications”.
April 2010	• Updated the section “SNMP Overview” in the chapter “SNMP”. • Created a section “Fan Tray Units for ONS 15454 Cards” in the chapter “Shelf Assembly Hardware”. • Added footnote and note for ONS-SC-2G-28.7 SFP in the chapter “Transponder and Muxponder Cards” and appendix “Hardware Specifications”.
June 2010	• Updated the table “ONS 15454 Security Levels—Node View” in the chapter “Security Reference”.
July 2010	• Updated the section, Y-cable protection in the chapter, Transponder and Muxponder Cards.
August 2010	• Updated the table “Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs and Subtab” in the chapter, “Cisco Transport Controller Operation”.
September 2010	• Added the FAPS switching criteria in the section, “Layer 2 Over DWDM Protection” in the chapter, “Transponder and Muxponder Cards”.

Date	Notes
November 2010	• Updated the section, “SNMP in Multishelf Management” in the chapter, SNMP. • Updated the width of the single slot cards for Control cards and Transponder and Muxponder Cards in the appendix, "Hardware Specifications". • Updated the table “SFP/XFP Card Compatibility” in the chapter “Transponder and Muxponder Cards”. • Updated the tables “SFP Specifications” and “Single-Mode Fiber SFP Port Cabling Specifications” in the appendix, “Hardware Specifications”.
January 2011	• Updated the width of all the cards in the appendix, "Hardware Specifications".
April 2011	• Updated the "Key Features" section for ADM-10G card in the chapter "Transponder and Muxponder Cards". • Updated the power values in the “Individual Card Power Requirements” table in the appendix, “Hardware Specifications”.
May 2011	• Updated the section “SFP and XFP Modules” in the chapter “Transponder and Muxponder Cards”. • Removed the sections “SFP Specifications” and “XFP Specifications” and added the section “SFP and XFP Specifications” in the appendix “Hardware Specifications”.
June 2011	Updated the section “AIC-I Card” in the chapter “Common Control Cards”.
July 2011	• Added a note in the “PC and UNIX Workstation Requirements” section of Chapter, “Cisco Transport Controller Operation”.
September 2011	• Updated the key features section of TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards in the chapter “Transponder and Muxponder Cards”. • Added a note to SONET PM Parameters table in “SONET PM Parameter Definitions” section. • Replaced G.975.1 with G.975.1 I.7 and added a note in the chapter, “Transponder and Muxponder Cards”. • Created a “Summary Pane” section in the chapter, “Cisco Transport Controller Operation”.
October 2011	• Removed the Temperature table and updated the Temperature section with standard operating temperature values and removed the Environmental section from all the 15454 card specifications in the appendix "Hardware Specifications." • Updated the figure “Scenario 3: Using Proxy ARP with Static Routing (ANSI and ETSI)” in the chapter “Management Network Connectivity”.
December 2011	• Updated the power values in the table “Individual Card Power Requirements” in the appendix “Hardware Specifications”. • Updated the section “Termination Modes” in the chapter “Transponder and Muxponder Cards”.

Date	Notes
April 2012	Upadted the section “SNMP in Multishelf Management” in the chapter “SNMP”.
May 2012	Updated the section “Optical Channel Circuits” in the chapter “Optical Channel Circuits and Virtual Patchcords Reference”.
June 2012	Updated the section “Generic Threshold and Performance Monitoring MIBs” in the chapter “SNMP”.
July 2012	Document Part Number revisioned to 78-18343-02 and a full length book-PDF was generated.

Document Objectives

This document provides background and reference material for Cisco ONS 15454 dense wavelength division (DWDM) systems.

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 Assembly Hardware”	Provides a description of Cisco ONS 15454 hardware for the ANSI and ETSI shelf assemblies.
Chapter 2, “Common Control Cards”	Includes descriptions of the TCC2, TCC2P, AIC-I, and MS-ISC-100T cards.
Chapter 3, “Optical Service Channel Cards”	Includes descriptions of OSCM and OSC-CSM cards.
Chapter 4, “Optical Amplifier Cards”	Includes descriptions of the OPT-PRE, OPT-BST, OPT-BST-E, OP-BST-L, OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards, as well as card temperature ranges and card compatibility.
Chapter 5, “Multiplexer and Demultiplexer Cards”	Includes descriptions of the 32-MUX-O, 32DMX-O, and 4MD-xx.x cards.
Chapter 6, “Optical Add/Drop Cards”	Includes descriptions of the AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, and AD-4B-xx.x cards, card temperature ranges, compatibility, and applications.

Table 1 Cisco ONS 15454 Reference Manual Chapters (continued)

Title	Summary
Chapter 7, "Reconfigurable Optical Add/Drop Cards"	Includes descriptions of the 32WSS, 32WSS-L, 32DMX, 32DMX-L, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, 40-WXC-C, and MMUC cards, card temperature ranges, compatibility, and applications.
Chapter 8, "Transponder and Muxponder Cards"	Includes information about ransponder (TXP), muxponder (MXP), GE_XP, 10GE_XP, and ADM-10G cards, as well as their associated plug-in modules (Small Form-factor Pluggables [SFPs or XFPs]).
Chapter 9, "Node Reference"	Explains the DWDM node types t available for the ONS 15454. The DWDM node type is determined by the type of amplifier and filter cards that are installed in an ONS 15454. Also explains the DWDM automatic power control (APC), reconfigurable optical add/drop multiplexing (ROADM) power equalization, span loss verification, and automatic node setup (ANS) functions.
Chapter 10, "Network Reference"	Explains the DWDM network applications and topologies. Also provides network-level optical performance references.
Chapter 11, "Optical Channel Circuits and Virtual Patchcords Reference"	Explains the DWDM optical channel (OCH) circuit types and virtual patchcords that can be provisioned. Circuit types include the OCH client connection (OCHCC), the OCH trail, and the OCH network connection (OCHNC).
Chapter 12, "Cisco Transport Controller Operation"	Describes Cisco Transport Controller (CTC), the software interface for the Cisco ONS 15454.
Chapter 13, "Security Reference"	Provides information about Cisco ONS 15454 users and security.
Chapter 14, "Timing Reference"	Provides information about Cisco ONS 15454 users and node timing.
Chapter 15, "Management Network Connectivity"	Provides an overview of ONS 15454 data communications network (DCN) connectivity. Cisco Optical Networking System (ONS) network communication is based on IP, including communication between Cisco Transport Controller (CTC) computers and ONS 15454 nodes, and communication among networked ONS 15454 nodes. The chapter shows common Cisco ONS 15454 IP network configurations and includes detailed data communications network (DCN) case studies.

Table 1 Cisco ONS 15454 Reference Manual Chapters (continued)

Title	Summary
Chapter 16, "Alarm and TCA Monitoring and Management"	Describes Cisco Transport Controller (CTC) alarm and threshold crossing alert (TCA) monitoring and management.
Chapter 17, "Performance Monitoring"	Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds for, and report performance data for early detection of problems. In this chapter, PM parameters and concepts are defined for transponder, muxponder, and dense wavelength division multiplexing (DWDM) cards in the Cisco ONS 15454 including optical amplifier, multiplexer, demutiplexer, optical add/drop multiplexer (OADM), and optical service channel (OSC) cards.
Chapter 18, "SNMP"	Explains Simple Network Management Protocol (SNMP) as implemented by the Cisco ONS 15454.
Appendix A, "Hardware Specifications"	Contains hardware and software specifications for the ONS 15454 ANSI and ETSI shelf assemblies and cards.
Appendix B, "Administrative and Service States"	Describes the administrative and service states for Cisco ONS 15454 dense wavelength division multiplexing (DWDM) cards, optical payload ports, out-of-band optical service channel (OSC) ports, optical channel network connections (OCHNCs), and transponder/muxponder cards and ports.

Related Documentation

Use the *Cisco ONS 15454 DWDM Reference Manual* in conjunction with the following referenced publications:

- *Cisco ONS 15454 DWDM Procedure Guide, Release 8.5*
- *Cisco ONS 15454 DWDM Troubleshooting Guide, Release 8.5*
- *Cisco ONS SONET TL1 Command Guide, Release 8.5*
- *Cisco ONS SONET TL1 Reference Guide, Release 8.5*
- Cisco *ONS SONET TL1 Command Quick Reference Guide, 8.5*
- *Cisco ONS 15454 SDH TL1 Command Guide, Release 8.5*
- *Cisco ONS 15454 SDH TL1 Reference Guide, Release 8.5*
- Cisco *ONS 15454 SDH TL1 Command Quick Reference Guide, 8.5*
- *Release Notes for Cisco ONS 15454 Release 8.5*
- *Release Notes for Cisco ONS 15454 SDH Release 8.5*
- *Cisco TransportPlanner DWDM Operations Guide, Release 8.5*

For an update on End-of-Life and End-of-Sale notices, refer to http://www.cisco.com/en/US/products/hw/optical/ps2006/prod_eol_notices_list.html.

Document Conventions

This publication uses the following conventions:

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

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. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Waarschuwing **BELANGRIJKE VEILIGHEIDSINSTRUCTIES**

Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van de standaard praktijken om ongelukken te voorkomen. Gebruik het nummer van de verklaring onderaan de waarschuwing als u een vertaling van de waarschuwing die bij het apparaat wordt geleverd, wilt raadplegen.

BEWAAR DEZE INSTRUCTIES

Varoitus **TÄRKEITÄ TURVALLISUUSOHJEITA**

Tämä varoitusmerkki merkitsee vaaraa. Tilanne voi aiheuttaa ruumiillisia vammoja. Ennen kuin käsittelet laitteistoa, huomioi sähköpiirien käsittelemiseen liittyvät riskit ja tutustu onnettomuuksien yleisiin ehkäisytapoihin. Turvallisuusvaroitusten käännökset löytyvät laitteen mukana toimitettujen käännettyjen turvallisuusvaroitusten joukosta varoitusten lopussa näkyvien lausuntonumeroiden avulla.

SÄILYTÄ NÄMÄ OHJEET

Attention **IMPORTANTES INFORMATIONS DE SÉCURITÉ**

Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant entraîner des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers liés aux circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents. Pour prendre connaissance des traductions des avertissements figurant dans les consignes de sécurité traduites qui accompagnent cet appareil, référez-vous au numéro de l'instruction situé à la fin de chaque avertissement.

CONSERVEZ CES INFORMATIONS

Warnung **WICHTIGE SICHERHEITSHINWEISE**

Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu Verletzungen führen kann. Machen Sie sich vor der Arbeit mit Geräten mit den Gefahren elektrischer Schaltungen und den üblichen Verfahren zur Vorbeugung vor Unfällen vertraut. Suchen Sie mit der am Ende jeder Warnung angegebenen Anweisungsnummer nach der jeweiligen Übersetzung in den übersetzten Sicherheitshinweisen, die zusammen mit diesem Gerät ausgeliefert wurden.

BEWAHREN SIE DIESE HINWEISE GUT AUF.

Avvertenza **IMPORTANTI ISTRUZIONI SULLA SICUREZZA**

Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di intervenire su qualsiasi apparecchiatura, occorre essere al corrente dei pericoli relativi ai circuiti elettrici e conoscere le procedure standard per la prevenzione di incidenti. Utilizzare il numero di istruzione presente alla fine di ciascuna avvertenza per individuare le traduzioni delle avvertenze riportate in questo documento.

CONSERVARE QUESTE ISTRUZIONI

Advarsel **VIKTIGE SIKKERHETSINSTRUKSJONER**

Dette advarselssymbolet betyr fare. Du er i en situasjon som kan føre til skade på person. Før du begynner å arbeide med noe av utstyret, må du være oppmerksom på farene forbundet med elektriske kretser, og kjenne til standardprosedyrer for å forhindre ulykker. Bruk nummeret i slutten av hver advarsel for å finne oversettelsen i de oversatte sikkerhetsadvarslene som fulgte med denne enheten.

TA VARE PÅ DISSE INSTRUKSJONENE

Aviso **INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você está em uma situação que poderá ser causadora de lesões corporais. Antes de iniciar a utilização de qualquer equipamento, tenha conhecimento dos perigos envolvidos no manuseio de circuitos elétricos e familiarize-se com as práticas habituais de prevenção de acidentes. Utilize o número da instrução fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham este dispositivo.

GUARDE ESTAS INSTRUÇÕES

¡Advertencia! **INSTRUCCIONES IMPORTANTES DE SEGURIDAD**

Este símbolo de aviso indica peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considere los riesgos de la corriente eléctrica y familiarícese con los procedimientos estándar de prevención de accidentes. Al final de cada advertencia encontrará el número que le ayudará a encontrar el texto traducido en el apartado de traducciones que acompaña a este dispositivo.

GUARDE ESTAS INSTRUCCIONES

Varning! **VIKTIGA SÄKERHETSANVISNINGAR**

Denna varningssignal signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanliga förfaranden för att förebygga olyckor. Använd det nummer som finns i slutet av varje varning för att hitta dess översättning i de översatta säkerhetsvarningar som medföljer denna anordning.

SPARA DESSA ANVISNINGAR

FONTOS BIZTONSÁGI ELOÍRÁSOK

Ez a figyelmezeto jel veszélyre utal. Sérülésveszélyt rejto helyzetben van. Mielott bármely berendezésen munkát végezte, legyen figyelemmel az elektromos áramkörök okozta kockázatokra, és ismerkedjen meg a szokásos balesetvédelmi eljárásokkal. A kiadványban szereplo figyelmeztetések fordítása a készülékhez mellékelt biztonsági figyelmeztetések között található; a fordítás az egyes figyelmeztetések végén látható szám alapján keresheto meg.

ORIZZE MEG EZEKET AZ UTASÍTÁSOKAT!

Предупреждение **ВАЖНЫЕ ИНСТРУКЦИИ ПО СОБЛЮДЕНИЮ ТЕХНИКИ БЕЗОПАСНОСТИ**

Этот символ предупреждения обозначает опасность. То есть имеет место ситуация, в которой следует опасаться телесных повреждений. Перед эксплуатацией оборудования выясните, каким опасностям может подвергаться пользователь при использовании электрических цепей, и ознакомьтесь с правилами техники безопасности для предотвращения возможных несчастных случаев. Воспользуйтесь номером заявления, приведенным в конце каждого предупреждения, чтобы найти его переведенный вариант в переводе предупреждений по безопасности, прилагаемом к данному устройству.

СОХРАНИТЕ ЭТИ ИНСТРУКЦИИ

警告 重要的安全性说明

此警告符号代表危险。您正处于可能受到严重伤害的工作环境中。在您使用设备开始工作之前，必须充分意识到触电的危险，并熟练掌握防止事故发生的标准工作程序。请根据每项警告结尾提供的声明号码来找到此设备的安全性警告说明的翻译文本。

请保存这些安全性说明

警告 安全上の重要な注意事項

「危険」の意味です。人身事故を予防するための注意事項が記述されています。装置の取り扱い作業を行うときは、電気回路の危険性に注意し、一般的な事故防止策に留意してください。警告の各国語版は、各注意事項の番号を基に、装置に付属の「Translated Safety Warnings」を参照してください。

これらの注意事項を保管しておいてください。

주의 중요 안전 지침

이 경고 기호는 위험을 나타냅니다. 작업자가 신체 부상을 일으킬 수 있는 위험한 환경에 있습니다. 장비에 작업을 수행하기 전에 전기 회로와 관련된 위험을 숙지하고 표준 작업 관례를 숙지하여 사고를 방지하십시오. 각 경고의 마지막 부분에 있는 경고문 번호를 참조하여 이 장치와 함께 제공되는 번역된 안전 경고문에서 해당 번역문을 찾으십시오.

이 지시 사항을 보관하십시오.

Aviso **INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você se encontra em uma situação em que há risco de lesões corporais. Antes de trabalhar com qualquer equipamento, esteja ciente dos riscos que envolvem os circuitos elétricos e familiarize-se com as práticas padrão de prevenção de acidentes. Use o número da declaração fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham o dispositivo.

GUARDE ESTAS INSTRUÇÕES

Advarsel **VIGTIGE SIKKERHEDSANVISNINGER**

Dette advarselssymbol betyder fare. Du befinder dig i en situation med risiko for legemesbeskadigelse. Før du begynder arbejde på udstyr, skal du være opmærksom på de involverede risici, der er ved elektriske kredsløb, og du skal sætte dig ind i standardprocedurer til undgåelse af ulykker. Brug erklæringsnummeret efter hver advarsel for at finde oversættelsen i de oversatte advarsler, der fulgte med denne enhed.

GEM DISSE ANVISNINGER

تحذير **إرشادات الأمان الهامة**

يوضح رمز التحذير هذا وجود خطر. وهذا يعني أنك متواجد في مكان قد ينتج عنه التعرض لإصابات. قبل بدء العمل، احذر مخاطر التعرض للصدمات الكهربائية وكن على علم بالإجراءات القياسية للحيلولة دون وقوع أي حوادث. استخدم رقم البيان الموجود في أخر كل تحذير لتحديد مكان ترجمته داخل تحذيرات الأمان المترجمة التي تأتي مع الجهاز.
قم بحفظ هذه الإرشادات

Upozorenje **VAŽNE SIGURNOSNE NAPOMENE**

Ovaj simbol upozorenja predstavlja opasnost. Nalazite se u situaciji koja može prouzročiti tjelesne ozljede. Prije rada s bilo kojim uređajem, morate razumjeti opasnosti vezane uz električne sklopove, te biti upoznati sa standardnim načinima izbjegavanja nesreća. U prevedenim sigurnosnim upozorenjima, priloženima uz uređaj, možete prema broju koji se nalazi uz pojedino upozorenje pronaći i njegov prijevod.

SAČUVAJTE OVE UPUTE

Upozornění **DŮLEŽITÉ BEZPEČNOSTNÍ POKYNY**

Tento upozorňující symbol označuje nebezpečí. Jste v situaci, která by mohla způsobit nebezpečí úrazu. Před prací na jakémkoliv vybavení si uvědomte nebezpečí související s elektrickými obvody a seznamte se se standardními opatřeními pro předcházení úrazům. Podle čísla na konci každého upozornění vyhledejte jeho překlad v přeložených bezpečnostních upozorněních, která jsou přiložena k zařízení.

USCHOVEJTE TYTO POKYNY

Προειδοποίηση

ΣΗΜΑΝΤΙΚΕΣ ΟΔΗΓΙΕΣ ΑΣΦΑΛΕΙΑΣ

Αυτό το προειδοποιητικό σύμβολο σημαίνει κίνδυνο. Βρίσκεστε σε κατάσταση που μπορεί να προκαλέσει τραυματισμό. Πριν εργαστείτε σε οποιοδήποτε εξοπλισμό, να έχετε υπόψη σας τους κινδύνους που σχετίζονται με τα ηλεκτρικά κυκλώματα και να έχετε εξοικειωθεί με τις συνήθεις πρακτικές για την αποφυγή ατυχημάτων. Χρησιμοποιήστε τον αριθμό δήλωσης που παρέχεται στο τέλος κάθε προειδοποίησης, για να εντοπίσετε τη μετάφρασή της στις μεταφρασμένες προειδοποιήσεις ασφαλείας που συνοδεύουν τη συσκευή.

ΦΥΛΑΞΤΕ ΑΥΤΕΣ ΤΙΣ ΟΔΗΓΙΕΣ

אזהרה

הוראות בטיחות חשובות

סימן אזהרה זה מסמל סכנה. אתה נמצא במצב העלול לגרום לפציעה. לפני שתעבוד עם ציוד כלשהו, עליך להיות מודע לסכנות הכרוכות במעגלים חשמליים ולהכיר את הנהלים המקובלים למניעת תאונות. השתמש במספר ההוראה המסופק בסופה של כל אזהרה כד לאתר את התרגום באזהרות הבטיחות המתורגמות שמצורפות להתקן.

שמור הוראות אלה

Opomena

ВАЖНИ БЕЗБЕДНОСНИ НАПАТСТВИЈА

Симболот за предупредување значи опасност. Се наоѓате во ситуација што може да предизвика телесни повреди. Пред да работите со опремата, бидете свесни за ризикот што постои кај електричните кола и треба да ги познавате стандардните постапки за спречување на несреќни случаи. Искористете го бројот на изјавата што се наоѓа на крајот на секое предупредување за да го најдете неговиот период во преведените безбедносни предупредувања што се испорачани со уредот.

ЧУВАЈТЕ ГИ ОВИЕ НАПАТСТВИЈА

Ostrzeżenie

WAŻNE INSTRUKCJE DOTYCZĄCE BEZPIECZEŃSTWA

Ten symbol ostrzeżenia oznacza niebezpieczeństwo. Zachodzi sytuacja, która może powodować obrażenia ciała. Przed przystąpieniem do prac przy urządzeniach należy zapoznać się z zagrożeniami związanymi z układami elektrycznymi oraz ze standardowymi środkami zapobiegania wypadkom. Na końcu każdego ostrzeżenia podano numer, na podstawie którego można odszukać tłumaczenie tego ostrzeżenia w dołączonym do urządzenia dokumencie z tłumaczeniami ostrzeżeń.

NINIEJSZE INSTRUKCJE NALEŻY ZACHOWAĆ

Upozornenie

DÔLEŽITÉ BEZPEČNOSTNÉ POKYNY

Tento varovný symbol označuje nebezpečenstvo. Nachádzate sa v situácii s nebezpečenstvom úrazu. Pred prácou na akomkoľvek vybavení si uvedomte nebezpečenstvo súvisiace s elektrickými obvodmi a oboznámte sa so štandardnými opatreniami na predchádzanie úrazom. Podľa čísla na konci každého upozornenia vyhľadajte jeho preklad v preložených bezpečnostných upozorneniach, ktoré sú priložené k zariadeniu.

USCHOVAJTE SI TENTO NÁVOD

Obtaining Optical Networking Information

This section contains information that is specific to optical networking products. For information that pertains to all of Cisco, refer to the Obtaining Documentation and Submitting a Service Request section.

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 15454 system. It also includes translations of the safety warnings that appear in the ONS 15454 system documentation.

Cisco Optical Networking Product Documentation CD-ROM

Optical networking-related documentation, including Cisco ONS 15xxx 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.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

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CHAPTER 1

Shelf Assembly Hardware

This chapter provides a description of Cisco ONS 15454 hardware for the ANSI and ETSI shelf assemblies. For card descriptions, see Chapter 2, "Common Control Cards," Chapter 3, "Optical Service Channel Cards," Chapter 4, "Optical Amplifier Cards," Chapter 5, "Multiplexer and Demultiplexer Cards," Chapter 6, "Optical Add/Drop Cards," or Chapter 8, "Transponder and Muxponder Cards." To install equipment, refer to the "Install the Shelf and Common Control Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 1.1 Overview, page 1-2
- 1.2 ONS 15454 ANSI Rack Installation, page 1-3
- 1.3 ONS 15454 ETSI Rack Installation, page 1-6
- 1.4 FlexLayer and Y-Cable Protection, page 1-9
- 1.5 Typical DWDM Rack Layouts, page 1-19
- 1.6 Front Door, page 1-21
- 1.7 ONS 15454 ANSI Backplane Covers, page 1-28
- 1.8 ONS 15454 ETSI Front Mount Electrical Connection, page 1-32
- 1.9 ONS 15454 ANSI Alarm Expansion Panel, page 1-32
- 1.10 Ethernet Adapter Panel, page 1-37
- 1.11 Filler Card, page 1-39
- 1.12 Cable Routing and Management, page 1-40
- 1.13 Fan-Tray Assembly, page 1-50
- 1.14 Power and Ground Description, page 1-54
- 1.15 ONS 15454 ANSI Alarm, Timing, LAN, and Craft Pin Connections, page 1-55
- 1.16 Cards and Slots, page 1-59

Note The Cisco ONS 15454 shelf assemblies are intended for use with telecommunications equipment only.

Caution Unused card slots should be filled with a blank faceplate (Cisco P/N 15454-BLANK for ANSI shelves and 15454E-BLANK for ETSI shelves). 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.

1.1 Overview

This section provides an introduction to the Cisco ONS 15454 ANSI and the Cisco ONS 15454 ETSI.

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.

1.1.1 Cisco ONS 15454 ANSI

When installed in an equipment rack, the ONS 15454 ANSI assembly is typically connected to a fuse and alarm panel to provide centralized alarm connection points and distributed power for the ONS 15454 ANSI. 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 ANSI allows access to the shelf assembly, fan-tray assembly, and fiber-storage area. The backplanes provide access to alarm contacts, external interface contacts, power terminals, and BNC/SMB connectors.

You can mount the ONS 15454 ANSI 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 ONS 15454 ETSI is powered using -48 VDC power. Negative and return power terminals are connected via the MIC-A/P and the MIC-C/T/P FMECs. The ground terminal is connected via the 2-hole grounding lug.

Note The ONS 15454 ANSI is designed to comply with Telcordia GR-1089-CORE Type 2 and Type 4. Install and operate the ONS 15454 ANSI 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).

1.1.2 Cisco ONS 15454 ETSI

When installed in an equipment rack, the ONS 15454 ETSI assembly is typically connected to a fuse and alarm panel to provide centralized alarm connection points and distributed power for the ONS 15454 ETSI. 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 ETSI allows

access to the shelf assembly, fan-tray assembly, and fiber-storage area. The FMEC cover at the top of the shelf allows access to power connectors, external alarms and controls, timing input and output, and craft interface terminals.

You can mount the ONS 15454 ETSI in an ETSI rack. The shelf assembly weighs approximately 26 kg (57 pounds) with no cards installed. The shelf assembly includes a front door and a Front Mount Electrical Connection (FMEC) cover for added security, a fan tray module for cooling, and extensive fiber-storage space.

The ONS 15454 ETSI is powered using -48 VDC power. Negative and return power terminals are connected via the MIC-A/P and the MIC-C/T/P FMECs. The ground terminal is connected via the 2-hole grounding lug.

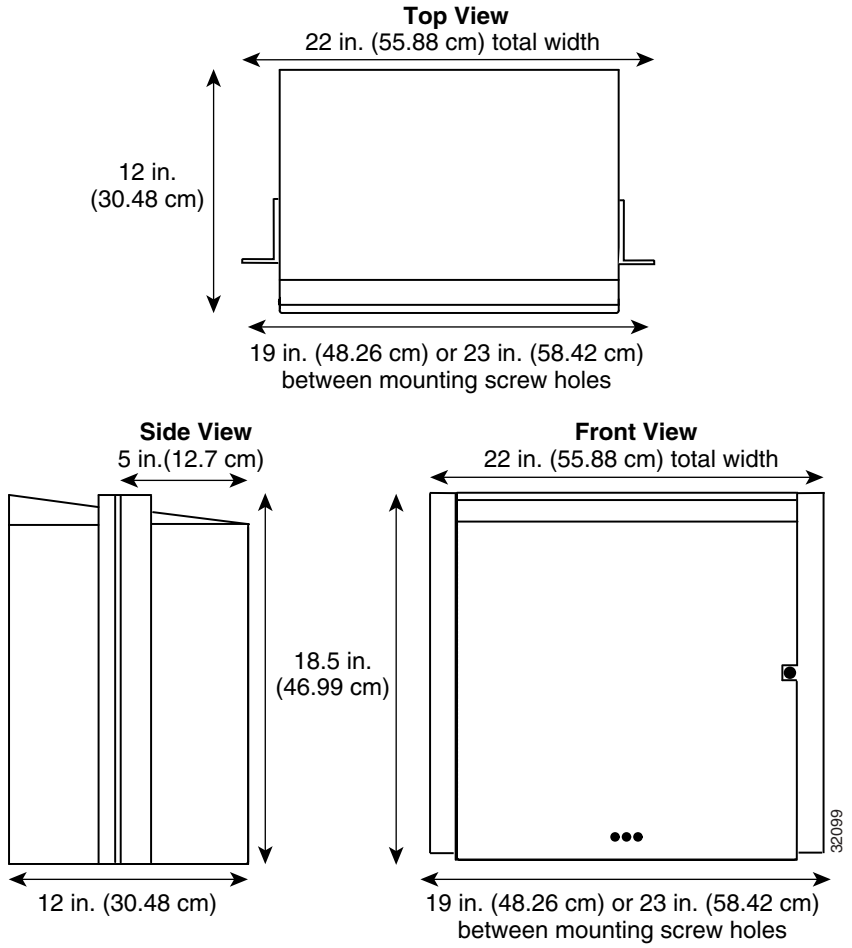
1.2 ONS 15454 ANSI Rack Installation

The ONS 15454 ANSI shelf 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 Electronic Industries Alliance (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 ANSI assembly 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 15454 ANSIs in a seven-foot (2133.6 mm) equipment rack. The ONS 15454 ANSI 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 ANSI 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 ANSI.

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

Figure 1-1 Cisco ONS 15454 ANSI Shelf Dimensions



1.2.1 Reversible Mounting Bracket

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

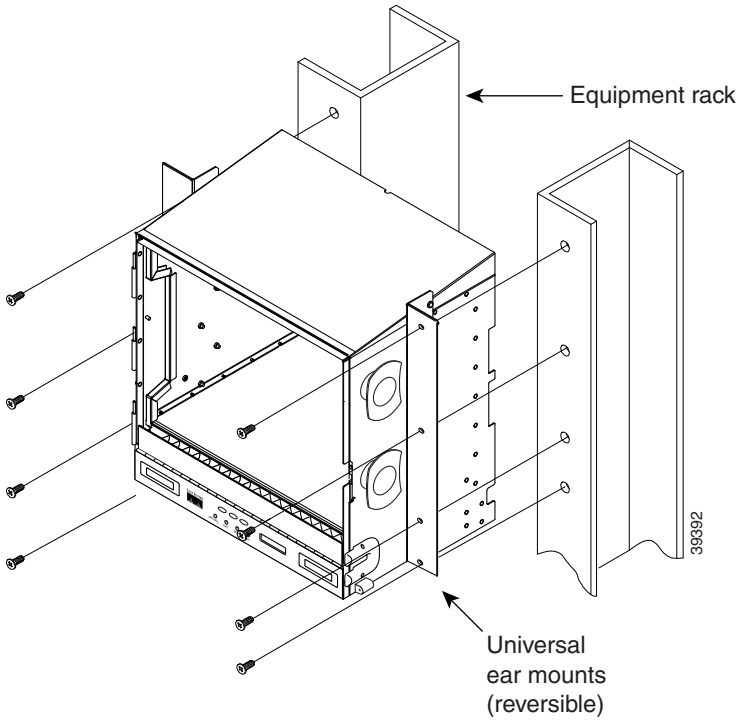
Caution When mounting the ONS 15454 ANSI shelf in a frame with a nonconductive coating (such as paint, lacquer, or enamel) either use the thread-forming screws provided with the ONS 15454 ANSI shipping kit, or remove the coating from the threads to ensure electrical continuity.

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 ANSI shelf 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 ANSI shelf.

Figure 1-2 Mounting an ONS 15454 ANSI Shelf 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.

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-m) racks can hold four ONS 15454 ANSI shelves and a fuse and alarm panel. However, unequal flange racks are limited to three ONS 15454 ANSI shelves and a fuse and alarm panel, or four ONS 15454 ANSI shelves using 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 of using the bottom brackets is that you can replace the filter without removing the fan tray.

1.2.4 ONS 15454 ANSI Bay Assembly

The Cisco ONS 15454 ANSI bay assembly simplifies ordering and installing the ONS 15454 ANSI shelf 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 ANSI shelf assemblies, a prewired fuse and alarm panel, and two fiber-storage trays. The four-shelf configuration includes four ONS 15454 ANSI 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.

1.3 ONS 15454 ETSI Rack Installation

The ONS 15454 ETSI shelf assembly (15454-SA-ETSI) is mounted in a 600 x 600-mm (23-inch) or 600 x 300-mm (11.8-inch) equipment cabinet/rack. The shelf assembly projects 240 mm (9.45 inches) from the front of the rack. It mounts in ETSI-standard racks. The shelf assembly is a total of 435 mm (17.35 inches) 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.

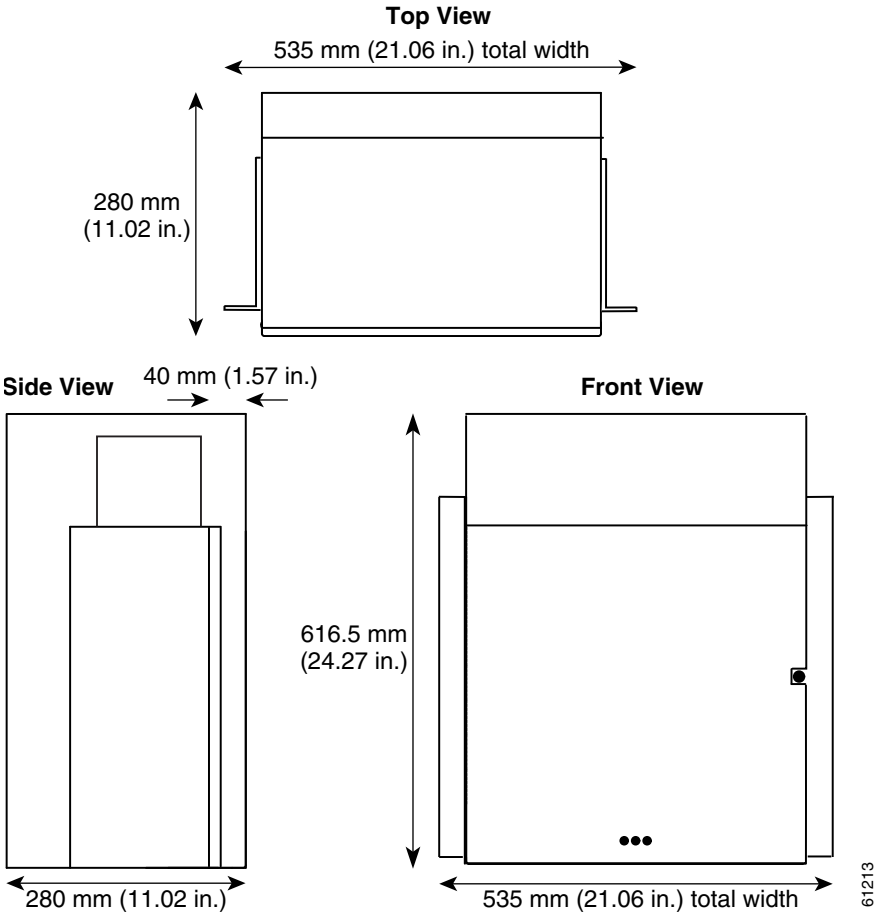
The ONS 15454 ETSI shelf assembly measures 616.5 mm (24.27 inches) high, 535 mm (21.06 inches) wide, and 280 mm (11.02 inches) deep. You can install up to three ONS 15454 ETSI shelves in a seven-foot (2133.6 mm) equipment rack. The ONS 15454 ETSI must have one inch (25.4 mm) of airspace below the installed shelf assembly to allow air flow to the fan intake. If a second ONS 15454 ETSI is installed below the first shelf assembly, an ETSI air ramp unit must be assembled between the two shelves to ensure adequate air flow.

Figure 1-3 provides the dimensions of the ONS 15454 ETSI shelf assembly.

Caution The standard ETSI racks can hold three ONS 15454 ETSI shelf assemblies and two air ramps. When mounting a shelf assembly in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack. If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the unit in the rack.

Caution The ONS 15454 ETSI 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 1-3 ONS 15454 ETSI Shelf Assembly Dimensions

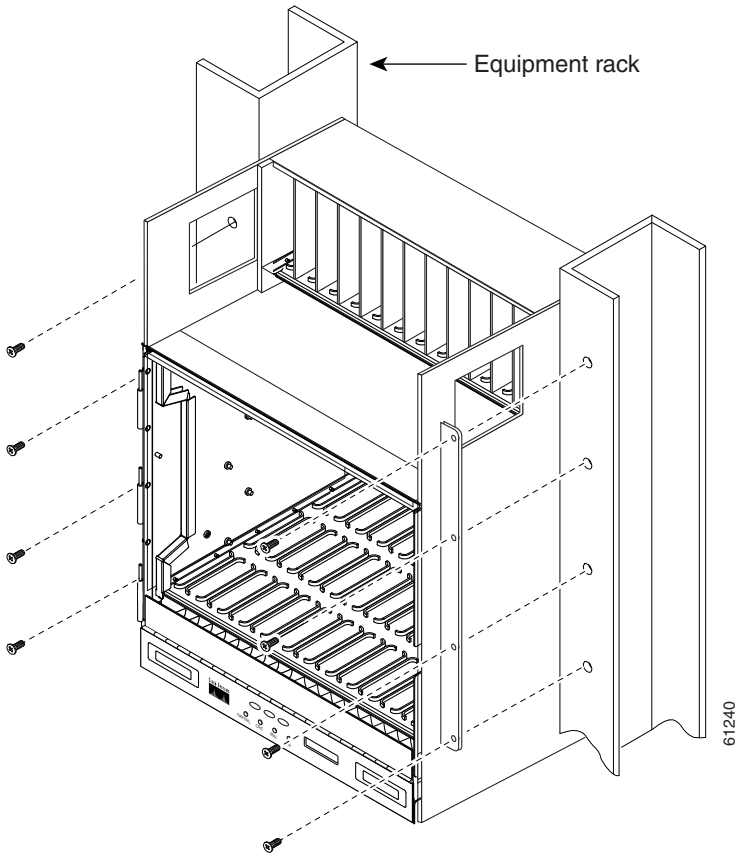


1.3.1 Mounting a Single Node

The ONS 15454 ETSI requires 616.5 mm (24.24 inch) minimum of vertical rack space and 25 mm (1 inch) below the installed shelf assembly to allow air flow to the fan intake. If a second ONS 15454 ETSI is installed above a shelf assembly, the air ramp between the shelves provides space for air flow. To ensure the mounting is secure, use two to four M6 mounting screws for each side of the shelf assembly. A shelf assembly should be mounted at the bottom of the rack if it is the only unit in the rack.

Figure 1-4 shows the rack mounting position for the ONS 15454 ETSI shelf.

Figure 1-4 Mounting an ONS 15454 ETSI Shelf in a Rack

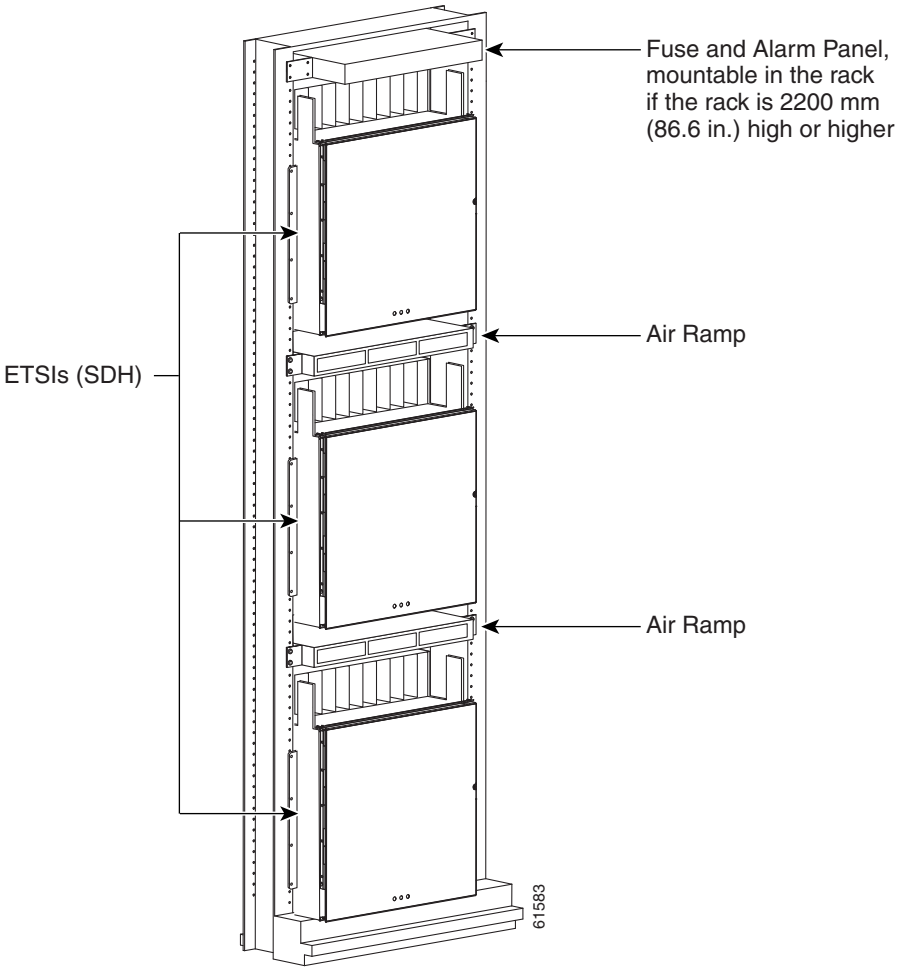


Two people should install the shelf assembly; however, one person can install it using the temporary set screws included. The shelf assembly should be empty for easier lifting. The front door can also be removed to lighten the shelf assembly.

1.3.2 Mounting Multiple Nodes

Most standard (Telcordia GR-63-CORE, 23-inch [584.2 mm]) seven-foot (2,133 mm) racks can hold three ONS 15454 ETSI shelves, two air ramps, and a fuse and alarm panel. Figure 1-5 shows a three-shelf ONS 15454 ETSI bay assembly.

Figure 1-5 Three-Shelf ONS 15454 ETSI Bay Assembly



1.4 FlexLayer and Y-Cable Protection

The Cisco ONS 15454 FlexLayer DWDM system includes the following components:

- Two-channel add or drop flex module
- FlexLayer shelf assembly
- Y-cable FlexLayer module
- Y-cable module tray

The FlexLayer shelf assembly is 1 rack unit (RU) high and can be mounted in a 19-inch (482.6-mm) or 23-inch (584.2-mm) rack (two-way mounting brackets). The FlexLayer shelf assembly is used to house the FlexLayer and Y-cable modules.

1.4.1 FlexLayer Modules

The two-channel add/drop FlexLayer module is a completely passive unidirectional component that allows the insertion or the extraction of two channels within the ONS 15454 channel plan. This module is used only in point-to-point, one-channel, amplified system configurations.

Sixteen specific modules are available to cover the whole 32-channel bandwidth. Table 1-1 shows how the FlexLayer add/drop modules are grouped in relation to the supported channels.

Table 1-1 ONS 15454 100-GHz Channel Plan

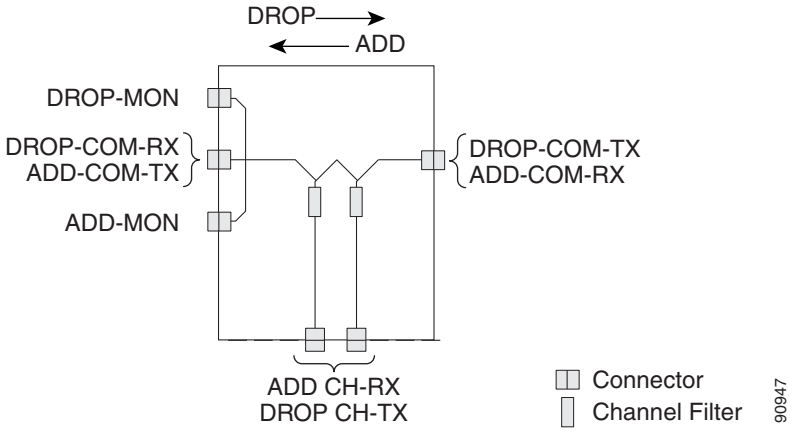
ITU	Channel ID	Frequency (THz)	Wavelength (nm)	Two-Channel A/D Flex Module
59	30.3	195.9	1530.33	15216-FLB-2-31.1=
58	31.1	195.8	1531.12	
57	31.9	195.7	1531.90	15216-FLB-2-32.6=
56	32.6	195.6	1532.68	
54	34.2	195.4	1534.25	15216-FLB-2-35.0=
53	35.0	195.3	1535.04	
52	35.8	195.2	1535.82	15216-FLB-2-36.6=
51	36.6	195.1	1536.61	
49	38.1	194.9	1538.19	15216-FLB-2-38.9=
48	38.9	194.8	1538.98	
47	39.7	194.7	1539.77	15216-FLB-2-40.5=
46	40.5	194.6	1540.56	
44	42.1	194.4	1542.14	15216-FLB-2-42.9=
43	42.9	194.3	1542.94	
42	43.7	194.2	1543.73	15216-FLB-2-44.5=
41	44.5	194.1	1544.53	
39	46.1	193.9	1546.12	15216-FLB-2-46.9=
38	46.9	193.8	1546.92	
37	47.7	193.7	1547.72	15216-FLB-2-48.5=
36	48.5	193.6	1548.51	
34	50.1	193.4	1550.12	15216-FLB-2-50.9=
33	50.9	193.3	1550.92	
32	51.7	193.2	1551.72	15216-FLB-2-52.5=
31	52.5	193.1	1552.52	
29	54.1	192.9	1554.13	15216-FLB-2-54.9=
28	54.9	192.8	1554.94	
27	55.7	192.7	1555.75	15216-FLB-2-56.5=
26	56.5	192.6	1556.55	

Table 1-1 ONS 15454 100-GHz Channel Plan (continued)

ITU	Channel ID	Frequency (THz)	Wavelength (nm)	Two-Channel A/D Flex Module
24	58.1	192.4	1558.17	15216-FLB-2-58.9=
23	58.9	192.3	1558.98	
22	59.7	192.2	1559.79	15216-FLB-2-60.6=
21	60.6	192.1	1560.61	

Figure 1-6 shows the module functional block diagram. In Figure 1-6, the signal flows from left to right when the card is used as a drop component and from right to left when the module is used as an add component.

Figure 1-6 Two-Channel Add/Drop FlexLayer Module Block Diagram

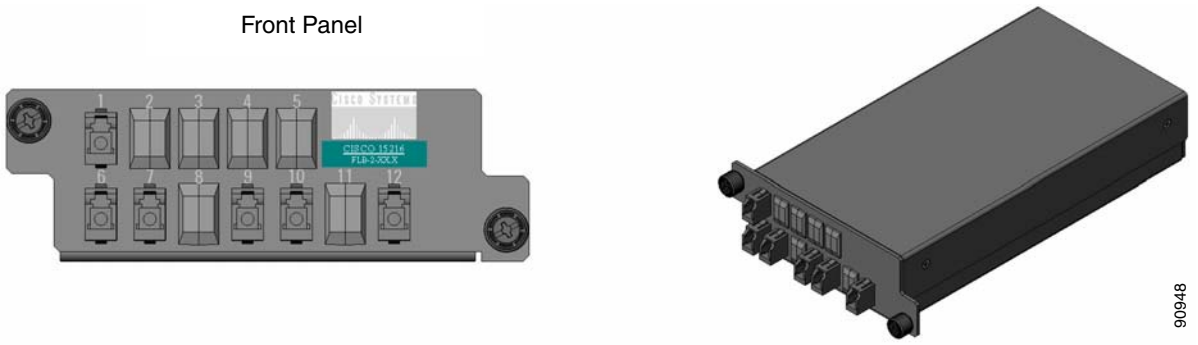


When the module is used as a drop component, the wave-division multiplexing (WDM) composite signal coming from the DROP-COM-RX port is filtered sequentially by two filters and the filtered channels are dropped at the two DROP-CH-TX ports. The rest of the WDM composite signal is sent to the DROP-COM-TX port. A two-percent tap coupler, DROP-MON, is used to monitor the input WDM composite signal.

When the module is used as an add component, the added channels coming from the two ADD-CH-RX ports are combined with the WDM composite signal coming from the ADD-COM-RX port. The multiplexed WDM composite signal is sent to the ADD-COM-TX port. A two-percent tap coupler, ADD-MON, is used to monitor the multiplexed WDM composite signal.

Figure 1-7 shows the physical appearance of the ONS 15454 two-channel add/drop FlexLayer module.

Figure 1-7 ONS 15454 Two-Channel Optical Add/Drop FlexLayer Module



Labels are provided to show how the module ports are mapped. It is the end user's responsibility to label the module for its intended use (drop or add component).

Figure 1-8 shows how the connectors are mapped and labeled on the front panel when the component is used as a drop component. The COM-RX is mapped to Port 1, the COM-TX is mapped to Port 12, and the two dropped channel TX ports are mapped to Ports 9 and 10. The two-percent tap MON port is mapped to Port 6. Port 7 is not active.

Figure 1-8 Two-Channel Drop Component Connector Mapping and Labeling

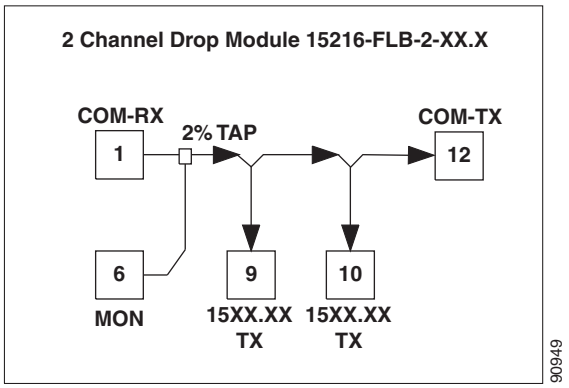
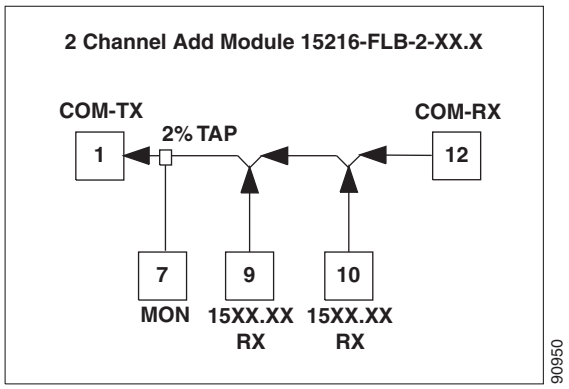


Figure 1-9 shows how the connectors are mapped and labeled in the front panel when the component is used as an add component. The COM-TX is mapped to Port 1, the COM-RX is mapped to Port 12, and the added channels are mapped to the two RX Ports 9 and 10. The two-percent tap MON port is mapped to Port 7. Port 6 is not active.

Figure 1-9 Two-Channel Add Component Connector Mapping and Labeling



1.4.2 Single Y-Cable Protection Module

The Y-cable protection module is a bidirectional module. It is equipped with two passive star couplers: one that is used as a splitter and one that is used as a coupler.

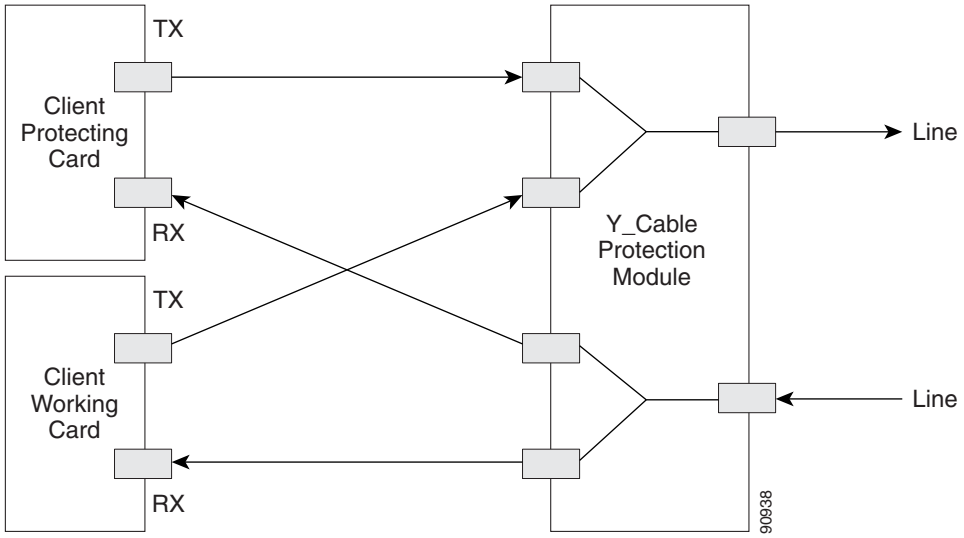
Note None of the modules in this equipment release can be used for video on demand (VoD) applications.

Note The ADM-10G card, which can be provisioned as either a transponder or muxponder, does not support Y-cable protection.

The purpose of this module is to provide Y-cable protection on the CLIENT side of transponder (TXP) cards such as the TXP_MR_10G, TXP_MR_10E, or TXP_MR_2.5G (Figure 1-10). There are two versions of this module, one for multimode applications (CS-MM-Y) and one for single-mode applications (CS-SM-Y).

Using one Y-cable protection module, you can protect one client signal with two TXP cards, and two client signals with four TXP cards.

Figure 1-10 Typical Y-Cable Protection Module Configuration



When the module is used in the coupler direction, the individual signals enter the module from the CPL-RX*n* ports and pass through a passive star coupler to the CPL-TX port. The coupler is not meant to combine both the protect and working client card signals. The module allows a path for the working client transmit interface to connect to the network in the event the opposite interface in the protection pair should fail (the protect interface switches to the working interface).

When the module is used in the splitter direction, the signal enters the module from the SPL-RX port and is split through a passive star coupler to the SPL-TX*n* ports. This module, although designed to pass wavelengths associated with the ONS 15454 32-channel plan, is not selective to specific wavelengths (modules do not filter wavelengths).

Figure 1-11 shows the block diagram of the Y-cable protection module.

Figure 1-11 1:2 Splitter and 2:1 Coupler (Y-Cable Protection) Module Block Diagram

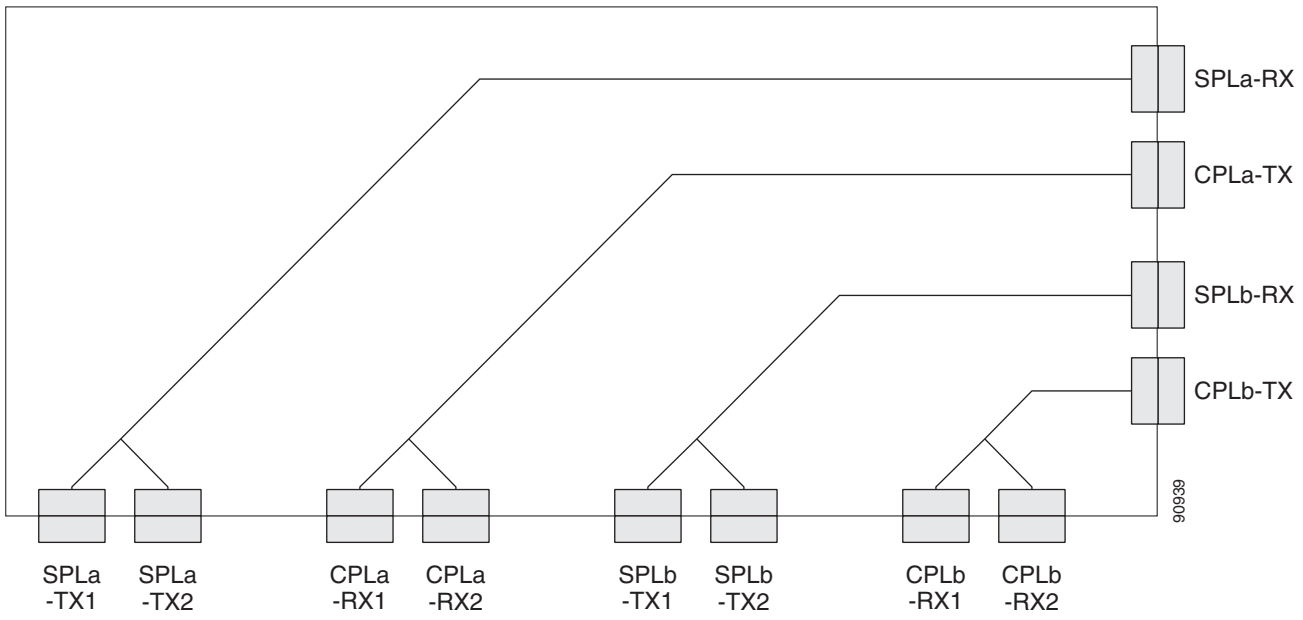


Figure 1-12 and Figure 1-13 show the physical appearance of the ONS 15454 Y-Cable Protection FlexLayer Module. This module has two versions, one for single-mode applications and the other for multimode applications.

Figure 1-12 ONS 15454 Y-Cable Protection FlexLayer Module (Single-Mode)

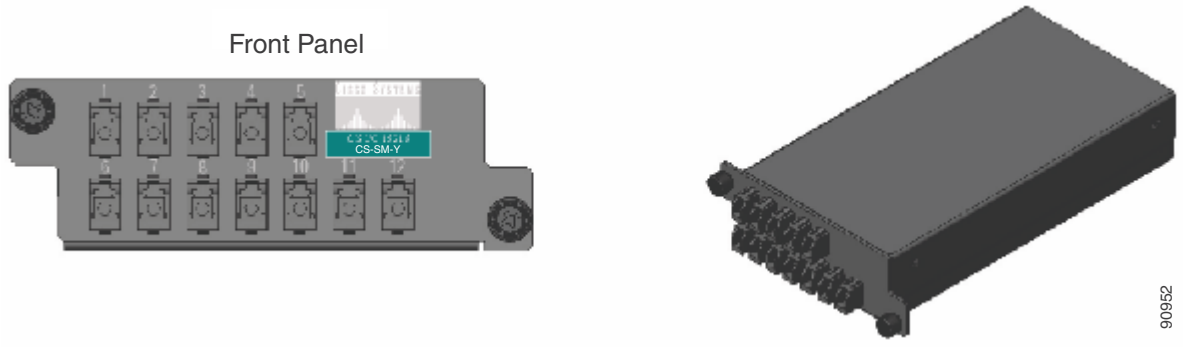


Figure 1-13 ONS 15454 Y-Cable Protection FlexLayer Module (Multimode)

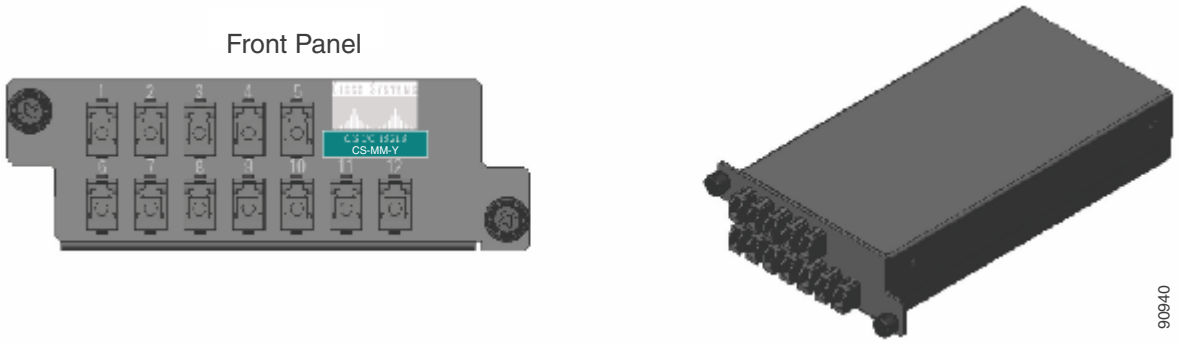


Figure 1-14 shows how the module front panel ports are mapped and labeled. The multimode module is mapped and labeled the same as the single-mode module.

Figure 1-14 Y-Cable Protection Component Connector Mapping and Labeling

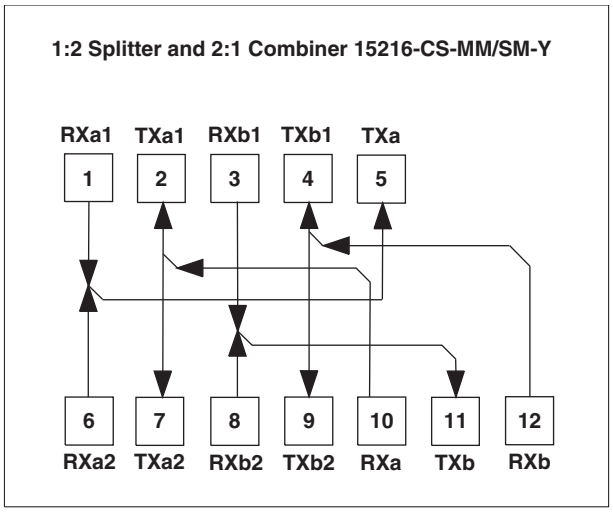


Table 1-2 details the single-mode and multimode front panel Protection A mapping. It shows how two DWDM receive inputs (client working and protect) provide one output signal to the customer client equipment, using the module combiner function.

Table 1-2 Protection A (TXP Cards 1 and 2) Port Mapping: Combiner from DWDM

Receive Port on the Y-Cable Module	Signal Sources
1 (RXa1)	Client TX port on the TXP 1 card
6 (RXa2)	Client TX port on the TXP 2 card
Transmit Port on the Y-Cable Module	**Signal Destination**
5 (TXa)	RX port on customer client equipment A

Table 1-3 details the single-mode and multimode front panel Protection A mapping. It shows how the module splits a single receive input from the equipment into two DWDM output signals (working and protect) to the TXP client port.

Table 1-3 Protection A (TXP Cards 1 and 2) Port Mapping: Splitter to DWDM

Receive Port	Signal Source
10 (RXa)	TX port on customer client equipment A
Transmit Port	**Signal Destinations**
2 (TXa1)	Client RX port on the TXP 1 card
7 (TXa2)	Client RX on the TXP 2 card

Table 1-4 details the single-mode and multimode front panel Protection B mapping. It shows how two DWDM receive inputs (client working and protect) provide one output signal to the equipment, using the module combiner function.

Table 1-4 Protection B (TXP Cards 3 and 4) Port Mapping: Combiner from DWDM

Receive Port	Signal Sources
3 (RXb1)	Client TX port on the TXP 3 card
8 (RXb2)	Client TX port on the TXP 4 card
Transmit Port	**Signal Destination**
11 (TXb)	RX port on customer client equipment B

Table 1-5 details the single-mode and multimode front panel Protection B mapping. It shows how the module splits a single receive input from the equipment into two DWDM output signals (working and protect) to the client.

Table 1-5 Protection B (TXP Cards 3 and 4) Port Mapping: Splitter to DWDM

Receive Port Number	Signal Source
12 (RXb)	TX port on customer client equipment B
Transmit Port Number	**Signal Destinations**
4 (TXb1)	Client RX on the TXP 3 port
9 (TXb2)	Client RX on the TXP 4 port

The following muxponder (MXP) and transponder (TXP) cards can use Y-cable protection:

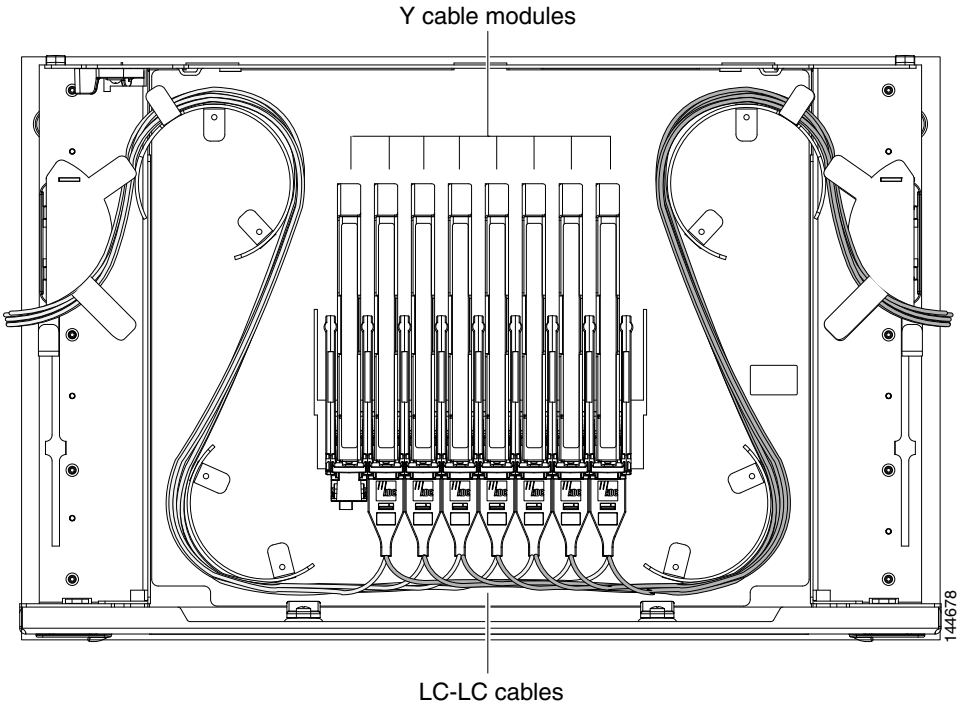
- MXP_2.5_10G
- MXP_2.5_10E
- MXP_MR_2.5G
- TXP_MR_10G
- TXP_MR_10E
- TXP_MR_2.5G
- MXP_MR_10DME_C
- MXP_MR_10DME_L

Note The MXP_MR_10DME_C card is labeled 10DME-C on the card faceplate. The MXP_MR_10DME_L card is labeled 10DME-L on the card faceplate.

1.4.3 Multiple Y-Cable Module Tray

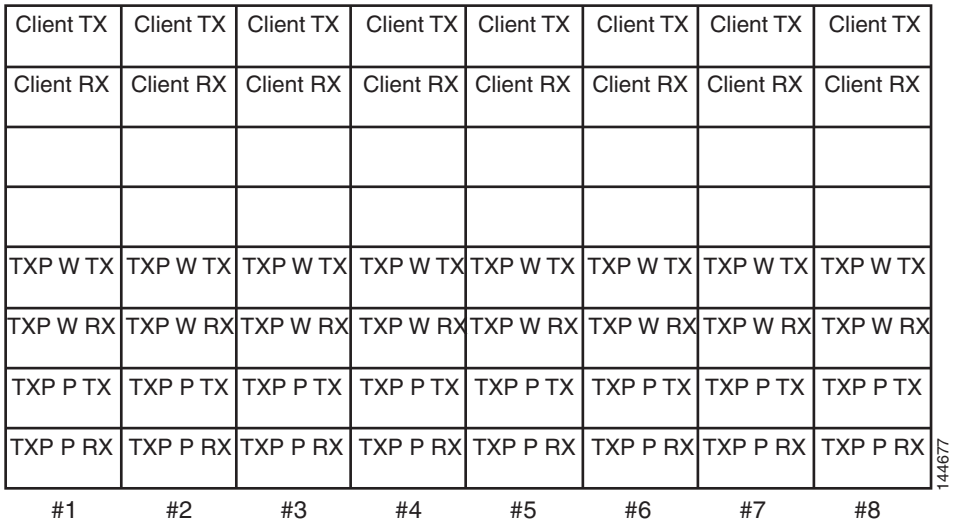
Another option for Y-cable protection is the Y-cable module tray. Each tray holds up to 8 individual Y-cable modules (Figure 1-15).

Figure 1-15 Y-Cable Protection Module Tray



The ports on these Y-cable modules are labelled according to their intended signal type (Client TX/RX, TXP Working TX/RX, TXP Protect TX/RX). You can use the port label on the front of the tray to identify the ports on each module (Figure 1-16).

Figure 1-16 Y-Cable Protection Port Label



1.5 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 trays), in either 1rack unit (RU)or 2 RU sizes
  - 1RU: Fiber-storage tray and 64-channel patch panel
  - 2 RU: Y-cable patch panel, 64-channel patch panel, 80-channel patch panel, and mesh patch panel (4 or 8 degree)

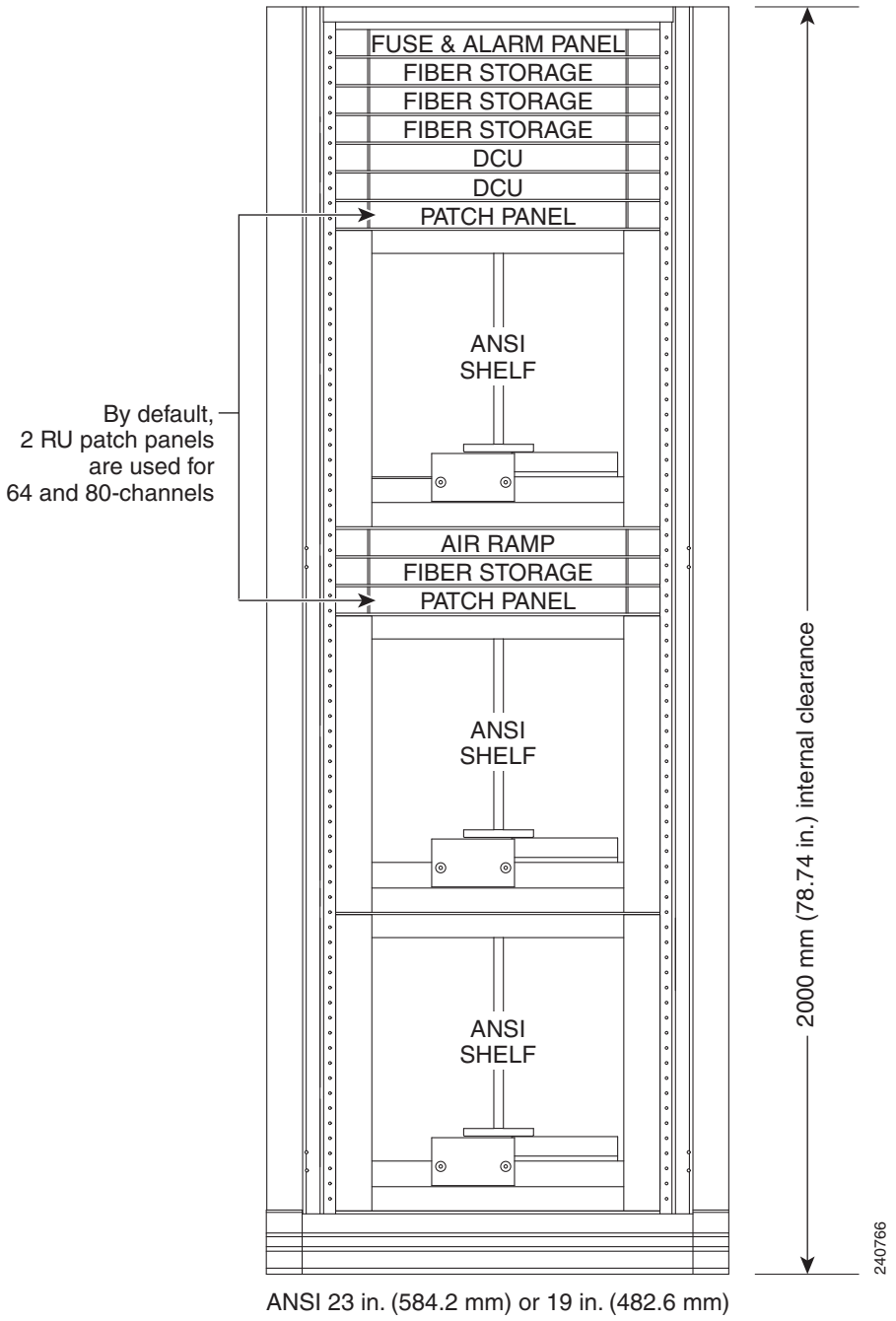
Or, alternatively:

- 3 ONS 15454 shelves
- 2 DCUs
- 6 standard patch-panel trays (or fiber-storage trays), or 3 deep patch-panel trays, in either 1 RU or 2 RU sizes
  - 1RU: Fiber-storage tray and 64-channel patch panel
  - 2 RU: Y-cable patch panel, 64-channel patch panel, 80-channel patch panel, and mesh patch panel (4 or 8 degree)

See Figure 1-17 for a typical rack layout.

Note Use the rack layout generated by Cisco TransportPlanner to determine your exact shelf layout.

Figure 1-17 Typical DWDM Equipment Layout in an ONS 15454 ANSI Rack

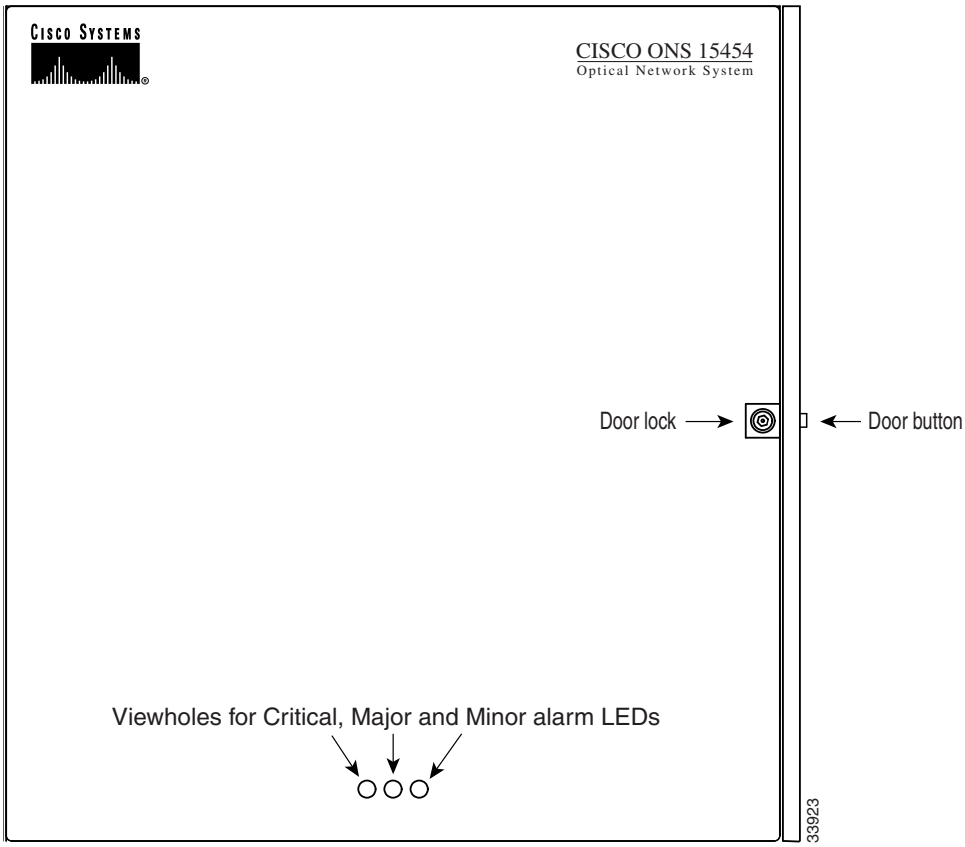


If you are installing a patch-panel or fiber-storage tray below the ONS 15454 shelf, you must install the air ramp between the shelf and patch-panel tray/fiber-management tray, or leave one rack unit (RU) space open.

1.6 Front Door

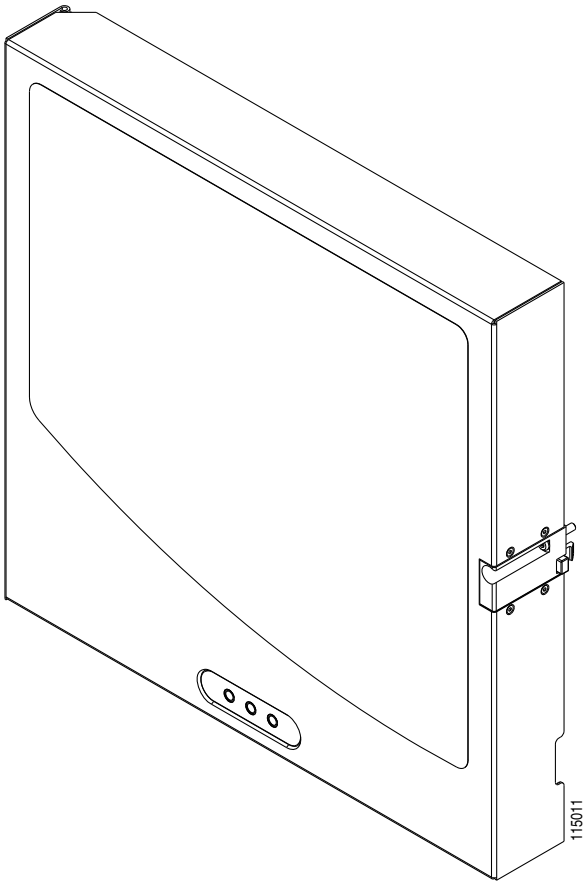
The Critical, Major, and Minor alarm LEDs visible through the front door indicate whether a critical, major, or minor alarm is present anywhere on the ONS 15454 shelf. These LEDs must be visible so that technicians can quickly determine if any alarms are present on the ONS 15454 shelf or the network. You can use the LCD to further isolate alarms. The front door (Figure 1-18) provides access to the shelf assembly, fiber-storage tray, fan-tray assembly, and LCD screen.

Figure 1-18 The ONS 15454 Front Door



The ONS 15454 ANSI ships with a standard door but can also accommodate a deep door and extended fiber clips (15454-DOOR-KIT) to provide additional room for cabling (Figure 1-19). The ONS 15454 ETSI does not support the deep door.

Figure 1-19 Cisco ONS 15454 ANSI Deep Door



The ONS 15454 door locks with a pinned hex key that ships with the shelf assembly. A button on the right side of the shelf assembly releases the door. You can remove the front door to provide unrestricted access to the front of the shelf assembly.

Note To mount the air ramp on an ONS 15454 ANSI with a deep door, mounting brackets (Cisco P/N 700-25319-01 for 19" deep door, and 700-25287-01 for 23" deep door) are provided. Refer to the “Install the Shelf and Common Control Cards” chapter in the *Cisco ONS 15454 DWDM Procedure Guide* for instructions on how to install the air ramp for standard and deep door chassis.

Before you remove the ONS 15454 front door, you must remove the ground strap of the front door (Figure 1-20).

Figure 1-20 ONS 15454 ANSI Front Door Ground Strap

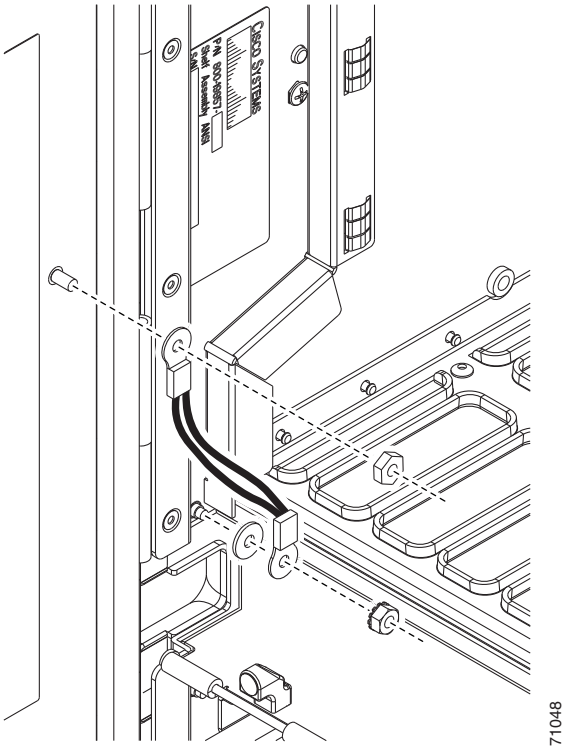


Figure 1-21 shows how to remove the ONS 15454 ANSI front door.

Figure 1-21 Removing the ONS 15454 ANSI Front Door

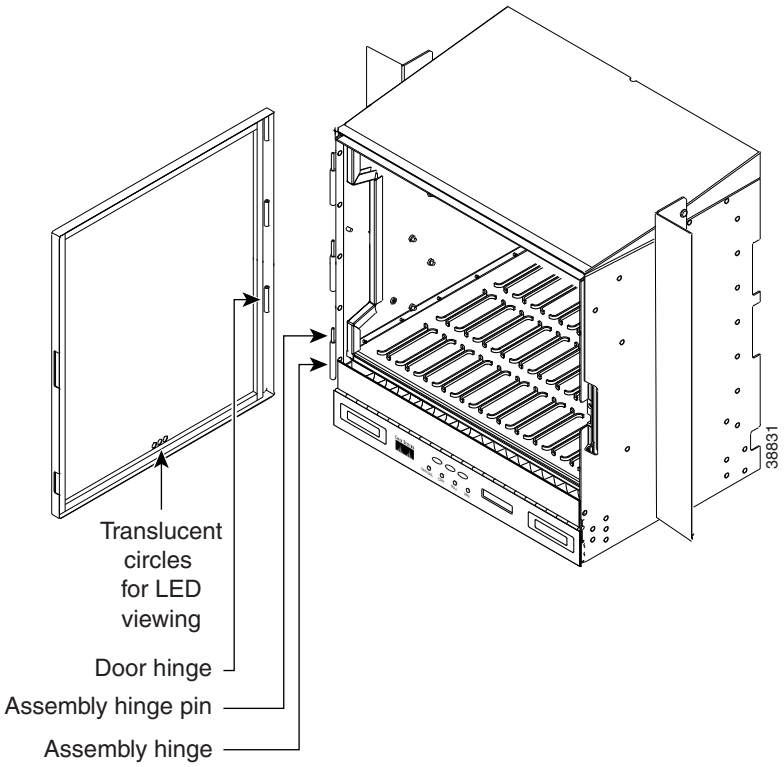
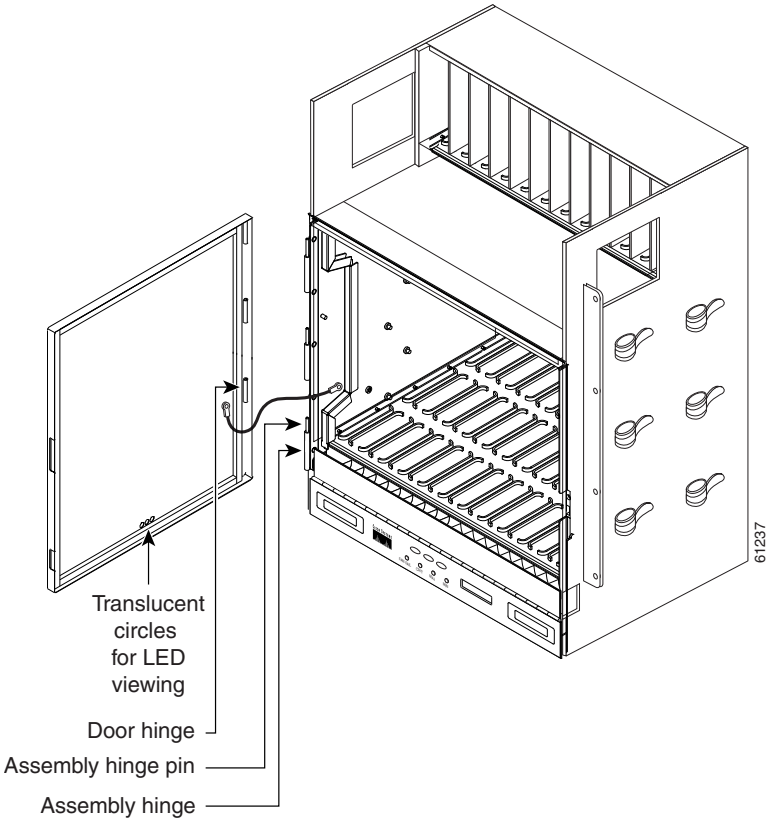


Figure 1-22 shows how to remove the ONS 15454 ETSI front door.

Figure 1-22 Removing the ONS 15454 ETSI Front Door



An erasable label is pasted on the inside of the front door. 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 1-23 shows the erasable label on the ONS 15454 ANSI shelf.

Figure 1-23 ONS 15454 ANSI Front-Door Erasable Label

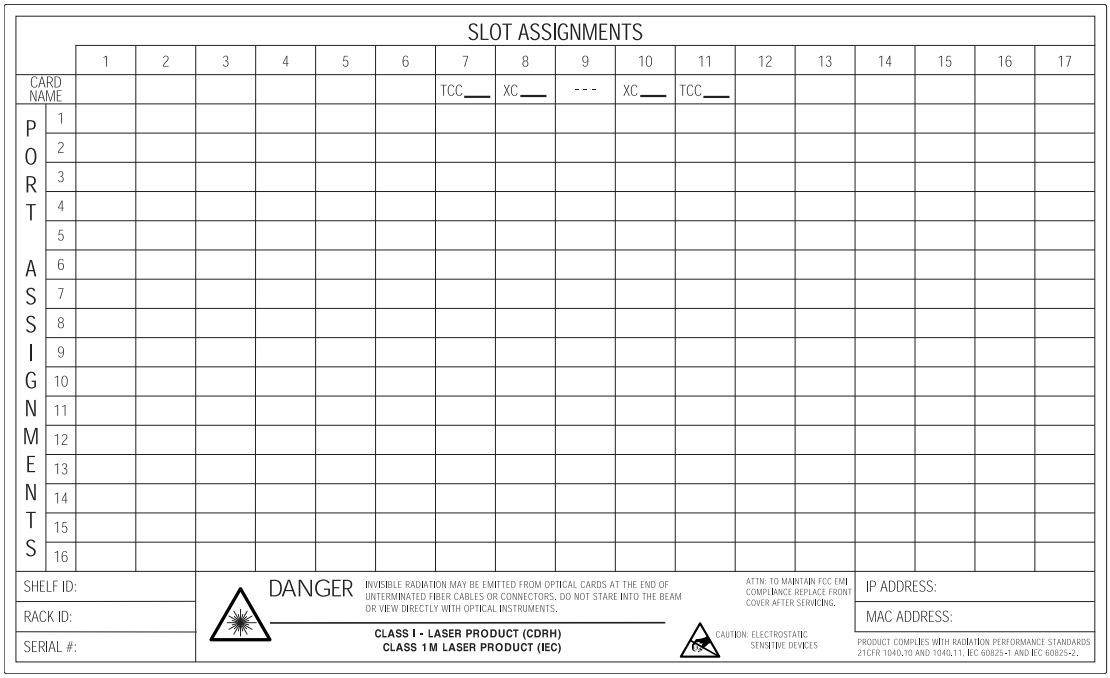
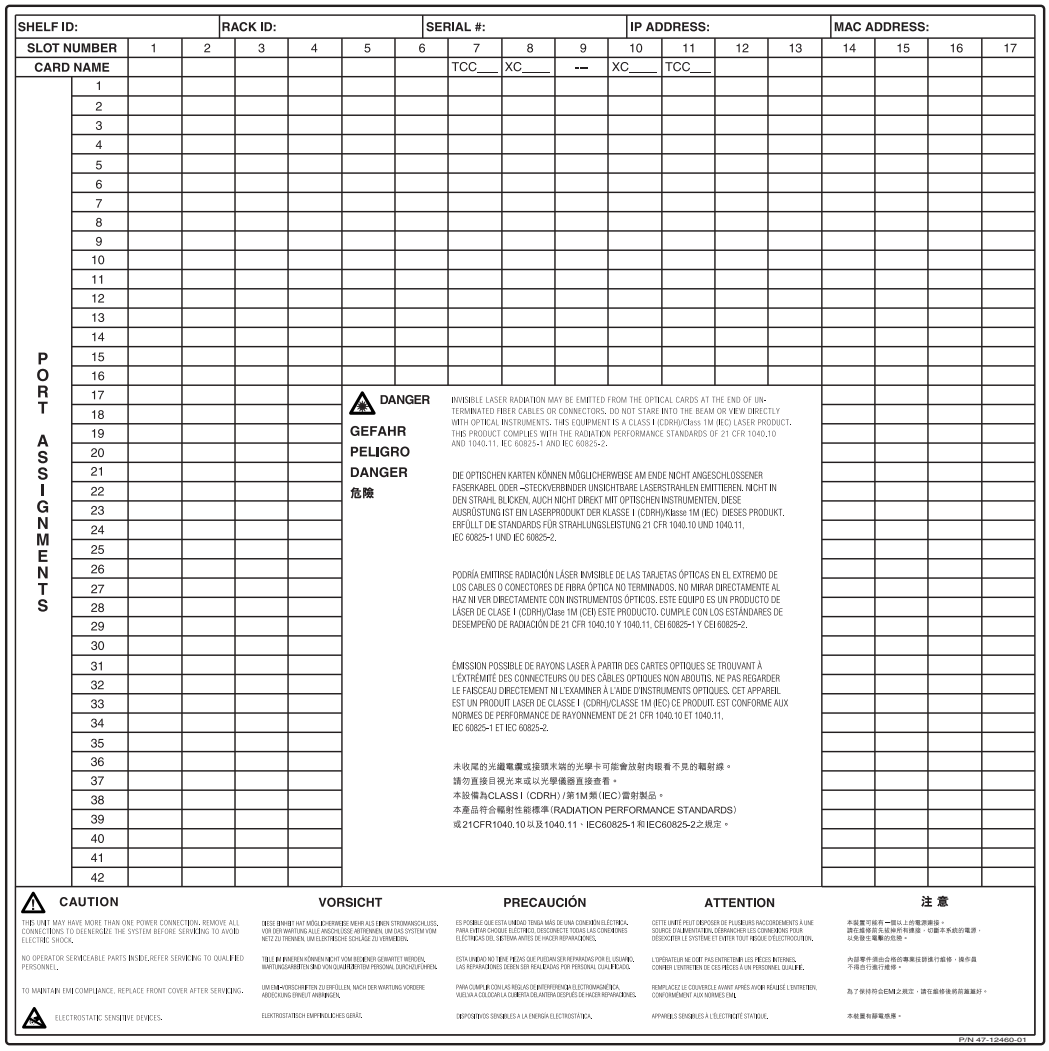


Figure 1-24 shows the erasable label on the ONS 15454 ETSI shelf.

Figure 1-24 ONS 15454 ETSI Front-Door Erasable Label



The front door label also includes the Class I and Class 1M laser warning. Figure 1-25 shows the ONS 15454 ANSI laser warning.

Figure 1-25 Laser Warning on the ONS 15454 ANSI Front-Door Label

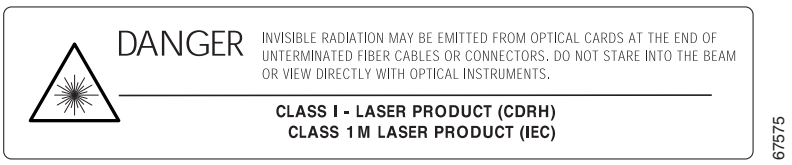
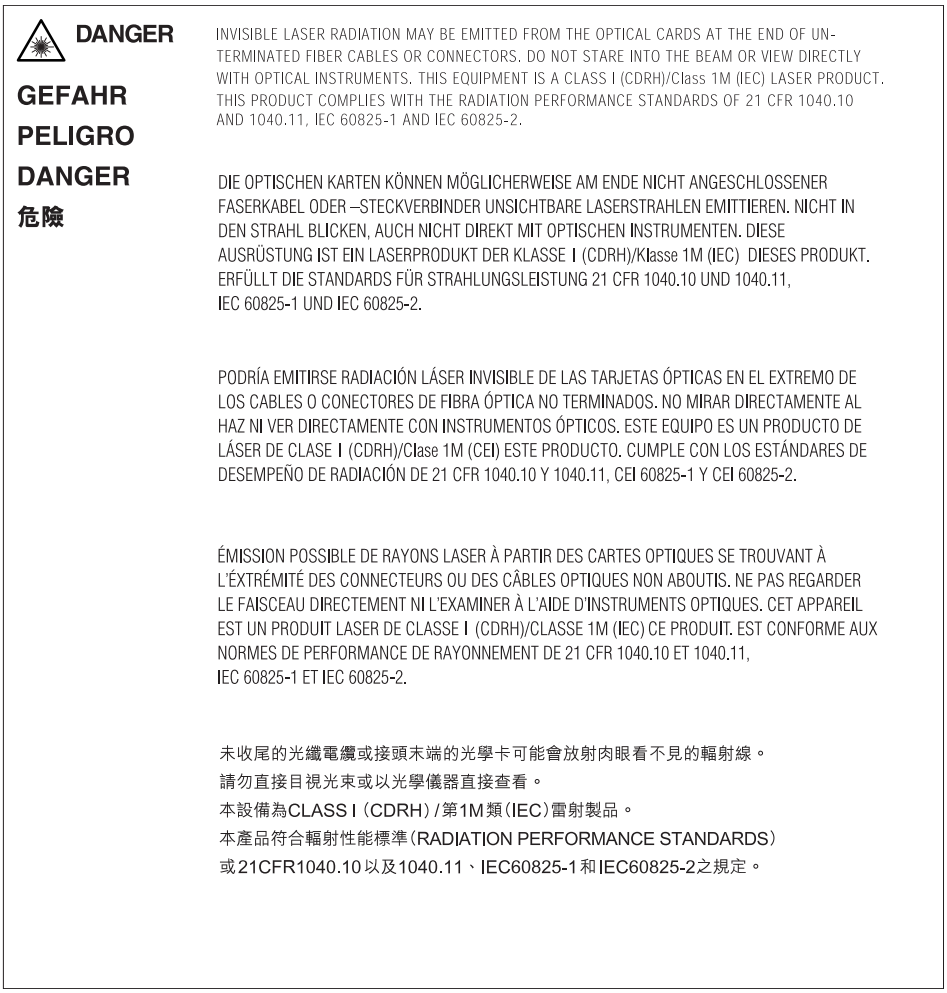


Figure 1-26 shows the ONS 15454 ETSI laser warning.

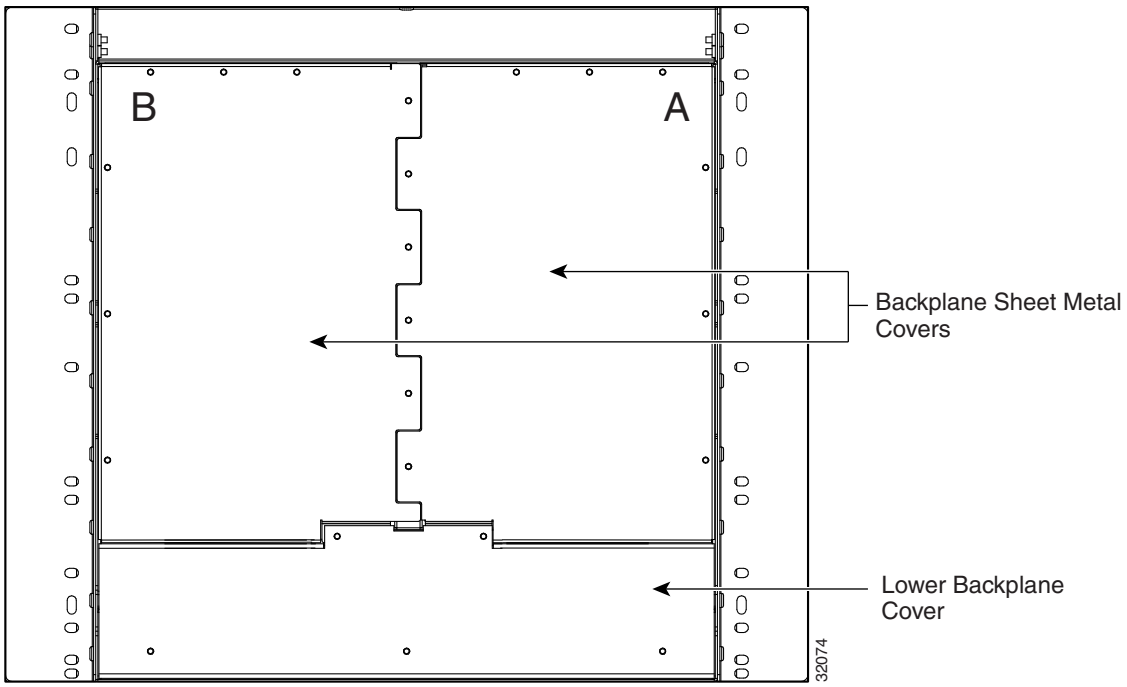
Figure 1-26 Laser Warning on the ONS 15454 ETSI Front-Door Label



1.7 ONS 15454 ANSI Backplane Covers

If a backplane does not have an electrical interface assembly (EIA) panel installed, it should have two sheet metal backplane covers (one on each side of the backplane). See Figure 1-27. Each cover is held in place with nine 6-32 x 3/8 inch Phillips screws.

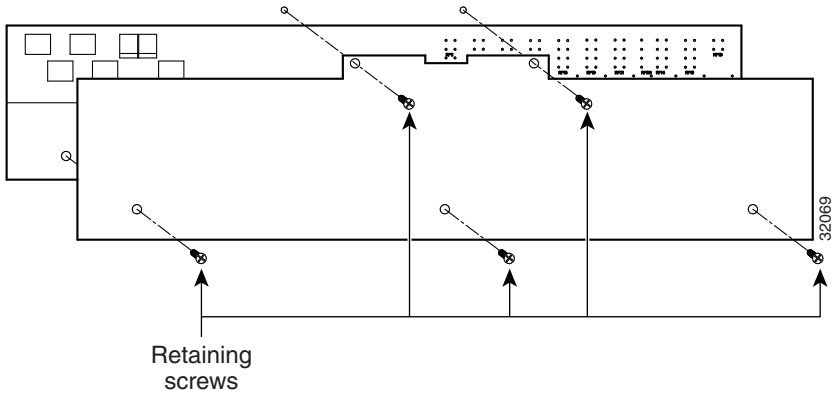
Figure 1-27 Backplane Covers



1.7.1 Lower Backplane Cover

The lower section of the ONS 15454 ANSI backplane is covered by either a clear plastic protector (15454-SA-ANSI) or a sheet metal cover (15454-SA-HD), 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 1-28).

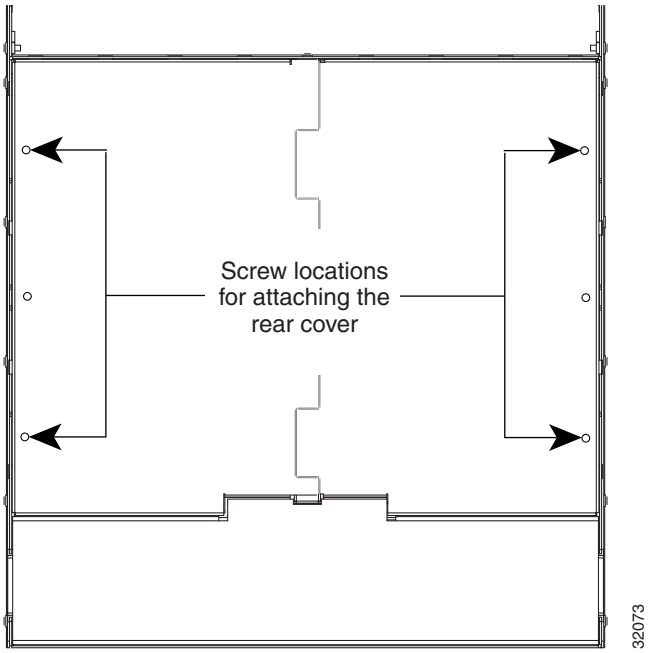
Figure 1-28 Removing the Lower Backplane Cover



1.7.2 Rear Cover

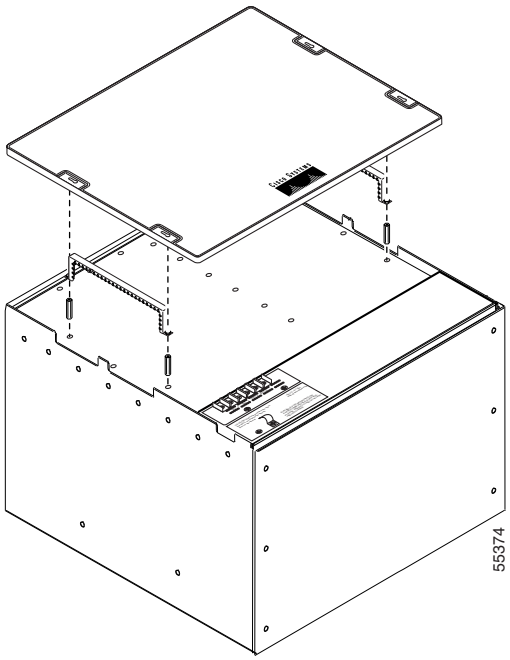
The ONS 15454 ANSI has an optional clear plastic rear cover. This clear plastic cover provides additional protection for the cables and connectors on the backplane. Figure 1-29 shows the rear cover screw locations.

Figure 1-29 Backplane Attachment for Cover



You can also install the optional spacers if more space is needed between the cables and rear cover (Figure 1-30).

Figure 1-30 Installing the Plastic Rear Cover with Spacers



1.7.3 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 ANSI. 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). The MAC address identifies the nodes that support circuits. It allows Cisco Transport Controller (CTC) to determine circuit sources, destinations, and spans. The TCC2/TCC2P cards in the ONS 15454 ANSI also use the MAC address to store the node database.

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

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

1.7.4 Alarm Interface Panel Replacement

If the AIP fails, a MAC Fail alarm appears 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 the Cisco Technical Assistance Center (Cisco TAC). For contact information, see the "Obtaining Documentation and Submitting a Service Request" section on page lxiv.

You can replace the AIP on an in-service system without affecting traffic (except Ethernet traffic on nodes running a release earlier than Software 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. Always replace an AIP during a maintenance window.

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.

1.8 ONS 15454 ETSI Front Mount Electrical Connection

The ONS 15454 ETSI positive and negative power terminals are located on FMEC cards in the Electrical Facility Connection Assembly (EFCA). The ground connection is the grounding receptacle on the side panel of the shelf.

The ONS 15454 ETSI EFCA at the top of the shelf has 12 FMEC slots numbered sequentially from left to right (18 to 29). Slots 18 to 22 and 25 to 29 provide electrical connections. Slots 23 and 24 host the MIC-A/P and MIC-C/T/P cards, respectively. The MIC-A/P and the MIC-C/T/P cards also connect alarm, timing, LAN, and craft connections to the ONS 15454 ETSI.

For more information about the MIC-A/P and MIC-C/T/P cards, see Chapter 2, “Common Control Cards.”

1.9 ONS 15454 ANSI Alarm Expansion Panel

The optional ONS 15454 ANSI alarm expansion panel (AEP) can be used with the AIC-I card to provide an additional 48 dry alarm contacts for the ONS 15454 ANSI: 32 inputs and 16 outputs. The AEP is a printed circuit board assembly that is installed on the backplane. Figure 1-31 shows the AEP board; 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 more information about the AIC-I, see Chapter 2, “Common Control Cards.”

Figure 1-31 AEP Printed Circuit Board Assembly

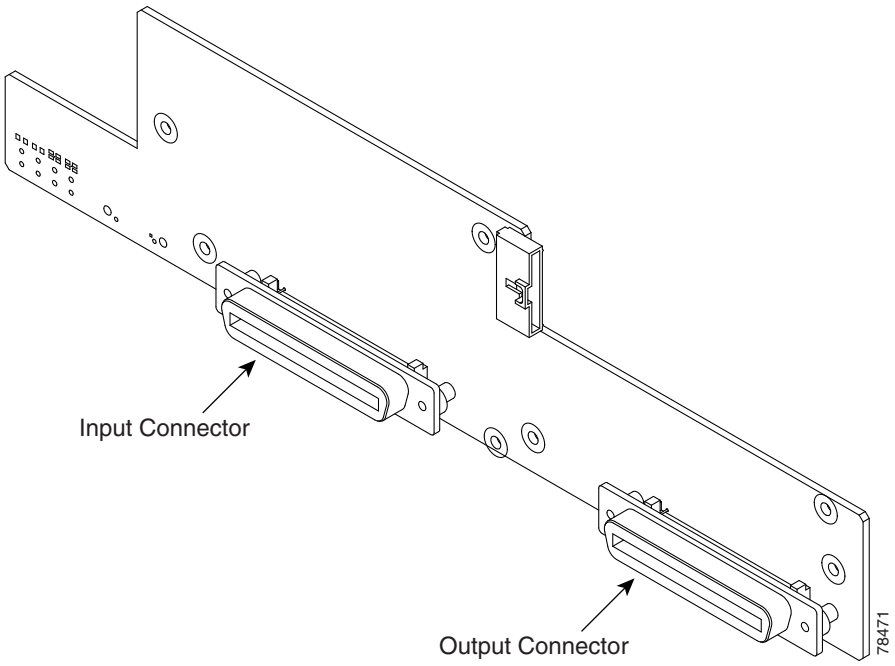
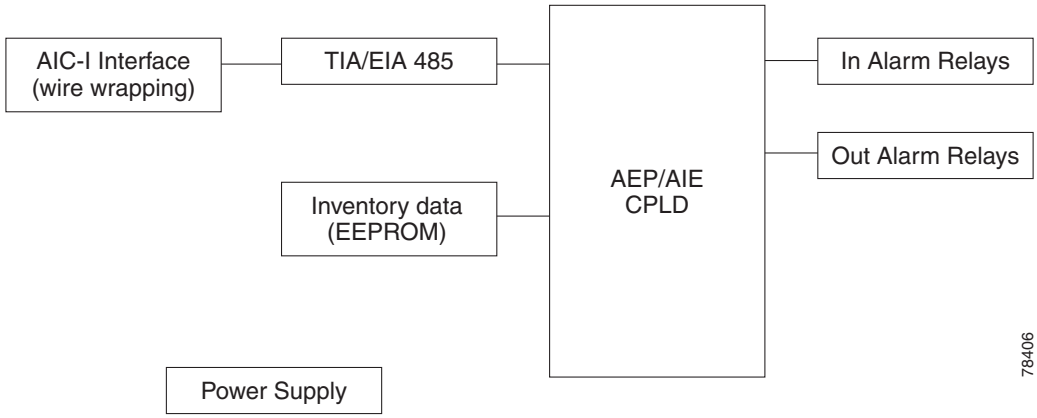


Figure 1-32 shows the AEP block diagram.

Figure 1-32 AEP Block Diagram



Each AEP alarm input port has a provisionable label and severity. The alarm inputs have optocoupler isolation. They have one common 32-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, and a maximum current of 100 mA. See the "16.6 External Alarms and Controls" section on page 16-13 for further information.

Figure 1-33 shows the wire-wrapping connections on the shelf backplane used to connect to the AEP.

Figure 1-33 AEP Wire-Wrap Connections to Backplane Pins

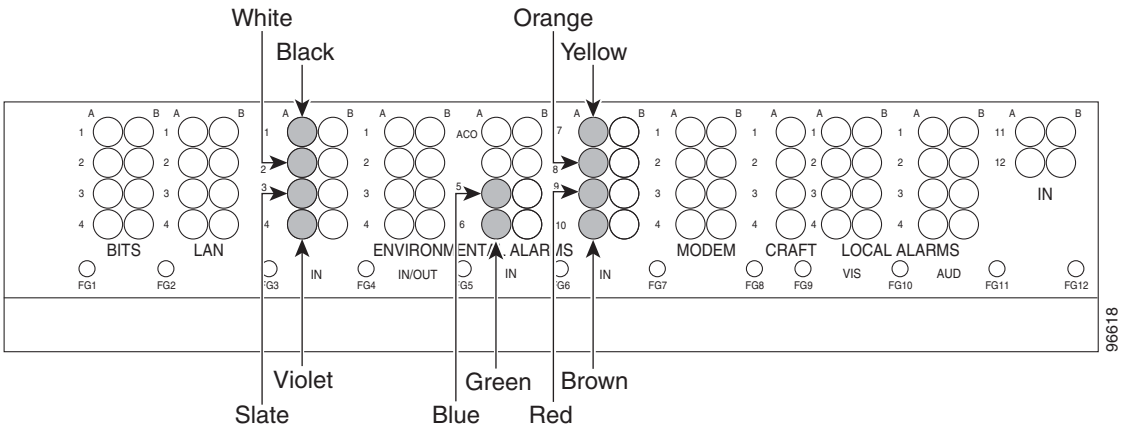


Table 1-6 shows the backplane pin assignments and corresponding signals on the AIC-I and AEP.

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 1-34 is a circuit diagram of the alarm inputs. (Inputs 1 and 48 are shown in the example.)

Figure 1-34 Alarm Input Circuit Diagram

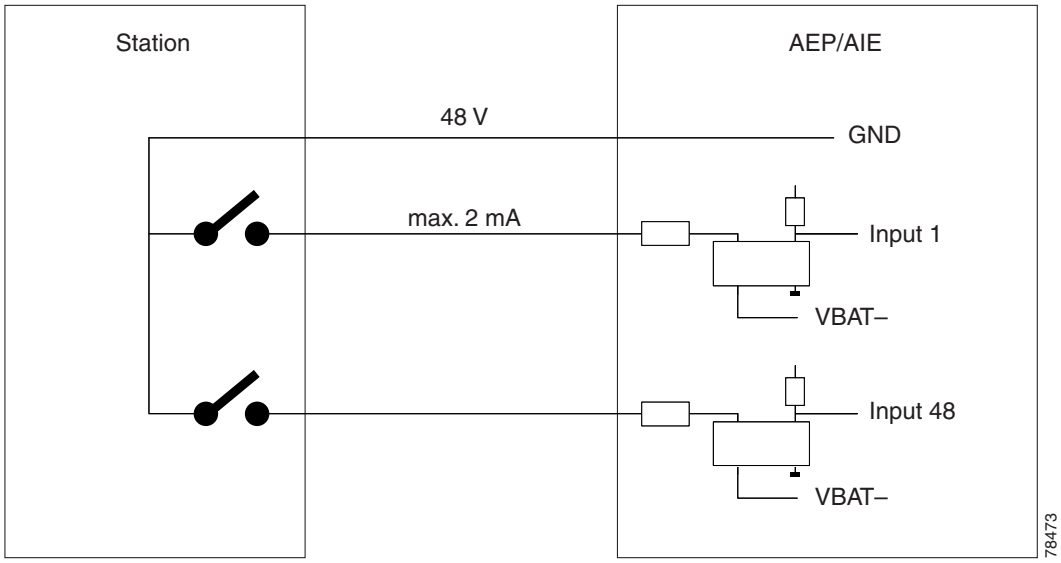


Table 1-7 lists the connections to the external alarm sources.

Table 1-7 Alarm Input Pin Association

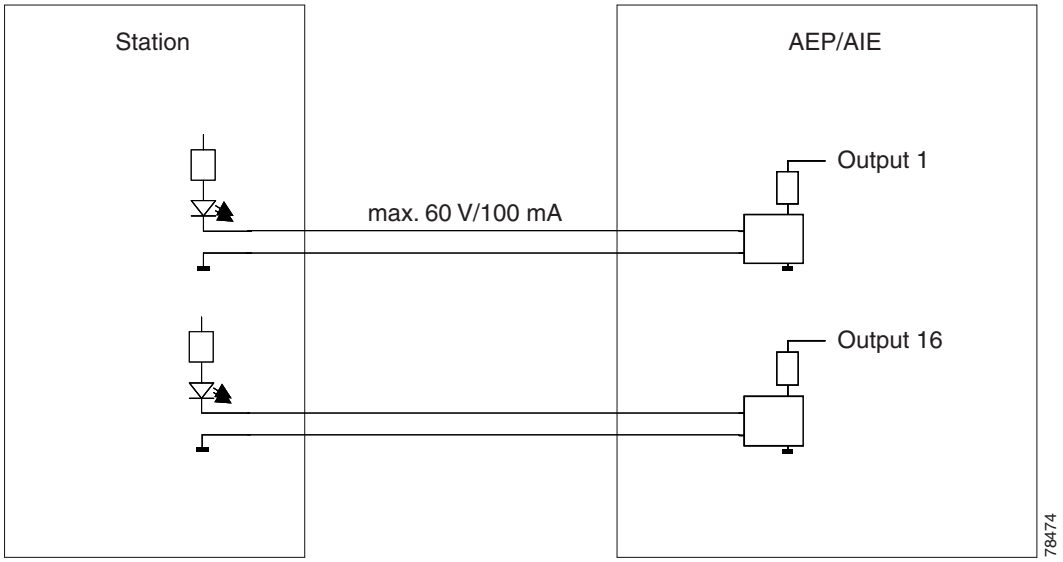
AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
1	ALARM_IN_1–	27	GND
2	GND	28	ALARM_IN_2–
3	ALARM_IN_3–	29	ALARM_IN_4–
4	ALARM_IN_5–	30	GND
5	GND	31	ALARM_IN_6–
6	ALARM_IN_7–	32	ALARM_IN_8–
7	ALARM_IN_9–	33	GND
8	GND	34	ALARM_IN_10–
9	ALARM_IN_11–	35	ALARM_IN_12–
10	ALARM_IN_13–	36	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–

Table 1-7 Alarm Input Pin Association (continued)

AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
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	—
25	ALARM_IN_+	51	GND1
26	ALARM_IN_0–	52	GND2

Figure 1-35 is a circuit diagram of the alarm outputs. (Outputs 1 and 16 are shown in the example.)

Figure 1-35 Alarm Output Circuit Diagram



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

Table 1-8 Pin Association for Alarm Output Pins

AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
1	—	27	COM_0
2	COM_1	28	—
3	NO_1	29	NO_2
4	—	30	COM_2

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

AMP Champ Pin Number	Signal Name	AMP Champ Pin Number	Signal Name
5	COM_3	31	—
6	NO_3	32	NO_4
7	—	33	COM_4
8	COM_5	34	—
9	NO_5	35	NO_6
10	—	36	COM_6
11	COM_7	37	—
12	NO_7	38	NO_8
13	—	39	COM_8
14	COM_9	40	—
15	NO_9	41	NO_10
16	—	42	COM_10
17	COM_11	43	—
18	NO_11	44	NO_12
19	—	45	COM_12
20	COM_13	46	—
21	NO_13	47	NO_14
22	—	48	COM_14
23	COM_15	49	—
24	NO_15	50	—
25	—	51	GND1
26	NO_0	52	GND2

1.10 Ethernet Adapter Panel

An ethernet adapter panel (EAP) is required in an ANSI or ETSI equipment rack for multishelf configurations. Two EAPs are required in a multishelf configuration, one for each MS-ISC-100T card. Figure 1-36 shows an example of two installed EAPs and the connection between each EAP and a node controller shelf and a subtending shelf.

An EAP cable is used to connect the MS-ISC-100T card ports to the EAP (Figure 1-37). The nine connector ends plug into Ports 0 through 8 of the MS-ISC-100T card, and the multiport connector plugs into the EAP. Ports 0 and 1 on the MS-ISC-100T card are the DCN ports; Ports 2 through 7 are the SSC ports. A cross-over (CAT-5) LAN cable is used to connect the DCN port on the EAP to the front panel of the TCC2/TCC2P cards in the subtending shelves.

Figure 1-36 Connecting the EAP to the Node Controller and Subtending Shelf

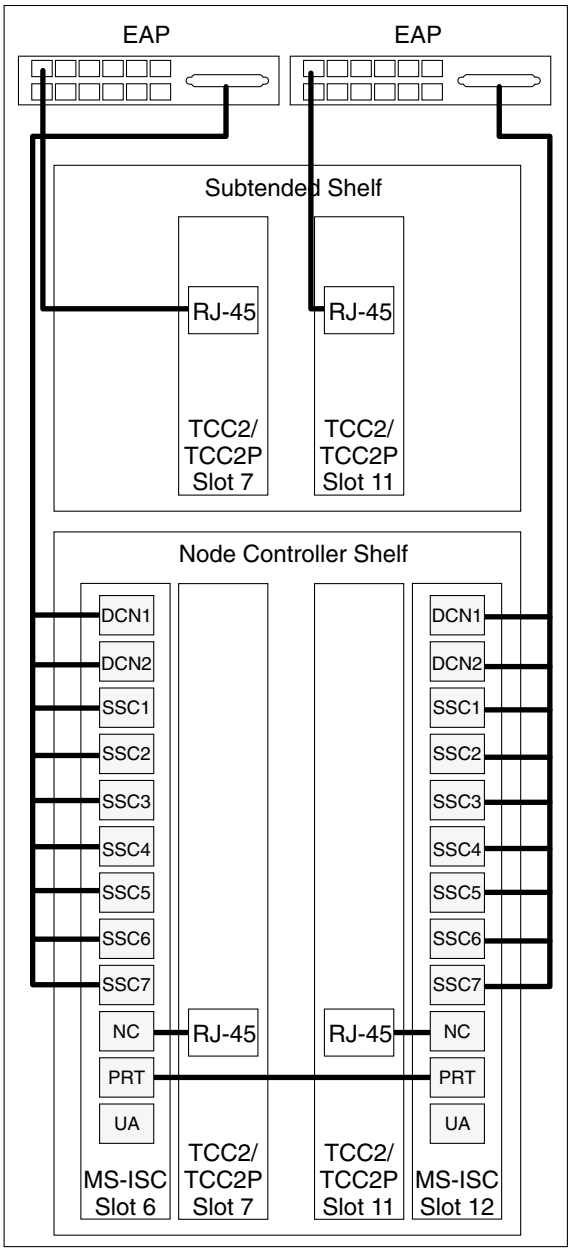
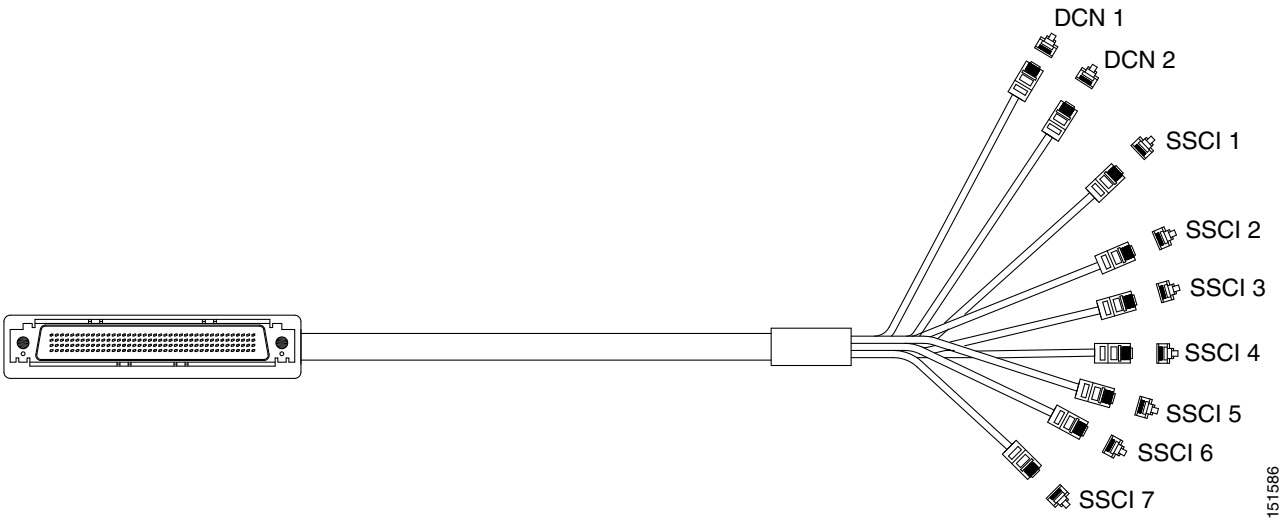


Figure 1-37 EAP Cable



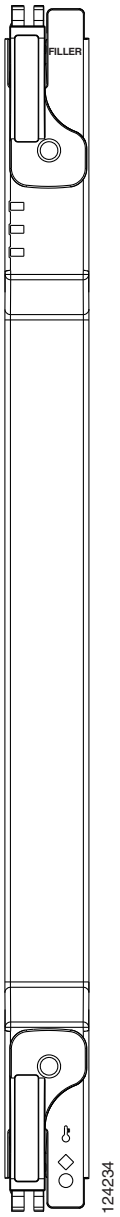
1.11 Filler Card

The filler card is designed to occupy empty multiservice and AIC-I slots in the Cisco ONS 15454 (Slots 1 to 6, 9, and 12 to17). The filler card cannot operate in the cross-connect (XC) slots (Slots 8 and 10) or TCC2/TCC2P slots (Slots 7 and 11). The filler card is detected by CTC.

When installed, the filler card aids in maintaining proper air flow and EMI requirements.

Figure 1-38 shows the card faceplate. The filler card has no card-level LED indicators.

Figure 1-38 Filler Card Faceplate



1.12 Cable Routing and Management

The ONS 15454 cable management facilities include the following:

- Fiber patch panels
- A cable-routing channel (behind the fold-down door) that runs the width of the shelf assembly (Figure 1-39 on page 1-41)
- Plastic horseshoe-shaped fiber guides at each side opening of the cable-routing channel that ensure that the proper bend radius is maintained in the fibers (Figure 1-40 on page 1-42)

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.

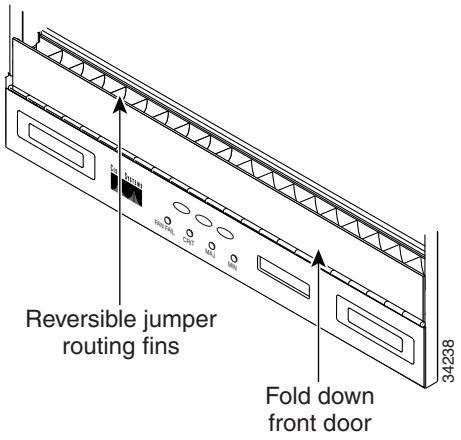
- Cable tie-wrap facilities on EIAs that secure cables to the cover panel (ANSI only)
- Reversible jumper routing fins that enable you to route cables out either side by positioning the fins as desired
- Jumper slack storage reels (2) on each side panel that reduce the amount of slack in cables that 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-storage tray (recommended for DWDM nodes)
- Optional tie-down bar (ANSI only)

Figure 1-39 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 1-39 Managing Cables on the Front Panel



1.12.1 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 1-40 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.

Figure 1-40 Fiber Capacity

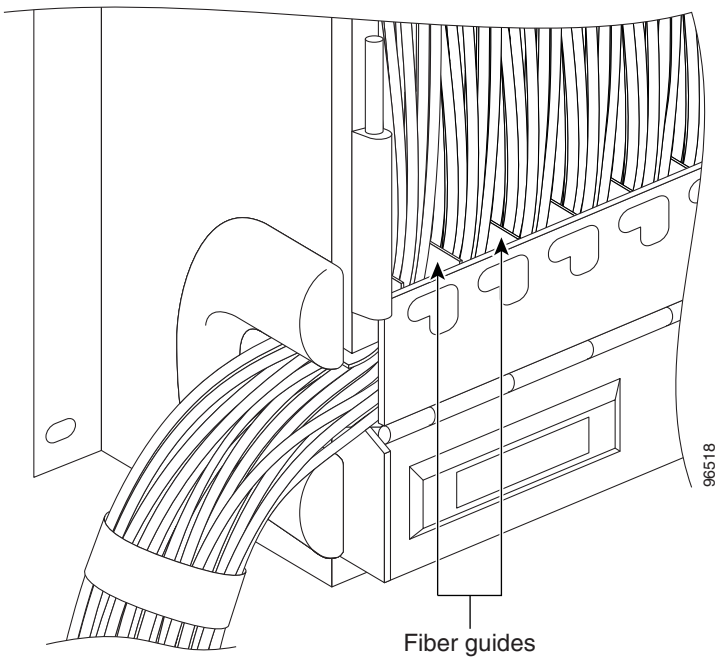


Table 1-9 provides the maximum capacity of the fiber channel for one side of an ANSI shelf, depending on fiber size and number of Ethernet cables running through that fiber channel.

Table 1-9 ANSI Fiber Channel Capacity (One Side of the Shelf)

	Maximum Number of Fibers Exiting Each Side		
Fiber Diameter	**No Ethernet Cables**	**One Ethernet Cable**	**Two Ethernet Cables**
0.6 inch (1.6 mm)	144	127	110
0.7 inch (2 mm)	90	80	70
0.11 inch (3 mm)	40	36	32

Table 1-10 provides the maximum capacity of the fiber channel for one side of an ETSI shelf, depending on fiber size and number of Ethernet cables running through that fiber channel.

Table 1-10 ETSI Fiber Channel Capacity (One Side of the Shelf)

	Maximum Number of Fibers Exiting Each Side		
Fiber Diameter	**No Ethernet Cables**	**One Ethernet Cable**	**Two Ethernet Cables**
0.6 inch (1.6 mm)	126	110	94
0.7 inch (2 mm)	80	70	60
0.11 inch (3 mm)	36	31	26

Determine 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.

1.12.2 Fiber Management Using the Patch-Panel Trays

The optional patch-panel trays manage the connections between multiplexer/demultiplexer and TXP cards by splitting multiple fiber push-on (MPO) cables into single fiber connections (LC cables). The patch-panel tray consists of a metal shelf, a pull-out drawer, a drop-in patch-panel module, and various cable routing mechanisms.

1.12.2.1 Standard and Deep Patch-Panel Trays (32-Channel)

There are two patch-panel trays intended for use with 32-channel cards, the standard tray (1 RU deep) and the deep tray (2 RUs deep). Both the standard patch-panel tray can host up to eight ribbon cables (with eight fibers each) entering the drawer, or 64 cables (with a maximum outer diameter of 2 mm [0.079 in.]). The deep patch-panel has the bulkheads organized in 8 packs, each housing 8 LC adapters, which allows for more room for internal fiber routing as well as more clearance for ingress and egress of the cables. The deep patch-panel comes with the MPO-LC cables preinstalled.

Because the standard and deep patch-panel tray can each host 64 connections, hub and ROADM nodes will typically require two standard patch-panel modules each, and other DWDM nodes might require one. (Only one standard or deep patch-panel tray is necessary for terminal nodes.) The module fits 19- and 23-inch (482.6-mm and 584.2-mm) ANSI racks and 600 mm (23.6 inch) x 300 mm (11.8 inch) ETSI racks, using reversible brackets.

Figure 1-41 shows a partially fibered standard patch-panel tray.

Figure 1-41 Standard Patch-Panel Tray

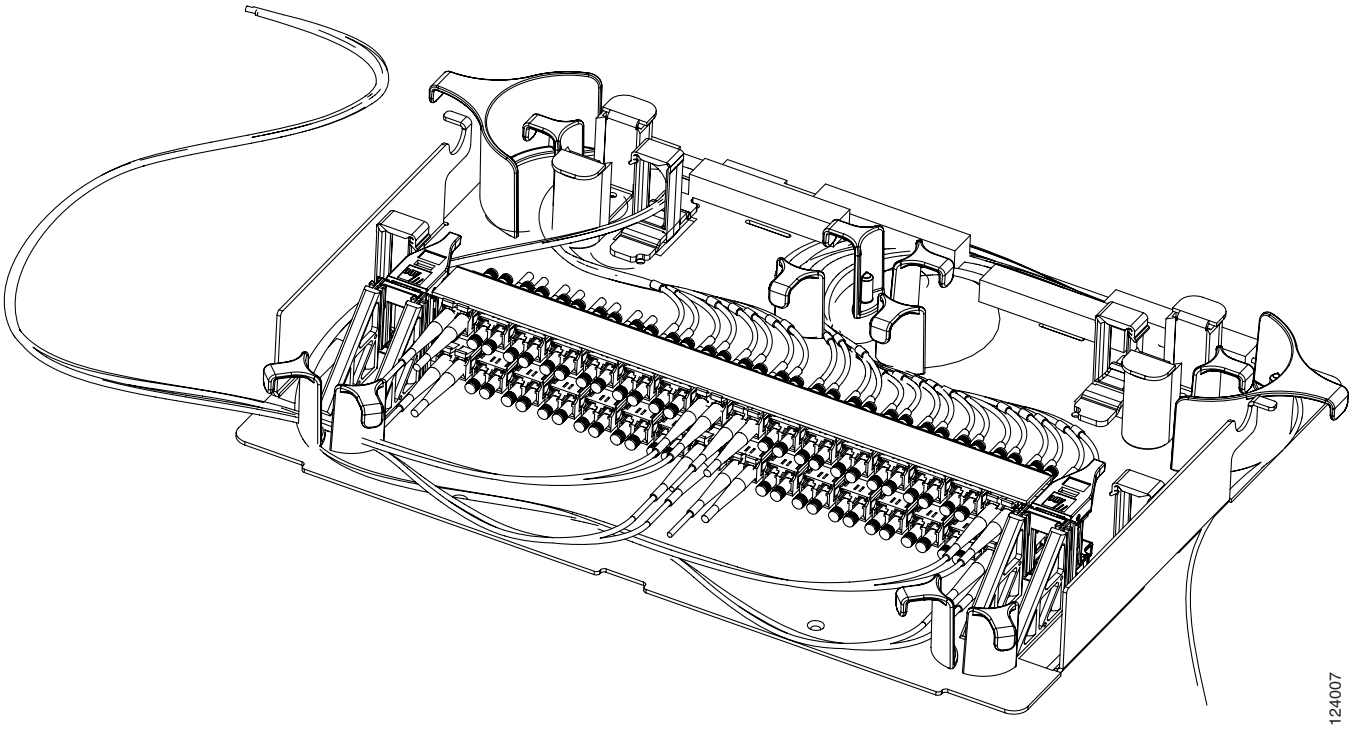


Figure 1-42 shows a partially fibered deep patch-panel tray.

Figure 1-42 Deep Patch-Panel Tray

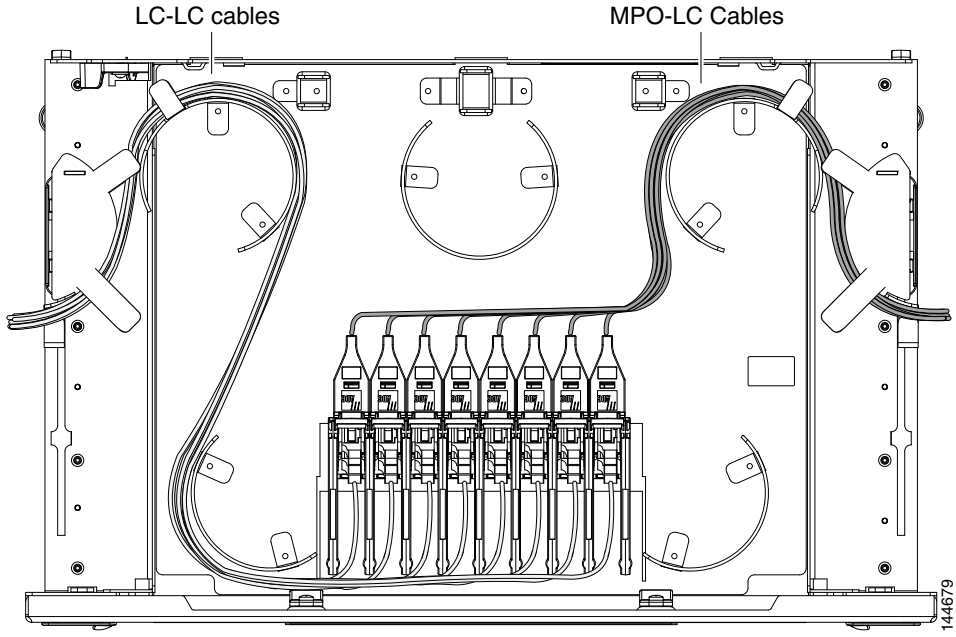
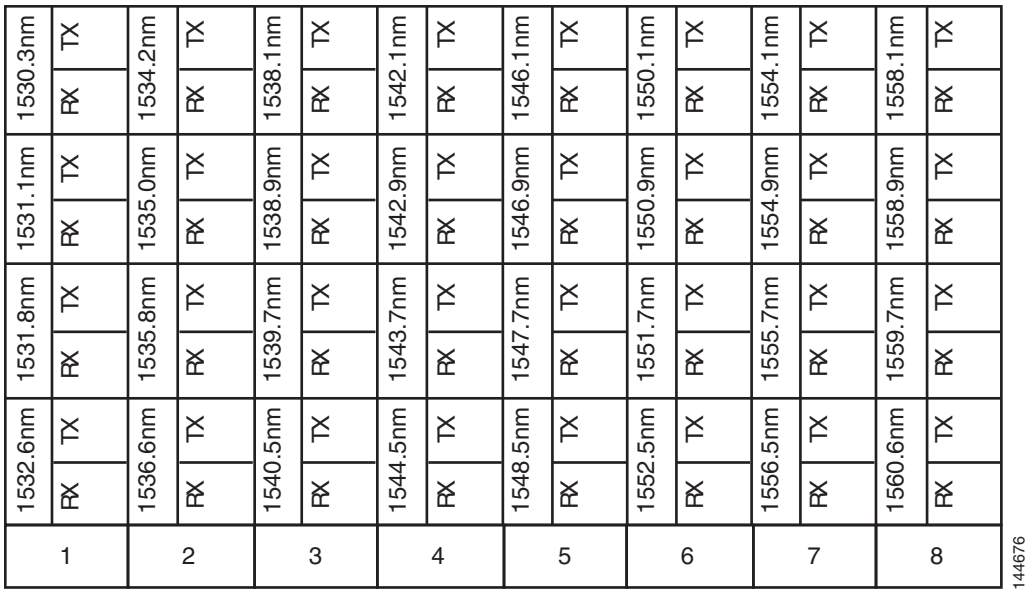


Figure 1-43 shows the label on the patch panel that identifies the wavelength for each port.

Figure 1-43 Patch-Panel Port Wavelengths



1.12.2.2 40-Channel Patch-Panel Tray

The 40-channel patch panel tray is 2 RUs deep and comes preinstalled with MPO-LC cables. The 40-channel patch-panel tray can host up to 10 ribbon cables (with eight fibers each), for a total of 80 connections, and is used with expanded ROADM, terminal, hub, and mesh nodes. Expanded hub and ROADM nodes will typically require two 40-channel patch-panel modules each; terminal nodes require one 40-channel patch-panel tray; and one 40-channel patch-panel tray is needed for mesh nodes for each direction.

The module fits 19- and 23-inch (482.6-mm and 584.2-mm) ANSI racks and 600 mm (23.6 inch) x 300 mm (11.8 inch) ETSI racks, using reversible brackets.

Figure 1-44 shows a 40-channel patch-panel tray.

Figure 1-44 40-Channel Patch-Panel Tray, Side View

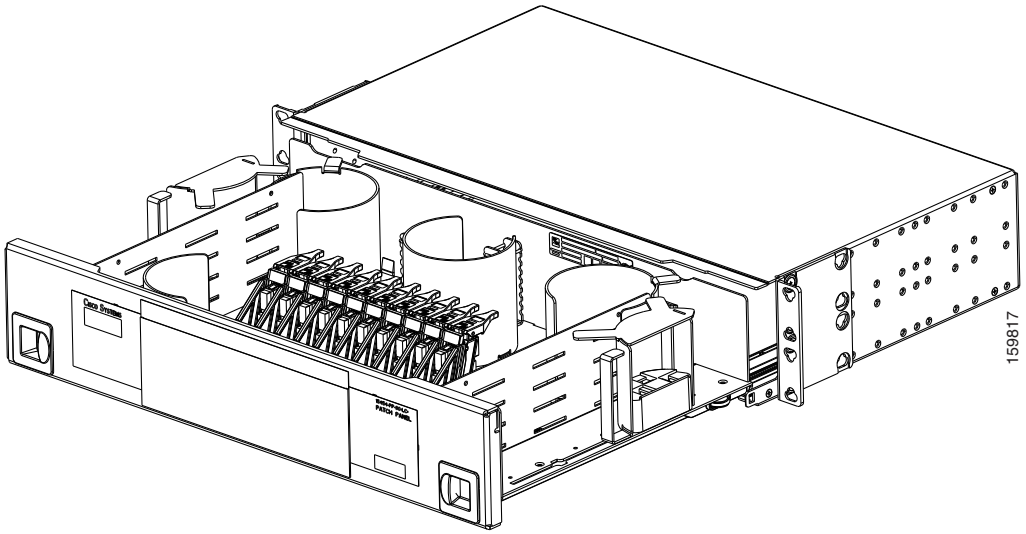


Figure 1-45 shows the 40-channel patch-panel ports and corresponding wavelengths.

Figure 1-45 40-Channel (15454-PP-80) Patch-Panel Port Wavelengths

1530.3nm	TX	1533.4nm	TX	1536.6nm	TX	1539.7nm	TX	1542.9nm	TX	1546.1nm	TX	1549.3nm	TX	1552.5nm	TX	1555.7nm	TX	1558.9nm	TX
	RX		RX		RX		RX		RX		RX		RX		RX		RX		RX
1531.1nm	TX	1534.2nm	TX	1537.4nm	TX	1540.5nm	TX	1543.7nm	TX	1546.9nm	TX	1550.1nm	TX	1553.3nm	TX	1556.5nm	TX	1559.7nm	TX
	RX		RX		RX		RX		RX		RX		RX		RX		RX		RX
1531.8nm	TX	1535.0nm	TX	1538.1nm	TX	1541.3nm	TX	1544.5nm	TX	1547.7nm	TX	1550.9nm	TX	1554.1nm	TX	1557.3nm	TX	1560.6nm	TX
	RX		RX		RX		RX		RX		RX		RX		RX		RX		RX
1532.6nm	TX	1535.8nm	TX	1538.9nm	TX	1542.1nm	TX	1545.3nm	TX	1548.5nm	TX	1551.7nm	TX	1554.9nm	TX	1558.1nm	TX	1561.4nm	TX
	RX		RX		RX		RX		RX		RX		RX		RX		RX		RX

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1.12.2.3 Mesh Patch-Panel Tray

There are two mesh patch-panel trays, four-degree (PP-MESH-4) and eight-degree (PP-MESH-8), which are intended for use with mesh nodes. Both trays are 2 RUs deep. The four-degree patch panel allows up to 4 sides to be used per mesh node, while the eight-degree patch panel allows up to 8 sides to be used per mesh node. The 4-degree patch-panel tray can host up to 4 MPO-MPO and 4 LC-LC cables, and the 8-degree patch-panel tray can host up to 8 MPO-MPO and 8 LC-LC cables. The module fits 19- and 23-inch (482.6-mm and 584.2-mm) ANSI racks and 600 mm (23.6 inch) x 300 mm (11.8 inch) ETSI racks, using reversible brackets.

Figure 1-46 shows a four-degree patch-panel tray.

Figure 1-46 Four-Degree Patch-Panel Tray

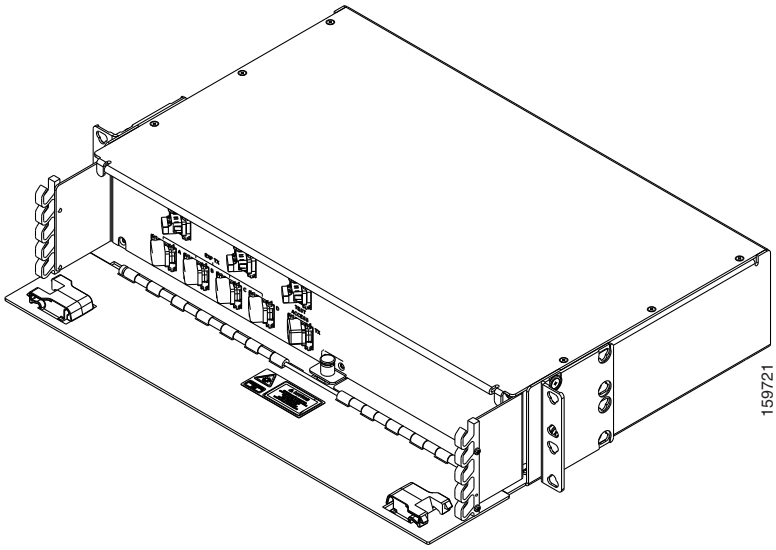
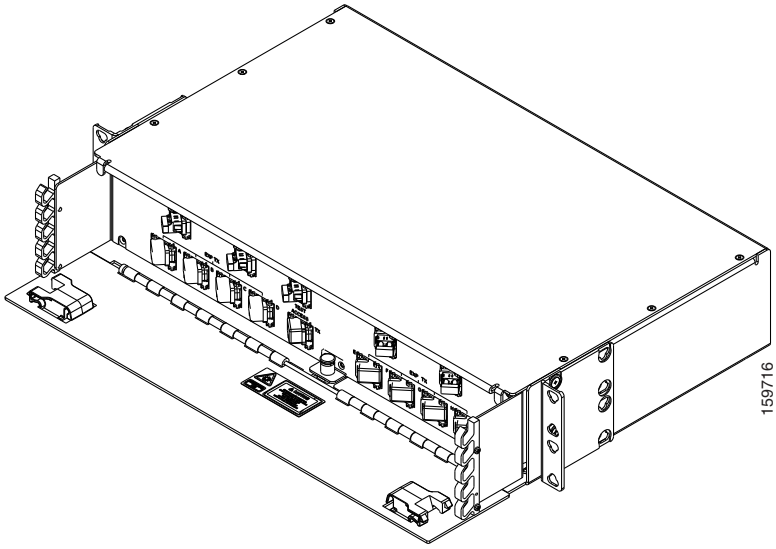


Figure 1-47 shows an eight-degree patch-panel tray.

Figure 1-47 Eight-Degree Patch-Panel Tray

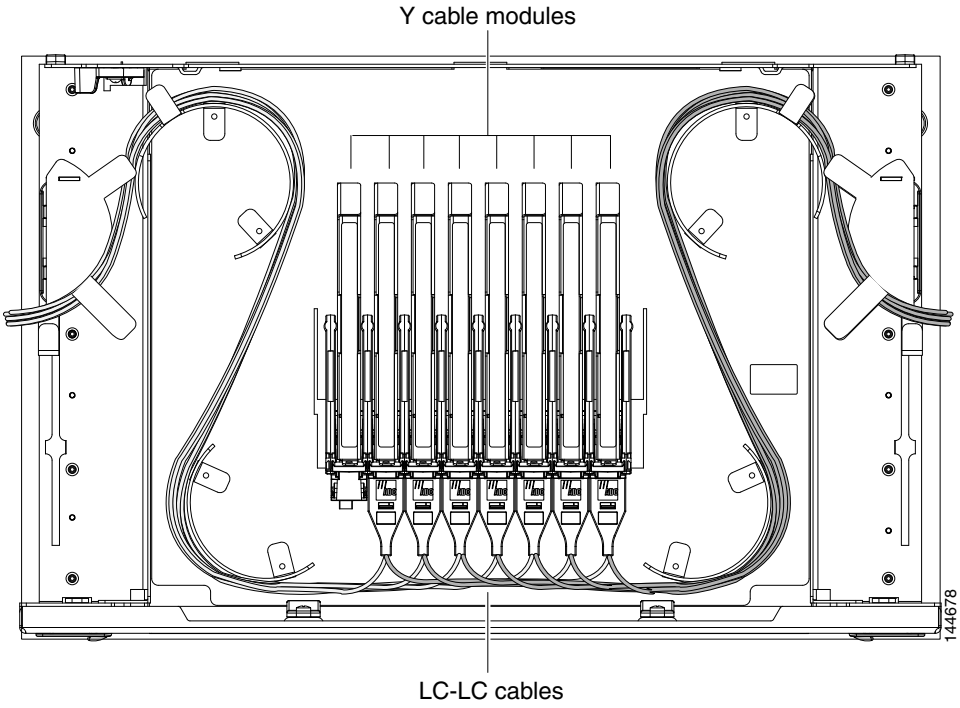


1.12.3 Fiber Management Using the Y-Cable Module Tray

The optional Y-cable module tray manages the connections between TXP cards by splitting patchcords into single connections. The patch-panel tray consists of a metal shelf, a pull-out drawer, and up to eight Y-cable modules.

Figure 1-48 shows a fibered Y-cable module tray.

Figure 1-48 Y-Cable Module Tray



To ensure diversity of the fiber coming from different cards in the Y-cable scheme, one pair of fibers (e.g. from the active transponder) should come out on the opposite side from the second pair of fibers (e.g. standby transponder), according to local site practice.

1.12.4 Fiber Management Using the Fiber-Storage Tray

Cisco recommends installing at least one fiber-storage tray in multinode racks to facilitate fiber-optic cable management for DWDM applications. This tray is usually used to store slack cable from cables installed between cards within a single node. Refer to Figure 1-17 on page 1-20 for typical mounting locations.

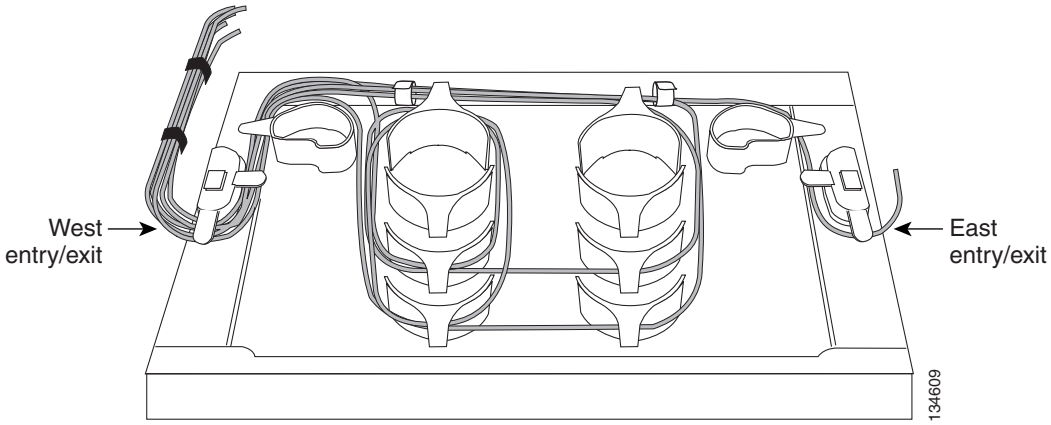
Table 1-11 provides the fiber capacity for each tray.

Table 1-11 Fiber-Storage Tray Capacity

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

Figure 1-49 shows an example of a fiber-management tray with fiber-optic cables routed through it. You can route cables around the cable rounders, entering and exiting from either side, as necessary. Route fibers as necessary for your site configuration.

Figure 1-49 Fiber-Storage Tray

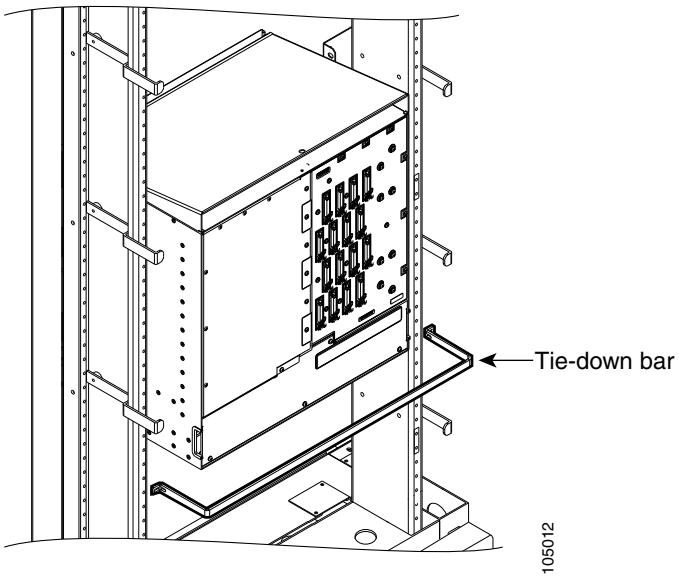


1.12.5 Fiber Management Using the Optional ANSI Tie-Down Bar

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 1-50 shows the tie-down bar, the ONS 15454 ANSI, and the rack.

Figure 1-50 Tie-Down Bar on the Cisco ONS 15454 ANSI Shelf Assembly



1.13 Fan-Tray Assembly

The fan-tray assembly is located at the bottom of the ONS 15454 shelf 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. Refer to the "Maintain the Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide* to clean and replace the fan-tray assembly.

The front of the fan-tray assembly has an LCD screen that provides slot- and port-level information for all card slots, including the number of Critical, Major, and Minor alarms.

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 "Maintain the Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide* for information about cleaning and maintaining the fan-tray air filter. Figure 1-51 shows the position of the ONS 15454 ETSI fan-tray assembly. (The fan-tray assembly on the ONS 15454 ANSI is located in a similar position.)

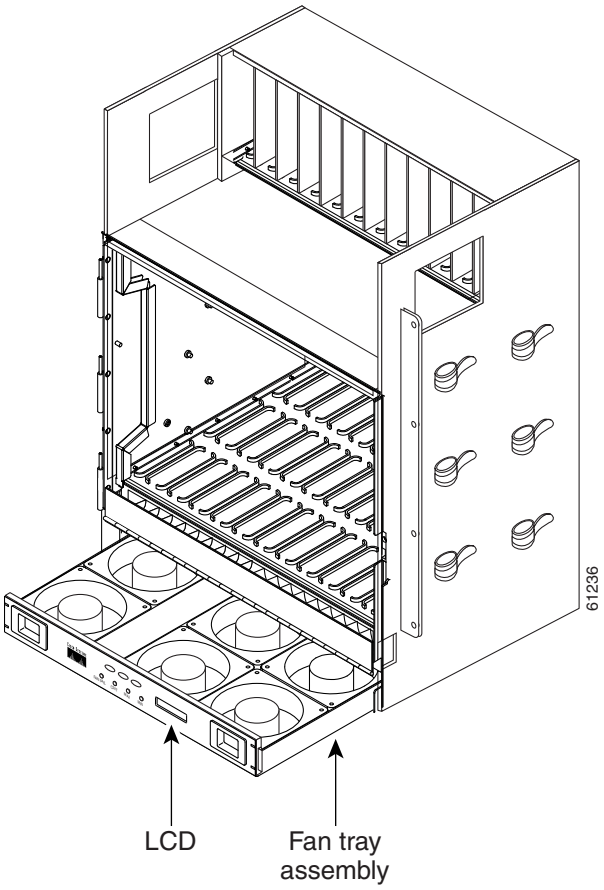
Caution Do not operate an ONS 15454 without the mandatory fan-tray air filter.

Caution Fan-tray assembly 15454E-CC-FTA (ETSI shelf)/15454-CC-FTA (ANSI shelf) is required when any of the following cards are used in an ONS 15454 DWDM application: ADM-10G, GE_XP, 10GE_XP, ML-MR-10, and CE-MR-10.

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). The fan-tray assembly includes a pin that prevents it from being installed in ONS 15454 shelf assemblies released before ONS 15454 Release 3.1 (15454-SA-NEBS3E, 15454-SA-NEBS3, and 15454-SA-R1). Equipment damage can result from attempting to install the 15454-FTA3 in an incompatible shelf assembly.

Note 15454-CC-FTA is compatible with Software Release 2.2.2 and greater and shelf assemblies 15454-SA-HD and 15454-SA-ANSI. 15454E-CC-FTA is compatible with Software Release 4.0 and greater and shelf assembly 15454-SA-ETSI.

Figure 1-51 Position of the ONS 15454 ETSI Fan-Tray Assembly



1.13.1 Fan Tray Units for ONS 15454 Cards

Table 1-12 lists the applicable fan tray units supported for ONS 15454 cards in Release 8.5:

Table 1-12 Fan Tray Units for ONS 15454 Cards

ONS 15454 Cards	15454E-FTA-48V (ETSI shelf) /15454-FTA3-T(ANSI shelf)	15454E-CC-FTA (ETSI shelf)/ 15454-CC-FTA (ANSI shelf)
TCC2/TCC2P	Yes	Yes
AIC-I	Yes	Yes
MS-ISC-100T	Yes	Yes
AEP	Yes	Yes
MIC-A/P	Yes	Yes
MIC-C/T/P	Yes	Yes
OSCM	Yes	Yes
OSC-CSM	Yes	Yes

Table 1-12 Fan Tray Units for ONS 15454 Cards

ONS 15454 Cards	15454E-FTA-48V (ETSI shelf) /15454-FTA3-T(ANSI shelf)	15454E-CC-FTA (ETSI shelf)/ 15454-CC-FTA (ANSI shelf)
OPT-PRE	Yes	Yes
OPT-BST	Yes	Yes
OPT-BST-E	Yes	Yes
OPT-BST-L	Yes	Yes
OPT-AMP-L	Yes	Yes
OPT-AMP-17-C	Yes	Yes
OPT-AMP-C	Yes	Yes
32MUX-O	Yes	Yes
32DMX-O	Yes	Yes
4MD-xx.x	Yes	Yes
AD-1C-xx.x	Yes	Yes
AD-2C-xx.x	Yes	Yes
AD-4C-xx.x	Yes	Yes
AD-1B-xx.x	Yes	Yes
AD-4B-xx.x	Yes	Yes
32-WSS	Yes	Yes
32-DMX	Yes	Yes
32-WSS-L	Yes	Yes
32-DMX-L	Yes	Yes
MMU	Yes	Yes
40-DMX-C	Yes	Yes
40-DMX-CE	Yes	Yes
40-MUX-C	Yes	Yes
40-WSS-C	Yes	Yes
40-WSS-CE	Yes	Yes
40-WXC-C	Yes	Yes
TXP_MR_10G	Yes	Yes
TXP_MR_2.5G	Yes	Yes
TXPP_MR_2.5G	Yes	Yes
MXP_2.5G_10G	Yes	Yes
TXP_MR_10E	Yes	Yes
MXP_2.5G_10E	Yes	Yes
MXP_MR_2.5G	Yes	Yes
MXPP_MR_2.5G	Yes	Yes
TXP_MR_10E_C	Yes	Yes

Table 1-12 Fan Tray Units for ONS 15454 Cards

ONS 15454 Cards	15454E-FTA-48V (ETSI shelf) /15454-FTA3-T(ANSI shelf)	15454E-CC-FTA (ETSI shelf)/ 15454-CC-FTA (ANSI shelf)
TXP_MR_10E_L	Yes	Yes
MXP_2.5G_10E_C	Yes	Yes
MXP_2.5G_10E_L	Yes	Yes
MXP_MR_10DME_C	Yes	Yes
MXP_MR_10DME_L	Yes	Yes
GE_XP/10GE_XP	No	Yes
ADM-10G	No	Yes

1.13.2 Fan Speed

Fan speed is controlled by the TCC2/TCC2P card's 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/TCC2P card fails, the fans automatically shift to high speed. The temperature measured by the TCC2/TCC2P sensors appears on the LCD screen.

1.13.3 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. The red Fan Fail LED clears after you install a working fan tray.

Caution As with the FTA3, the 15454E-CC-FTA (for ETSI) and 15454-CC-FTA (for ANSI) Fan Fail LED on the front of the fan-tray assembly illuminates when one or more fans fail to indicate that a fan-tray assembly or AIP replacement is required. But the Fan Fail LED on the 15454E-CC-FTA and 15454-CC-FTA will also illuminate when only one power source is connected to the chassis, and or any fuse blows. In such conditions, the Fan Alarm is triggered and the fans run at maximum speed.

1.13.4 Air Filter

The ONS 15454 contains a reusable air filter (for ANSI: 15454-FTF2; for ETSI: 15454E-ETSI-FTF) that is installed either below the fan-tray assembly or, for the ONS 15454 ANSI, in the optional external filter brackets.

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. Inspect the air filter every 30 days, and clean the filter every three to six months. Replace the air filter every two to three years. Avoid cleaning the air filter with harsh cleaning agents or solvents.

Earlier versions of the ONS 15454 ANSI shelf used a disposable air filter that is installed beneath the fan-tray assembly only. However, the reusable air filter is backward compatible.

1.14 Power and Ground Description

Ground the equipment according to Telcordia standards or local practices. The following sections describe power and ground for the ONS 15454 shelves.

1.14.1 ONS 15454 ANSI Power and Ground

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

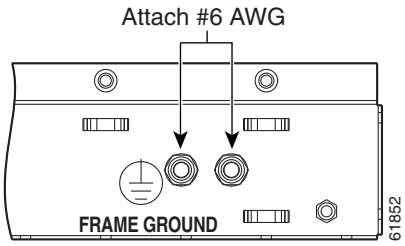
- Red wire for battery connections (–48 VDC).
- Black wire for battery return connections (0 VDC).
- The battery return connection is treated as DC-I, as defined in Telcordia GR-1089-CORE, Issue 3.

The ONS 15454 ANSI 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, copper conductor, 194 degrees F [90 degrees C]) and one ground cable (#6 AWG) 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.

The existing ground post is a #10-32 bolt. The nut provided for a field connection is also a #10 AWG, with an integral lock washer. The lug must be a dual-hole type and rated to accept the #6 AWG cable. Two posts are provided on the ONS 15454 ANSI to accommodate the dual-hole lug. Figure 1-52 shows the location of the ground posts.

Figure 1-52 Ground Posts on the ONS 15454 ANSI Backplane



1.14.2 ONS 15454 ETSI Power and Ground

The ONS 15454 ETSI has redundant –48 VDC power connectors on the MIC-A/P and MIC-C/T/P faceplates. To install redundant power feeds, use the two power cables shipped with the ONS 15454 ETSI and one ground cable. For details, see the "2.6.1 MIC-A/P FMEC" section on page 2-18 and the "2.6.2 MIC-C/T/P FMEC" section on page 2-21.

Caution Only use the power cables shipped with the ONS 15454 ETSI.

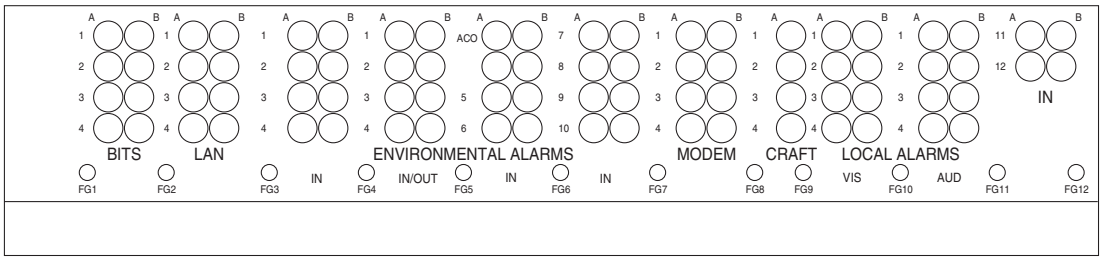
1.15 ONS 15454 ANSI Alarm, Timing, LAN, and Craft Pin Connections

Pin connections are provided on the ONS 15454 ANSI backplane. For information about ONS 15454 ETSI connections, see the "1.8 ONS 15454 ETSI Front Mount Electrical Connection" section on page 1-32.

The ONS 15454 ANSI has a backplane pin field located at the bottom of the backplane. The backplane pin field provides 0.045 inch^2 (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 1-54 on page 1-57 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 R3.4.0 or later. The backplane of the ANSI shelf contains a wire-wrap field with pin assignment according to the layout in Figure 1-53 on page 1-56. The shelf assembly might be an existing shelf that has been upgraded to Software R3.4 or later. In this case, the backplane pin labeling appears as indicated in Figure 1-54 on page 1-57, but you must use the pin assignments provided by the AIC-I card as shown in Figure 1-53 on page 1-56.

Figure 1-53 Cisco 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	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	
	A5	Alarm input pair number 5: Reports closure on connected wires.
	B5	
	A6	Alarm input pair number 6: Reports closure on connected wires.
	B6	
	A7	Alarm input pair number 7: Reports closure on connected wires.
	B7	
	A8	Alarm input pair number 8: Reports closure on connected wires.
	B8	
	A9	Alarm input pair number 9: Reports closure on connected wires.
	B9	
	A10	Alarm input pair number 10: Reports closure on connected wires.
	B10	
	A11	Alarm input pair number 11: Reports closure on connected wires.
	B11	
	A12	Alarm input pair number 12: Reports closure on connected wires.
	B12	

Field	Pin	Function
ENVIR ALARMS IN/OUT N/O	A1/A13	Normally open output pair number 1
	B1/B13	
	A2/A14	Normally open output pair number 2
	B2/B14	
	A3/A15	Normally open output pair number 3
	B3/B15	
	A4/A16	Normally open output pair number 4
	B4/B16	
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	

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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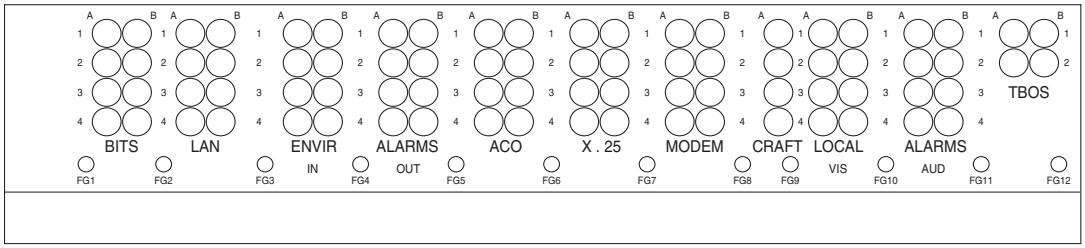
Figure 1-54 ONS 15454 ANSI Backplane Pinouts



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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1.15.1 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-I 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 1-53 on page 1-56 and Figure 1-54 on page 1-57 show 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 ACO pins to activate a remote ACO for audible alarms. You can also activate the ACO function by pressing the ACO button on the TCC2/TCC2P 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.

1.15.2 Timing Connections

The ONS 15454 ANSI 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 1-13 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 1-13 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.

1.15.3 LAN Connections

Use the LAN pins on the ONS 15454 ANSI backplane to connect the ONS 15454 ANSI 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/TCC2P faceplate to connect a workstation or to connect the ONS 15454 ANSI to the network. Table 1-14 shows the LAN pin assignments.

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

Table 1-14 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 ANSI is DCE.

1.15.4 TL1 Craft Interface Installation

You can use the craft pins on the ONS 15454 ANSI backplane or the EIA/TIA-232 port on the TCC2/TCC2P faceplate to create a VT100 emulation window to serve as a TL1 craft interface to the ONS 15454 ANSI. Use a straight-through cable to connect to the EIA/TIA-232 port. Table 1-15 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/TCC2P card simultaneously.

Note To use the serial port craft interface wire-wrap pins on the backplane, the DTR signal line on the backplane port wire-wrap pin must be connected and active.

Table 1-15 Craft Interface Pin Assignments

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

1.16 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 1-55 shows card installation for an ONS 15454 ANSI shelf.

Figure 1-55 Installing Cards in the ONS 15454 ANSI

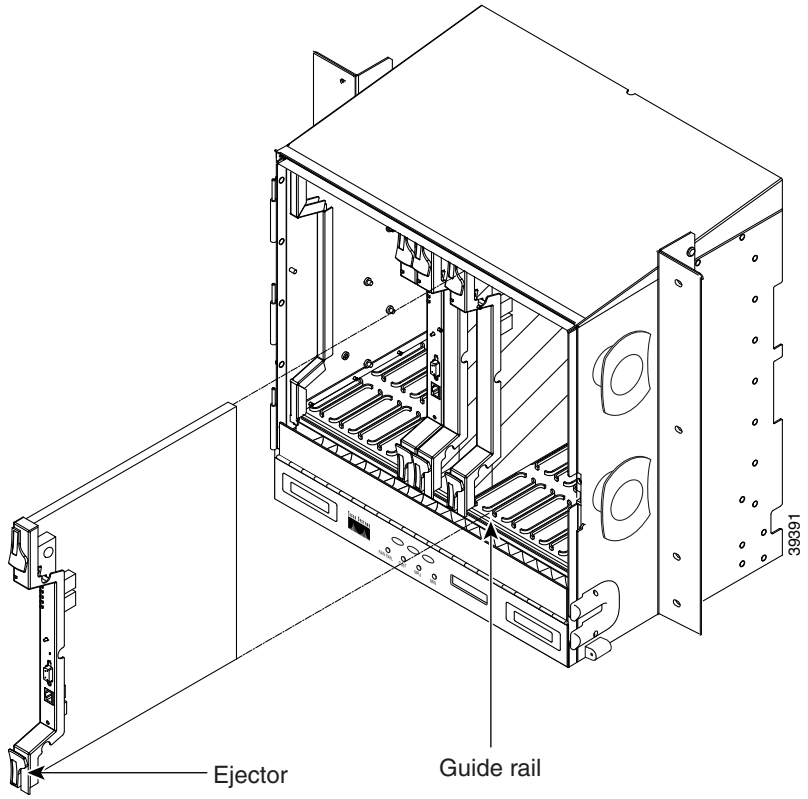
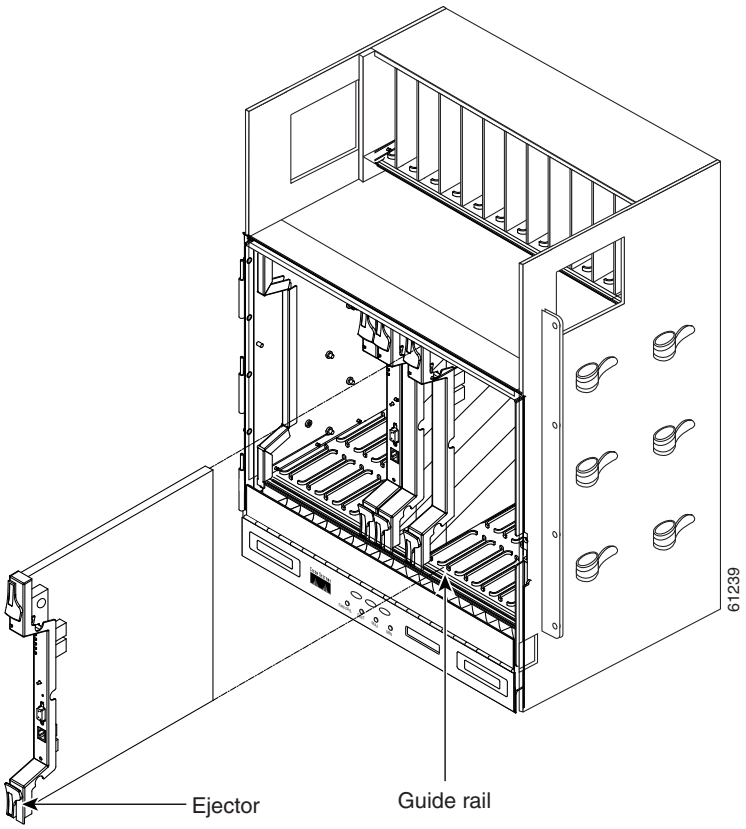


Figure 1-56 shows card installation in the ONS 15454 ETSI shelf.

Figure 1-56 Installing Cards in the ONS 15454 ETSI Shelf



1.16.1 Card Slot Requirements

The ONS 15454 shelf assemblies have 17 card slots numbered sequentially from left to right. Slots 7 and 11 are dedicated to TCC2/TCC2P cards. Slot 9 is reserved for the optional AIC-I card.

Caution Do not operate the ONS 15454 with a single TCC2/TCC2P card. 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 1-16 shows the slot and card symbol definitions.

Table 1-16 Slot and Card Symbols

Symbol Color/Shape	Definition
Orange/Circle	Slots 1 to 6 and 12 to 17. Only install cards with a circle symbol on the faceplate.
Blue/Triangle	Slots 5, 6, 12, and 13. Only install cards with circle or a triangle symbol on the faceplate.
Purple/Square	TCC2/TCC2P slot, Slots 7 and 11. Only install 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. **Note** Cross-connect cards are not required in DWDM applications. Install a FILLER card or blank card if not using Slots 8 and 10.
Red/P	Protection slot in 1:N protection schemes.
Red/Diamond	AIC/AIC-I slot, Slot 9. Only install cards with a diamond symbol on the faceplate.
Gold/Star	Slots 1 to 4 and 14 to 17. Only install 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 ANSI cards with a blue hexagon symbol on the faceplate.

1.16.2 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 "Maintain the Node" chapter in the *Cisco ONS 15454 DWDM 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 DWDM 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.

CHAPTER 2

Common Control Cards

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.

This chapter describes the Cisco ONS 15454 common-control cards. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 2.1 Card Overview, page 2-1
- 2.2 TCC2 Card, page 2-2
- 2.3 TCC2P Card, page 2-6
- 2.4 AIC-I Card, page 2-10
- 2.5 MS-ISC-100T Card, page 2-15
- 2.6 Front Mount Electrical Connections, page 2-18

2.1 Card Overview

The card overview section lists the cards described in this chapter.

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 “1.16.1 Card Slot Requirements” section on page 1-61 for a list of slots and symbols.

2.1.1 Common Control Cards

The following common control cards are needed to support the functions of the DWDM, transponder, and muxponder cards:

- TCC2 or TCC2P
- AIC-I (optional)
- MS-ISC-100T (multishelf configurations only)

2.1.2 Front Mount Electrical Connections (ETSI only)

The following Front Mount Electrical Connections (FMECs) are needed to support the functions of the DWDM, transponder, and muxponder cards:

- MIC-A/P
- MIC-C/T/P

2.2 TCC2 Card

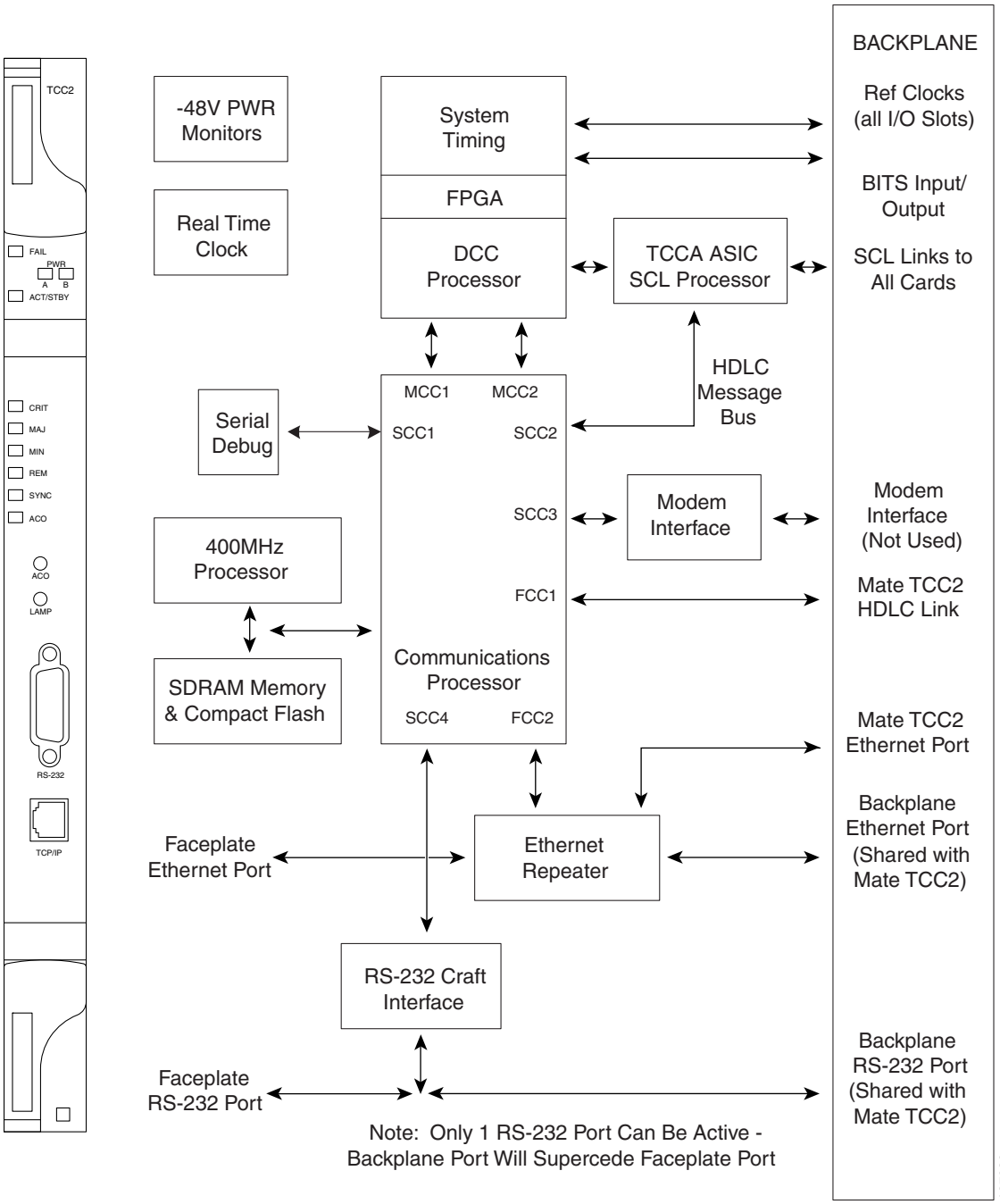
Note For TCC2 card specifications, see the "A.3.1 TCC2 Card Specifications" section on page A-8.

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 communications channel/generic communications channel (DCC/GCC) termination, optical service channel (OSC) DWDM data communications network (DCN) 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 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).

Figure 2-1 shows the faceplate and block diagram for the TCC2.

Figure 2-1 TCC2 Faceplate and Block Diagram



2.2.1 TCC2 Functionality

The TCC2 card terminates up to 32 DCCs. The TCC2 hardware is prepared for up to 84 DCCs, which will be available in a future software release.

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 building integrated timing supply (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.

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.

2.2.2 Redundant TCC2 Card Installation

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.

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.

2.2.3 TCC2 Card-Level Indicators

The TCC2 faceplate has ten LEDs. Table 2-1 describes the two card-level LEDs on the TCC2 faceplate.

Table 2-1 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.

2.2.4 Network-Level Indicators

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

Table 2-2 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 minor alarms in the network at the local terminal.
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 alarm cutoff (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.

2.2.5 Power-Level Indicators

Table 2-3 describes the two power-level LEDs on the TCC2 faceplate.

Table 2-3 TCC2 Power-Level Indicators

Power-Level LEDs	Definition
Green/Amber/Red PWR A LED	The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is amber when the voltage on supply input A is between the high battery voltage and extremely high battery voltage (EHIBATVG) thresholds or between the low battery voltage and extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is above extremely high battery voltage or below extremely low battery voltage thresholds.
Green/Amber/Red PWR B LED	The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is amber when the voltage on supply input B is between the high battery voltage and extremely high battery voltage thresholds or between the low battery voltage and extremely low battery voltage thresholds. The LED is red when the voltage on supply input B is above extremely high battery voltage or below extremely low battery voltage thresholds.

Note For ONS 15454 ETSI shelf, the power-level LEDs are either green or red. The LED is green when the voltage on supply inputs is between the extremely low battery voltage and extremely high battery voltage thresholds. The LED is red when the voltage on supply inputs is above extremely high battery voltage or below extremely low battery voltage thresholds.

2.3 TCC2P Card

Note For TCC2P card specifications, see the "A.3.2 TCC2P Card Specifications" section on page A-8.

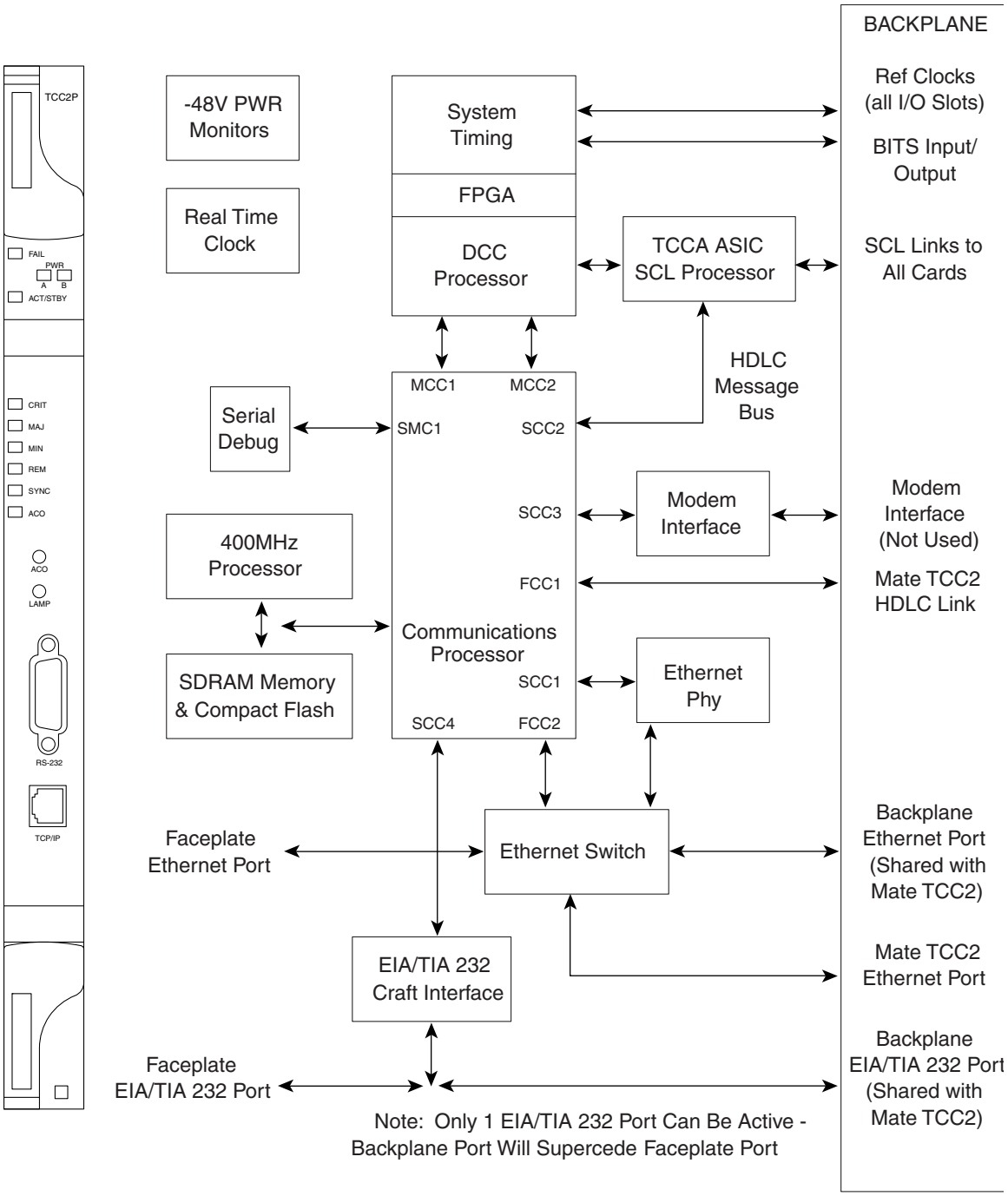
The Advanced Timing, Communications, and Control Plus (TCC2P) card is an enhanced version of the TCC2 card. The primary enhancements are Ethernet security features and 64K composite clock BITS timing.

The TCC2P card performs system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection/resolution, SONET SOH DCC/GCC termination, and system fault detection for the ONS 15454. The TCC2P also ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing requirements. It monitors the supply voltage of the system.

Note The LAN interface of the TCC2P 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 2-2 shows the faceplate and block diagram for the TCC2P card.

Figure 2-2 TCC2P Faceplate and Block Diagram



2.3.1 TCC2P Functionality

The TCC2P card supports multichannel, high-level data link control (HDLC) processing for the DCC. Up to 84 DCCs can be routed over the TCC2P card and up to 84 section DCCs can be terminated at the TCC2P card (subject to the available optical digital communication channels). The TCC2P selects and processes 84 DCCs to facilitate remote system management interfaces.

The TCC2P card 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 TCC2P card nonvolatile memory, which allows quick recovery in the event of a power or card failure.

The TCC2P card performs all system-timing functions for each ONS 15454. The TCC2P card monitors the recovered clocks from each traffic card and two BITS ports for frequency accuracy. The TCC2P card 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 TCC2P card to synchronize with the recovered clock, which provides holdover if the reference is lost.

The TCC2P card supports 64/8K composite clock and 6.312 MHz timing output.

The TCC2P card 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 TCC2P cards in Slots 7 and 11 for redundancy. If the active TCC2P card fails, traffic switches to the protect TCC2P card. All TCC2P card 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 TCC2P card has two built-in Ethernet interface ports for accessing the system: one built-in RJ-45 port on the front faceplate for on-site craft access and a second port on the backplane. The rear Ethernet interface is for permanent LAN access and all remote access via TCP/IP as well as for Operations Support System (OSS) access. The front and rear Ethernet interfaces can be provisioned with different IP addresses using CTC.

Two EIA/TIA-232 serial ports, one on the faceplate and a second on the backplane, allow for craft interface in TL1 mode.

Note To use the serial port craft interface wire-wrap pins on the backplane, the DTR signal line on the backplane port wire-wrap pin must be connected and active.

2.3.2 Redundant TCC2P Card Installation

Cisco does not support operation of the ONS 15454 with only one TCC2P card. For full functionality and to safeguard your system, always operate with two TCC2P cards.

When a second TCC2P card is inserted into a node, it synchronizes its software, its backup software, and its database with the active TCC2P card. If the software version of the new TCC2P card does not match the version on the active TCC2P card, the newly inserted TCC2P card copies from the active TCC2P card, taking about 15 to 20 minutes to complete. If the backup software version on the new TCC2P card does not match the version on the active TCC2P card, the newly inserted TCC2P card copies the backup

software from the active TCC2P card again, taking about 15 to 20 minutes. Copying the database from the active TCC2P card takes about 3 minutes. Depending on the software version and backup version the new TCC2P card started with, the entire process can take between 3 and 40 minutes.

2.3.3 TCC2P Card-Level Indicators

The TCC2P faceplate has ten LEDs. Table 2-4 describes the two card-level LEDs on the TCC2P faceplate.

Table 2-4 TCC2P 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) Amber (Standby)	Indicates the TCC2P is active (green) or in standby (amber) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TCC2P is writing to its database or to the standby TCC2P database, the card LEDs blink. To avoid memory corruption, do not remove the TCC2P when the active or standby LED is blinking.

2.3.4 Network-Level Indicators

Table 2-5 describes the six network-level LEDs on the TCC2P faceplate.

Table 2-5 TCC2P 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.
Amber MIN LED	Indicates minor alarms in the network at the local terminal.
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.

2.3.5 Power-Level Indicators

Table 2-6 describes the two power-level LEDs on the TCC2P faceplate.

Table 2-6 TCC2P Power-Level Indicators

Power-Level LEDs	Definition
Green/Amber/Red PWR A LED	The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is amber when the voltage on supply input A is between the high battery voltage and extremely high battery voltage (EHIBATVG) thresholds or between the low battery voltage and extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is above extremely high battery voltage or below extremely low battery voltage thresholds.
Green/Amber/Red PWR B LED	The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is amber when the voltage on supply input B is between the high battery voltage and extremely high battery voltage thresholds or between the low battery voltage and extremely low battery voltage thresholds. The LED is red when the voltage on supply input B is above extremely high battery voltage or below extremely low battery voltage thresholds.

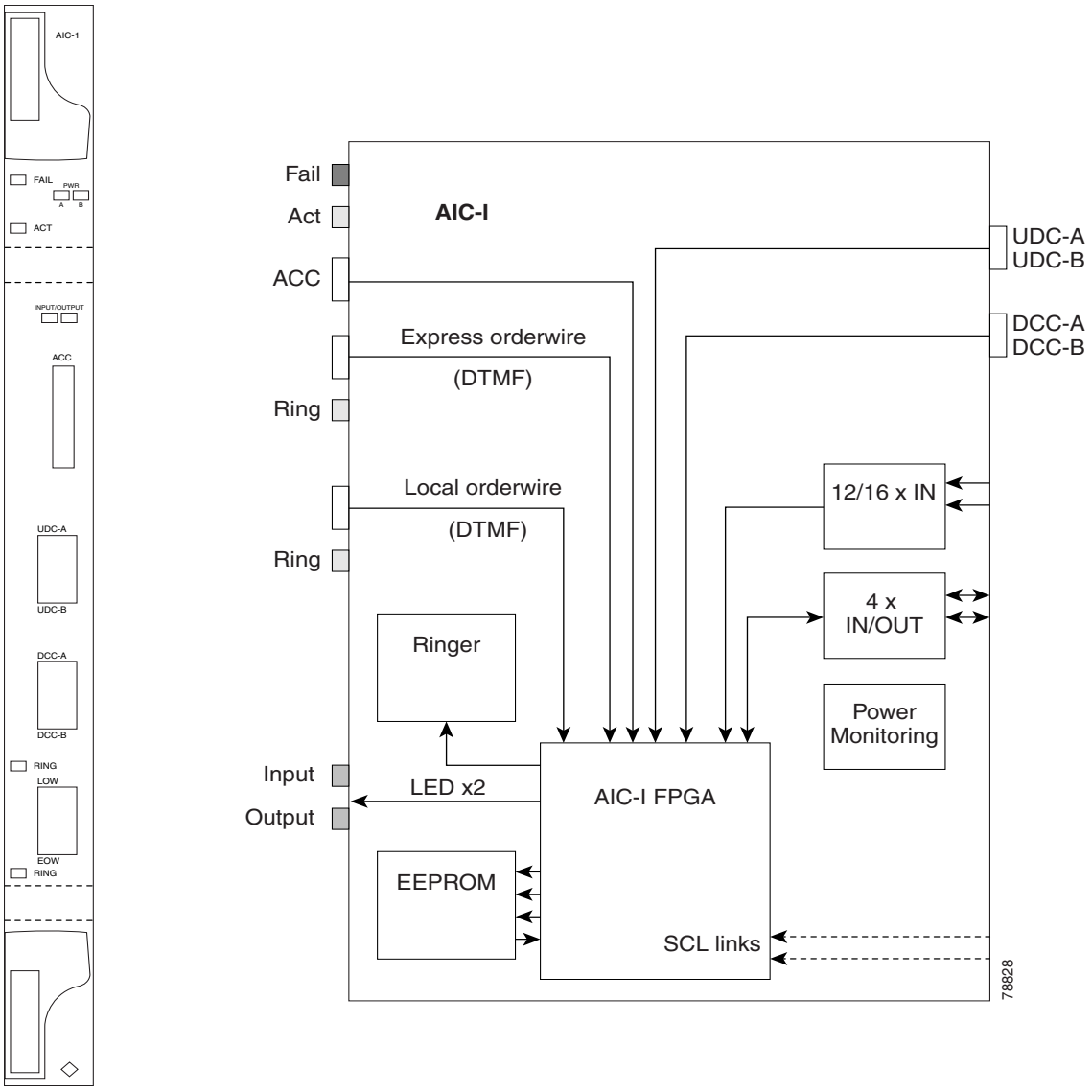
Note For ONS 15454 ETSI shelf, the power-level LEDs are either green or red. The LED is green when the voltage on supply inputs is between the extremely low battery voltage and extremely high battery voltage thresholds. The LED is red when the voltage on supply inputs is above extremely high battery voltage or below extremely low battery voltage thresholds.

2.4 AIC-I Card

Note For hardware specifications, see the "A.3.3 AIC-I Card Specifications" section on page A-9.

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. The AEP is compatible with ANSI shelves only. A power monitoring function monitors the supply voltage (–48 VDC). Figure 2-3 shows the AIC-I faceplate and a block diagram of the card.

Figure 2-3 AIC-I Faceplate and Block Diagram



2.4.1 AIC-I Card-Level Indicators

Table 2-7 describes the eight card-level LEDs on the AIC-I card faceplate.

Table 2-7 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.

Table 2-7 AIC-I Card-Level Indicators (continued)

Card-Level LEDs	Description
Green/Red PWR A LED	The PWR A LED is green when a supply voltage within a 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 a 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.

2.4.2 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 or FMEC connections. See the "1.9 ONS 15454 ANSI Alarm Expansion Panel" section on page 1-32 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 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 Not Reported, Not 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 For ANSI shelves, 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.

2.4.3 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/SDH 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/SDH 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. Orderwire is not protected in ring topologies such as bidirectional line switched ring (BLSR), multiplex section-shared protection ring (MS-SPRing), path protection, or subnetwork connection protection (SNCP) ring.

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/STM-N facilities for each local and express orderwire are provisionable as orderwire paths.

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 2-8 shows the pins on the orderwire connector that correspond to the tip and ring orderwire assignments.

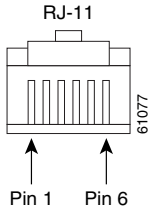
Table 2-8 Orderwire Pin Assignments

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 2-4 shows the standard RJ-11 connectors used for orderwire ports.

Figure 2-4 RJ-11 Connector



2.4.4 Power Monitoring

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

2.4.5 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, see the *Cisco ONS 15454 DWDM Procedure Guide*.

The UDC ports are standard RJ-11 receptacles. Table 2-9 lists the UDC pin assignments.

Table 2-9 UDC Pin Assignments

RJ-11 Pin Number	Description
1	For future use
2	TXN
3	RXN

Table 2-9 UDC Pin Assignments (continued)

RJ-11 Pin Number	Description
4	RXP
5	TXP
6	For future use

2.4.6 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, see the *Cisco ONS 15454 DWDM Procedure Guide*.

The DCC ports are synchronous serial interfaces. The DCC ports are standard RJ-45 receptacles. Table 2-10 lists the DCC pin assignments.

Table 2-10 DCC Pin Assignments

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

2.5 MS-ISC-100T Card

Note For hardware specifications, see the "A.3.7 MS-ISC-100T Card Specifications" section on page A-12.

The Multishelf Internal Switch Card (MS-ISC-100T) is an Ethernet switch used to implement the multishelf LAN. It connects the node controller shelf to the network and to subtending shelves. The MS-ISC-100T must always be equipped on the node controller shelf; it cannot be provisioned on a subtending controller shelf.

The recommended configuration is to implement LAN redundancy using two MS-ISC-100T cards: one switch is connected to the Ethernet front panel port of the TCC2/TCC2P card in Slot 7, and the other switch is connected to the Ethernet front panel port of the TCC2/TCC2P card in Slot 11. The Ethernet configuration of the MS-ISC-100T card is part of the software package and is automatically loaded. The MS-ISC-100T card operates in Slots 1 to 6 and 12 to 17 on the node controller shelf; the recommended slots are Slot 6 and Slot 12.

Table 2-11 lists the MS-ISC-100T port assignments.

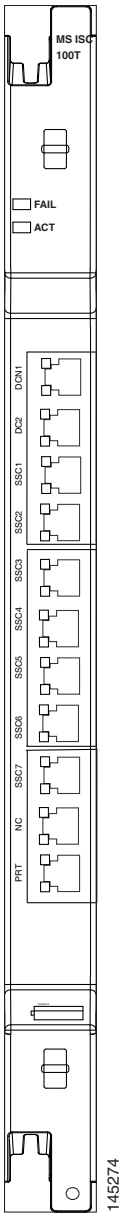
Table 2-11 MS-ISC-100T Card Port Assignments

Port	Description
DCN 1and DCN 2	Connection to the network
SSC1 to SSC7	Connection to subtending shelves
NC	Connection to TCC2/TCC2P using a cross-over cable
PRT	Connection to the PRT port of the redundant MS-ISC-100T

Figure 2-5 shows the card faceplate.

Caution Shielded twisted-pair cabling should be used for interbuilding applications.

Figure 2-5 MS-ISC-100T Faceplate



2.5.1 MS-ISC-100T Card-Level Indicators

The MS-ISC-100T card supports two card-level LED indicators. The card-level indicators are described in Table 2-12.

Table 2-12 MS-ISC-100T Card-Level Indicators

Card-Level LEDs	Description
FAIL LED (Red)	The red FAIL LED indicates that the card processor is not ready or that a catastrophic software failure occurred on the card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
ACT LED (Green)	The green ACT LED provides the operational status of the card. If the ACT LED is green, it indicates that the card is active and the software is operational.

2.6 Front Mount Electrical Connections

This section describes the MIC-A/P and MIC-C/T/P FMECs, which provide power, external alarm, and timing connections for the ONS 15454 ETSI shelf.

2.6.1 MIC-A/P FMEC

Note For hardware specifications, see the "A.3.5 MIC-A/P FMEC Specifications (ETSI only)" section on page A-11.

The MIC-A/P FMEC provides connection for the BATTERY B input, one of the two possible redundant power supply inputs. It also provides connection for eight alarm outputs (coming from the TCC2/TCC2P card), sixteen alarm inputs, and four configurable alarm inputs/outputs. Its position is in Slot 23 in the center of the subrack Electrical Facility Connection Assembly (EFCA) area.

The MIC-A/P FMEC has the following features:

- Connection for one of the two possible redundant power supply inputs
- Connection for eight alarm outputs (coming from the TCC2/TCC2P card)
- Connection for four configurable alarm inputs/outputs
- Connection for sixteen alarm inputs
- Storage of manufacturing and inventory data

For proper system operation, both the MIC-A/P and MIC-C/T/P FMECs must be installed in the ONS 15454 ETSI shelf. Figure 2-6 shows the MIC-A/P faceplate.

Figure 2-6 MIC-A/P Faceplate

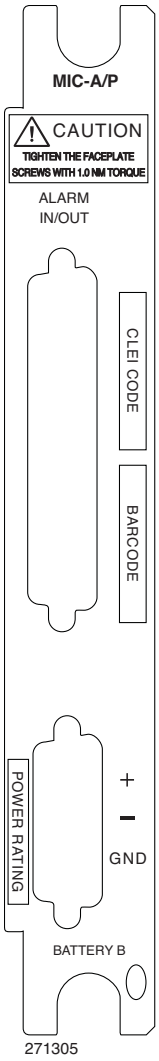


Figure 2-7 shows a block diagram of the MIC-A/P.

Figure 2-7 MIC-A/P Block Diagram

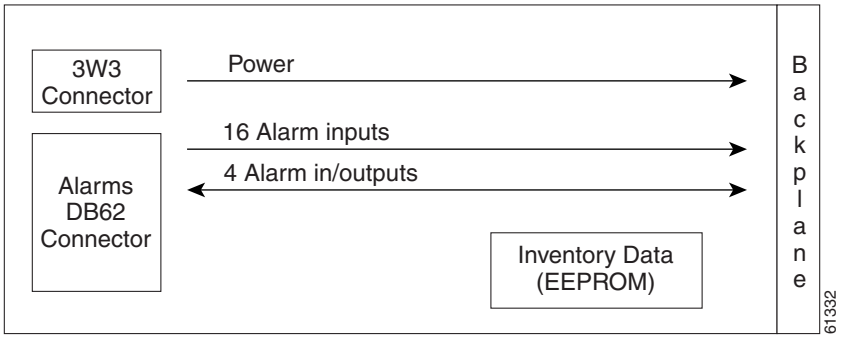


Table 2-13 shows the alarm interface pinouts on the MIC-A/P DB-62 connector.

Table 2-13 Alarm Interface Pinouts on the MIC-A/P DB-62 Connector

Pin No.	Signal Name	Signal Description
1	ALMCUTOFF N	Alarm cutoff, normally open ACO pair
2	ALMCUTOFF P	Alarm cutoff, normally open ACO pair
3	ALMINP0 N	Alarm input pair 1, reports closure on connected wires
4	ALMINP0 P	Alarm input pair 1, reports closure on connected wires
5	ALMINP1 N	Alarm input pair 2, reports closure on connected wires
6	ALMINP1 P	Alarm input pair 2, reports closure on connected wires
7	ALMINP2 N	Alarm input pair 3, reports closure on connected wires
8	ALMINP2 P	Alarm input pair 3, reports closure on connected wires
9	ALMINP3 N	Alarm input pair 4, reports closure on connected wires
10	ALMINP3 P	Alarm input pair 4, reports closure on connected wires
11	EXALM0 N	External customer alarm 1
12	EXALM0 P	External customer alarm 1
13	GND	Ground
14	EXALM1 N	External customer alarm 2
15	EXALM1 P	External customer alarm 2
16	EXALM2 N	External customer alarm 3
17	EXALM2 P	External customer alarm 3
18	EXALM3 N	External customer alarm 4
19	EXALM3 P	External customer alarm 4
20	EXALM4 N	External customer alarm 5
21	EXALM4 P	External customer alarm 5
22	EXALM5 N	External customer alarm 6
23	EXALM5 P	External customer alarm 6
24	EXALM6 N	External customer alarm 7
25	EXALM6 P	External customer alarm 7
26	GND	Ground
27	EXALM7 N	External customer alarm 8
28	EXALM7 P	External customer alarm 8
29	EXALM8 N	External customer alarm 9
30	EXALM8 P	External customer alarm 9
31	EXALM9 N	External customer alarm 10
32	EXALM9 P	External customer alarm 10
33	EXALM10 N	External customer alarm 11
34	EXALM10 P	External customer alarm 11
35	EXALM11 N	External customer alarm 12
36	EXALM11 P	External customer alarm 12

Table 2-13 Alarm Interface Pinouts on the MIC-A/P DB-62 Connector (continued)

Pin No.	Signal Name	Signal Description
37	ALMOUP0 N	Normally open output pair 1
38	ALMOUP0 P	Normally open output pair 1
39	GND	Ground
40	ALMOUP1 N	Normally open output pair 2
41	ALMOUP1 P	Normally open output pair 2
42	ALMOUP2 N	Normally open output pair 3
43	ALMOUP2 P	Normally open output pair 3
44	ALMOUP3 N	Normally open output pair 4
45	ALMOUP3 P	Normally open output pair 4
46	AUDALM0 N	Normally open Minor audible alarm
47	AUDALM0 P	Normally open Minor audible alarm
48	AUDALM1 N	Normally open Major audible alarm
49	AUDALM1 P	Normally open Major audible alarm
50	AUDALM2 N	Normally open Critical audible alarm
51	AUDALM2 P	Normally open Critical audible alarm
52	GND	Ground
53	AUDALM3 N	Normally open Remote audible alarm
54	AUDALM3 P	Normally open Remote audible alarm
55	VISALM0 N	Normally open Minor visual alarm
56	VISALM0 P	Normally open Minor visual alarm
57	VISALM1 N	Normally open Major visual alarm
58	VISALM1 P	Normally open Major visual alarm
59	VISALM2 N	Normally open Critical visual alarm
60	VISALM2 P	Normally open Critical visual alarm
61	VISALM3 N	Normally open Remote visual alarm
62	VISALM3 P	Normally open Remote visual alarm

2.6.2 MIC-C/T/P FMEC

Note For hardware specifications, see the "A.3.6 MIC-C/T/P FMEC Specifications (ETSI only)" section on page A-11.

The MIC-C/T/P FMEC provides connection for the BATTERY A input, one of the two possible redundant power supply inputs. It also provides connection for system management serial port, system management LAN port, modem port (for future use), and system timing inputs and outputs. Install the MIC-C/T/P in Slot 24.

The MIC-C/T/P FMEC has the following features:

- Connection for one of the two possible redundant power supply inputs
- Connection for two serial ports for local craft/modem (for future use)
- Connection for one LAN port
- Connection for two system timing inputs
- Connection for two system timing outputs
- Storage of manufacturing and inventory data

For proper system operation, both the MIC-A/P and MIC-C/T/P FMECs must be installed in the shelf. Figure 2-8 shows the MIC-C/T/P FMEC faceplate.

Figure 2-8 MIC-C/T/P Faceplate

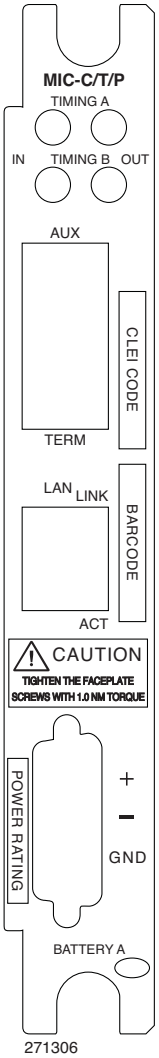
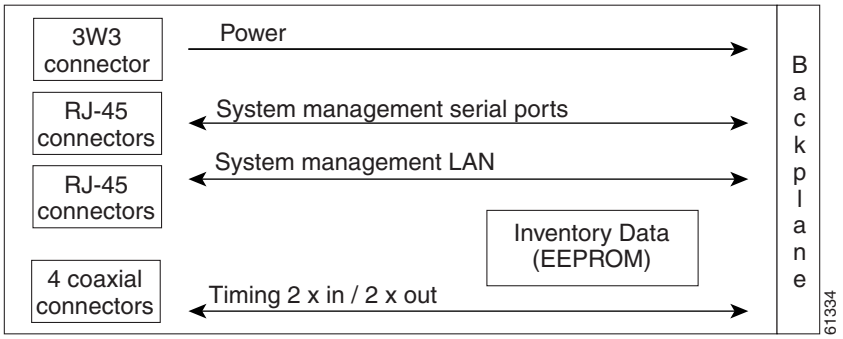


Figure 2-9 shows a block diagram of the MIC-C/T/P.

Figure 2-9 MIC-C/T/P Block Diagram



The MIC-C/T/P FMEC has one pair of LEDs located on the RJ45 LAN connector. The green LED is on when a link is present, and the amber LED is on when data is being transferred.

CHAPTER 3

Optical Service Channel Cards

This chapter describes the optical service channel (OSC) cards for Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 3.1 Card Overview, page 3-1
- 3.2 Class 1 Laser Safety Labels, page 3-2
- 3.3 OSCM Card, page 3-4
- 3.4 OSC-CSM Card, page 3-8

3.1 Card Overview

This section provides card summary and compatibility information.

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 "1.16.1 Card Slot Requirements" section on page 1-61 for a list of slots and symbols.

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 terminations are present, one for the west side and another for the east side. The channel transports OSC overhead that is used to manage ONS 15454 DWDM networks. An 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/STM-1 formatted signal.

There are two versions of the OSC modules: the OSCM, and the OSC-CSM, which contains the OSC wavelength combiner and separator component in addition to the OSC module.

The Mesh/Multiring Upgrade (MMU) card is used to optically bypass a given wavelength from one section of the network or ring to another one without requiring 3R regeneration.

3.1.1 Card Summary

Table 3-1 lists and summarizes the functions of each card.

Table 3-1 OSCM, OSC-CSM, and MMU Card Summary

Card	Port Description	For Additional Information
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 "3.3 OSCM Card" section on page 3-4.
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 "3.4 OSC-CSM Card" section on page 3-8.

3.1.2 Card Compatibility

Table 3-2 lists the CTC software compatibility for the OSC and OSCM cards.

Table 3-2 Software Release Compatibility for Optical Service Channel Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5
OSCM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OSC-CSM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3.2 Class 1 Laser Safety Labels

This section explains the significance of the safety labels attached to the OSCM and OSC-CSM cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

3.2.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in Figure 3-1.

Figure 3-1 Class 1 Laser Product Label

Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and may therefore be considered safe. However, some Class 1 laser products may contain laser systems of a higher

Class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

3.2.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 3-2.

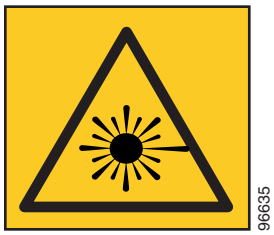
Figure 3-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

3.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 3-3.

Figure 3-3 Laser Source Connector Label

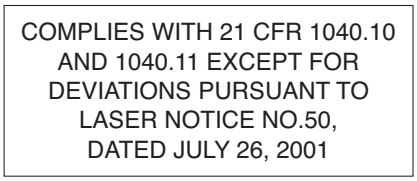


This label indicates that a laser source is present at the optical connector where the label has been placed.

3.2.4 FDA Statement Label

The FDA Statement label is shown in Figure 3-4.

Figure 3-4 FDA Statement Label

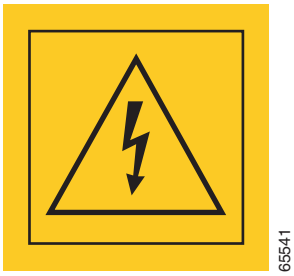


This label shows compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

3.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 3-5.

Figure 3-5 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

This section describes the optical service channel cards. 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 terminations are present, one for the west side and another for the east side. The channel transports OSC overhead that is used to manage ONS 15454 DWDM networks. An 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/STM-1 formatted signal.

There are two versions of the OSC modules: the OSCM, and the OSC-CSM, which contains the OSC wavelength combiner and separator component in addition to the OSC module.

3.3 OSCM Card

Note For OSCM card specifications, see the "A.4.1 OSCM Card Specifications" section on page A-13.

The OSCM card is used in amplified nodes that include the OPT-BST, OPT-BST-E, or OPT-BST-L booster amplifier. The OPT-BST, OPT-BST-E, and OPT-BST-L cards include the required OSC wavelength combiner and separator component. The OSCM cannot be used in nodes where you use OC-N/STM-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/STM-1 formatted OSC
- Supervisory data channel (SDC) forwarded to the TCC2/TCC2P cards for processing
- Distribution of the synchronous clock to all nodes in the ring
- 100BaseT far-end (FE) User Channel (UC)
- Monitoring functions such as orderwire support and optical safety

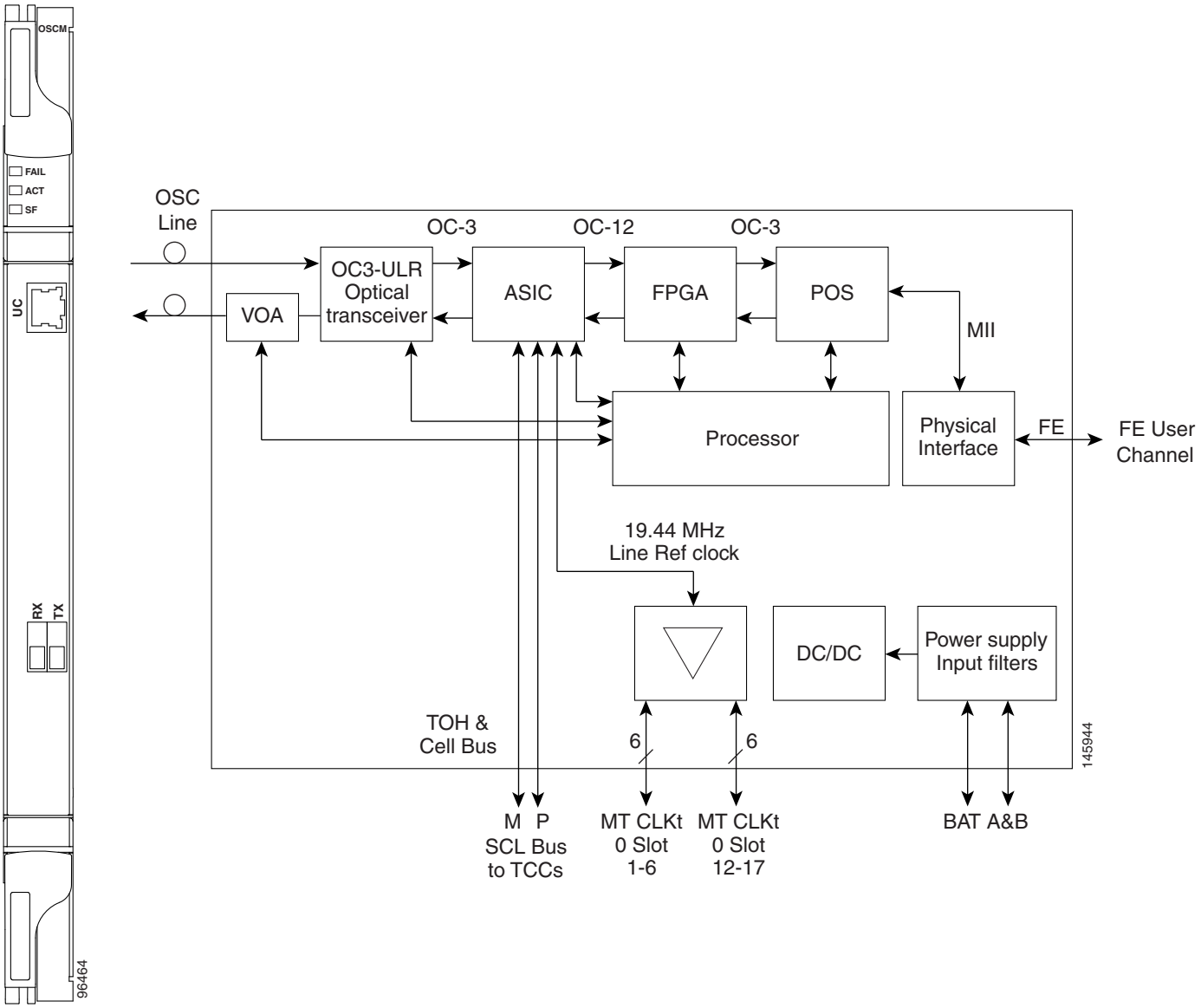
The OC-3/STM-1 section data communications channel (SDCC or RS-DCC) overhead bytes are used for network communications. An optical transceiver terminates the OC-3/STM-1, then it is regenerated and converted into an electrical signal. The SDCC or RS-DCC bytes are forwarded to the active and standby TCC2/TCC2P cards for processing through the system communication link (SCL) bus on the backplane. Orderwire bytes (E1, E2, F1) are also forwarded via the SCL bus to the TCC2/TCC2P for forwarding to the AIC-I card.

The payload portion of the OC-3/STM-1 is used to carry the fast Ethernet UC. The frame is sent to a packet-over-SONET/SDH (POS) processing block that extracts the Ethernet packets and makes them available at the RJ-45 connector.

The OSCM distributes the reference clock information by removing it from the incoming OC-3/STM-1 signal and then sending it to the DWDM cards. The DWDM cards then forward the clock information to the active and standby TCC2/TCC2P cards.

Figure 3-6 shows the OSCM card faceplate and block diagram.

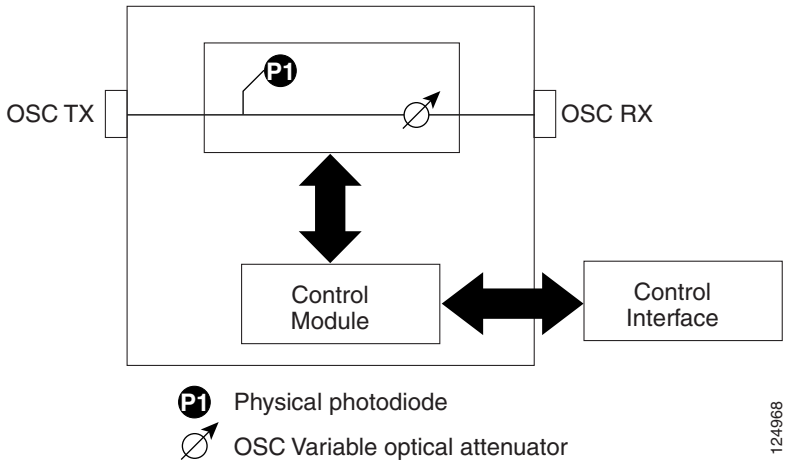
Figure 3-6 OSCM Card Faceplate



For information on safety labels for the card, see the "3.2 Class 1 Laser Safety Labels" section on page 3-2.

Figure 3-7 shows the block diagram of the variable optical attenuator (VOA) within the OSCM.

Figure 3-7 OSCM VOA Optical Module Functional Block Diagram



3.3.1 Power Monitoring

Physical photodiode P1 monitors the power for the OSCM card. The returned power level value is calibrated to the OSC TX port (Table 3-3).

Table 3-3 OSCM VOA Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	Output OSC	OSC TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

3.3.2 OSCM Card-Level Indicators

The OSCM card has three card-level LED indicators, described in Table 3-4.

Table 3-4 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.

Table 3-4 OSCM Card-Level Indicators (continued)

Card-Level Indicators	Description
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 loss of signal (LOS), loss of frame alignment (LOF), line alarm indication signal (AIS-L), or high BER on one or more of the card's ports. The amber signal fail (SF) LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

3.3.3 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/STM-1 optical port located on the faceplate. One long-reach OSC transmits and receives the OSC to and from another DWDM node. Both DCN data and FE payload are carried on this link.

3.4 OSC-CSM Card

Note For OSC-CSM card specifications, see the "A.4.2 OSC-CSM Card Specifications" section on page A-13.

The OSC-CSM card 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. To operate in hybrid mode, the OSC-CSM cards must be accompanied by cross-connect cards. The cross-connect cards enable functionality on the OC-N/STM-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/STM-1 formatted OSC
- SDC forwarded to the TCC2/TCC2P cards for processing
- Distribution of the synchronous clock to all nodes in the ring
- 100BaseT FE UC
- Monitoring functions such as orderwire support
- 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. For details on ALS provisioning for the card, see the *Cisco ONS 15454 DWDM Procedure Guide*. For information on using the card to implement ALS in a network, see the "10.7 Network Optical Safety" section on page 10-18.

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/STM-1 formatted signal. The OC-3/STM-1 SDCC or RS-DCC overhead bytes are used for network communications. An optical transceiver terminates the OC-3/STM-1, and then it is regenerated and converted into an electrical signal. The SDCC or RS-DCC bytes are forwarded to the active and standby TCC2/TCC2P 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/TCC2P for forwarding to the AIC-I card.

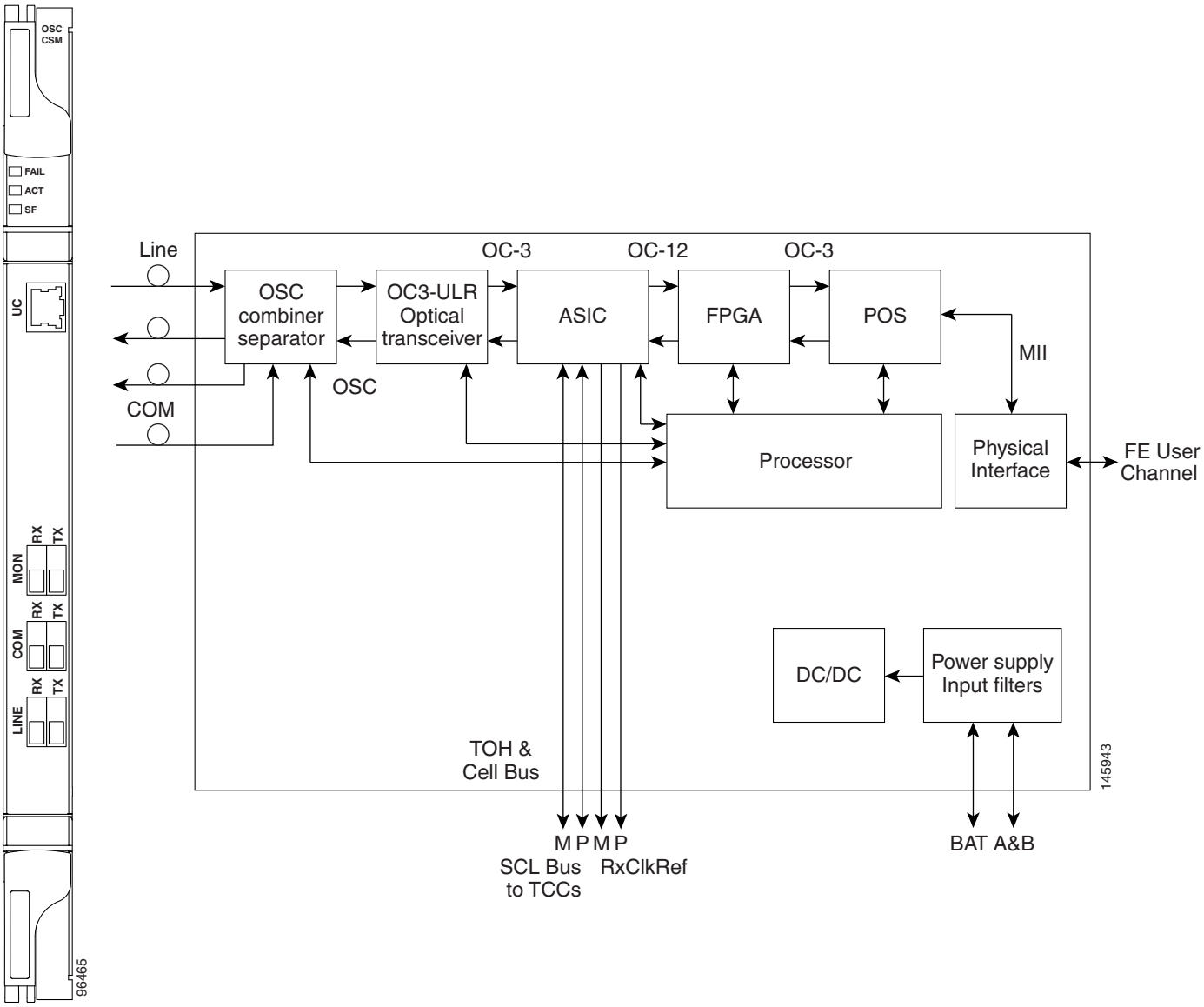
The payload portion of the OC-3/STM-1 is used to carry the fast Ethernet UC. The frame is sent to a POS processing block that extracts the Ethernet packets and makes them available at the RJ-45 front panel connector.

The OSC-CSM distributes the reference clock information by removing it from the incoming OC-3/STM-1 signal and then sending it to the active and standby TCC2/TCC2P cards. The clock distribution is different from the OSCM card because the OSC-CSM does not use Slot 8 or 10 (cross-connect card slots).

Note S1 and S2 (Figure 3-10 on page 3-12) 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.

Figure 3-8 shows the OSC-CSM faceplate.

Figure 3-8 OSC-CSM Faceplate



For information on safety labels for the card, see the "3.2 Class 1 Laser Safety Labels" section on page 3-2.

Figure 3-9 shows a block diagram of the OSC-CSM card.

Figure 3-9 OSC-CSM Block Diagram

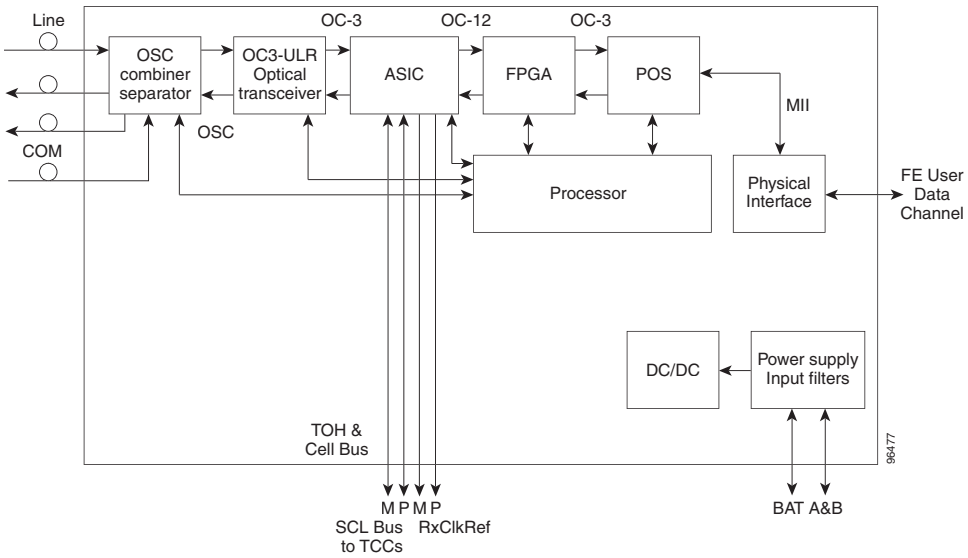
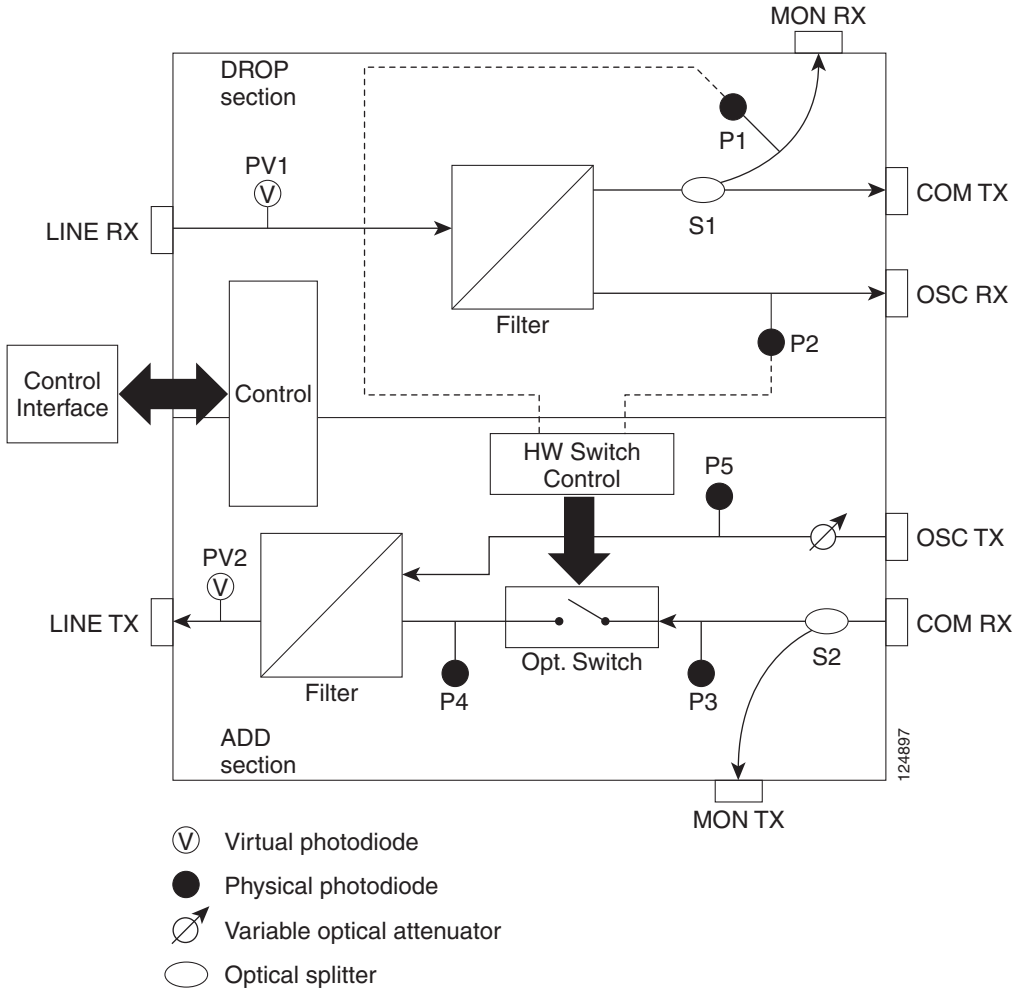


Figure 3-10 shows the OSC-CSM optical module functional block diagram.

Figure 3-10 OSC-CSM Optical Module Functional Block Diagram



3.4.1 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 3-5.

Table 3-5 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

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

3.4.2 OSC-CSM Card-Level Indicators

The OSC-CSM card has three card-level LED indicators, described in Table 3-6.

Table 3-6 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.

3.4.3 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 OC3 port and three other sets of ports located on the faceplate.

CHAPTER 4

Optical Amplifier Cards

This chapter describes the optical amplifier cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 4.1 Card Overview, page 4-1
- 4.2 Class 1M Laser Safety Labels, page 4-3
- 4.3 OPT-PRE Amplifier Card, page 4-5
- 4.4 OPT-BST Amplifier Card, page 4-9
- 4.5 OPT-BST-E Amplifier Card, page 4-13
- 4.6 OPT-BST-L Amplifier Card, page 4-17
- 4.7 OPT-AMP-L Card, page 4-21
- 4.8 OPT-AMP-17-C Card, page 4-26
- 4.9 OPT-AMP-C Card, page 4-30

4.1 Card Overview

This section provides summary and compatibility information for the optical amplifier cards.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. Cards should be installed in slots that have the same symbols. See the "1.16.1 Card Slot Requirements" section on page 1-61 for a list of slots and symbols.

Optical amplifiers are used in amplified nodes (such as hub nodes), amplified OADM nodes, and line amplifier nodes. The seven types of ONS 15454 DWDM amplifiers are:

- Optical Preamplifier (OPT-PRE)
- Optical Booster amplifier (OPT-BST)

- Optical Booster Enhanced amplifier (OPT-BST-E)
- Optical Booster L-Band amplifier (OPT-BST-L)
- Optical L-Band preamplifier (OPT-AMP-L)
- Optical C-Band amplifier (OPT-AMP-17-C).
- Optical C-band high-gain high-power amplicier (OPT-AMP-C)

Note The OPT-AMP-L preamplifier, OPT-AMP-C and OPT-AMP-17-C amplifiers are software-configurable as a preamplifier or as a booster amplifier.

Optical amplifier card architecture includes an optical plug-in module with a controller that manages optical power, laser current, and temperature control loops. An amplifier also manages communication with the TCC2/TCC2P card and operation, administration, maintenance, and provisioning (OAM&P) functions such as provisioning, controls, and alarms.

4.1.1 Card Summary

Table 4-1 lists and summarizes the functions of each optical amplifier card.

Table 4-1 Optical Amplifier Cards for the ONS 15454

Card	Port Description	For Additional Information
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 "4.3 OPT-PRE Amplifier Card" section on page 4-5.
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 "4.4 OPT-BST Amplifier Card" section on page 4-9.
OPT-BST-E	The OPT-BST-E amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.5 OPT-BST-E Amplifier Card" section on page 4-13.
OPT-BST-L	The OPT-BST-L L-band amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.6 OPT-BST-L Amplifier Card" section on page 4-17.
OPT-AMP-L	The OPT-AMP-L L-band preamplifier have five sets of optical ports located on the faceplate. It is a two-slot card that operates in Slots 1 to 6 and 12 to 17.	See the "4.7 OPT-AMP-L Card" section on page 4-21.

Table 4-1 Optical Amplifier Cards for the ONS 15454 (continued)

Card	Port Description	For Additional Information
OPT-AMP-17-C	The OPT-AMP-17-C C-band low-gain preamplifier/booster amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.8 OPT-AMP-17-C Card" section on page 4-26.
OPT-AMP-C	The OPT-AMP-C C-band high-gain, high-power preamplifier/booster amplifier has five sets of optical ports located on the faceplate. It operates as a preamplifier when equipped and provisioned in Slots 2 to 6 and 11 to 16 or as a booster amplifier when equipped and provisioned in Slot 1 and 17.	See the "4.9 OPT-AMP-C Card" section on page 4-30.

4.1.2 Card Compatibility

Table 4-2 lists the Cisco Transport Controller (CTC) software compatibility for each optical amplifier card.

Table 4-2 Software Release Compatibility for Optical Amplifier Cards

Card Type	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5
OPT-PRE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OPT-BST	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OPT-BST-E	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OPT-BST-L	No	No	No	No	No	Yes	Yes	Yes	Yes
OPT-AMP-L	No	No	No	No	No	Yes	Yes	Yes	Yes
OPT-AMP-17-C	No	No	No	No	No	No	No	Yes	Yes
OPT-AMP-C	No	No	No	No	No	No	No	No	Yes

4.2 Class 1M Laser Safety Labels

This section explains the significance of the safety labels attached to the optical amplifier cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

4.2.1 Class 1M Laser Product Label

Figure 4-1 shows the Class 1M Laser Product label. Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

Figure 4-1 Class 1M Laser Product Label

4.2.2 Hazard Level 1M Label

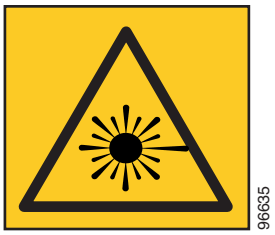
Figure 4-2 shows the Hazard Level 1M label. The Hazard Level label warns users against exposure to laser radiation calculated in accordance with IEC60825-1 Ed.1.2.

Figure 4-2 Hazard Level Label

4.2.3 Laser Source Connector Label

Figure 4-3 shows the Laser Source Connector label. This label indicates that a laser source is present at the optical connector where the label appears.

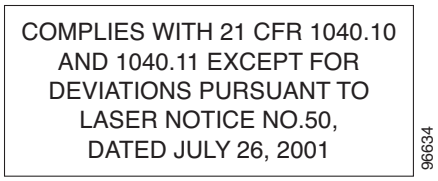
Figure 4-3 Laser Source Connector Label



4.2.4 FDA Statement Label

Figure 4-4 shows the FDA Statement label. This label represents compliance to FDA standards and a hazard-level classification in accordance with IEC60825-1 Am.2 or Ed.1.2.

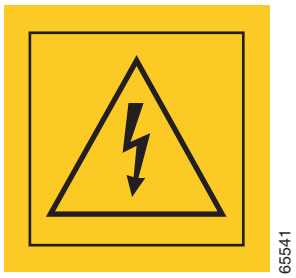
Figure 4-4 FDA Statement Label



4.2.5 Shock Hazard Label

Figure 4-5 shows the Shock Hazard label. This label alerts you to an electrical hazard within the card. The potential for shock exists when you remove adjacent cards during maintenance or touch exposed electrical circuity on the card.

Figure 4-5 Shock Hazard Label



4.3 OPT-PRE Amplifier Card

Note For hardware specifications, see the "A.5.1 OPT-PRE Amplifier Card Specifications" section on page A-14.

Note For OPT-PRE card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-PRE is a C-band, DWDM, two-stage erbium-doped fiber amplifier (EDFA) with midamplifier loss (MAL) that can be connected to a dispersion compensating unit (DCU). The OPT-PRE is equipped with a built-in variable optical attenuator (VOA) that controls the gain tilt and 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 card is designed to support up to 80 channels at 50-GHz channel spacing. The OPT-PRE 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
- Amplified spontaneous emissions (ASE) compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- 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, resulting in about 20 dB-lower power at the MON port than at the COM TX port.

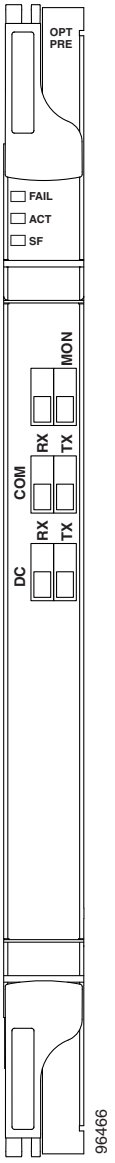
4.3.1 OPT-PRE Faceplate Ports

The OPT-PRE amplifier has five optical ports located on the faceplate:

- MON is the output monitor port
- COM RX (receive) is the input signal port
- COM TX (transmit) is the output signal port
- DC RX is the MAL input signal port
- DC TX is the MAL output signal port

Figure 4-6 shows the OPT-PRE amplifier card faceplate.

Figure 4-6 OPT-PRE Faceplate



4.3.2 OPT-PRE Block Diagrams

Figure 4-7 shows a simplified block diagram of the OPT-PRE card's features.

Figure 4-7 OPT-PRE Block Diagram

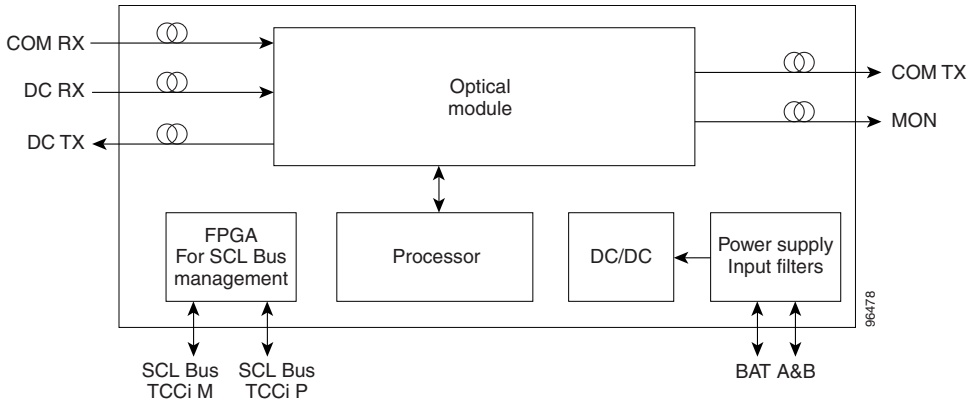
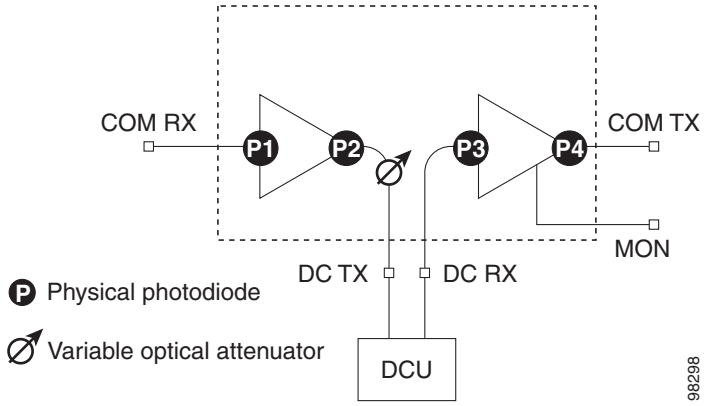


Figure 4-8 shows the a block diagram of how the OPT-PRE optical module functions.

Figure 4-8 OPT-PRE Optical Module Functional Block Diagram



4.3.3 OPT-PRE Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-PRE card. Table 4-3 shows the returned power level values calibrated to each port.

Table 4-3 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)	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.3.4 OPT-PRE Amplifier Card-Level Indicators

Table 4-4 shows the three card-level LED indicators on the OPT-PRE amplifier card.

Table 4-4 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 an internal hardware failure occurred. 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.3.5 OPT-PRE Ampifier Port-Level Indicators

You can determine 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.

4.4 OPT-BST Amplifier Card

Note For hardware specifications, see the "A.5.2 OPT-BST Amplifier Card Specifications" section on page A-15.

Note For OPT-BST card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-BST is designed to ultimately support up to 80 channels at 50-GHz channel spacing. The OPT-BST is a C-band, DWDM EDFA with optical service channel (OSC) add-and-drop capability. When an OPT-BST installed in the an ONS 15454, an OSCM card is also needed to process the OSC. You can install the OPT-BST in Slots 1 to 6 and 12 to 17. The card's features include:

- Fixed gain mode (with programmable tilt)
- Gain range of 5 to 20 dB in constant gain mode and output power mode
- True variable gain
- Built-in VOA to control gain tilt
- Fast transient suppression

- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- Optical Safety Remote Interlock (OSRI), a CTC software feature capable of shutting down optical output power or reducing the power to a safe level (automatic power reduction)
- Automatic laser shutdown (ALS), a safety mechanism used in the event of a fiber cut. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For information about using the card to implement ALS in a network, see the "10.7 Network Optical Safety" section on page 10-18.

Note The optical splitters each have a ratio of 1:99. The result is that MON TX and MON RX port power is about 20 dB lower than COM TX and COM RX port power.

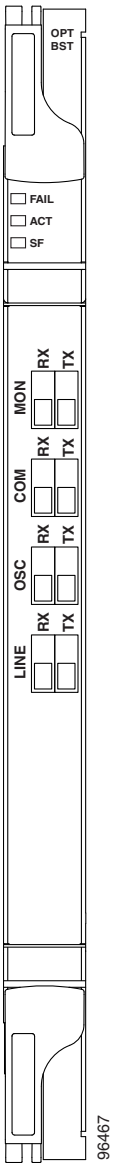
4.4.1 OPT-BST Faceplate Ports

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.

Figure 4-9 shows the OPT-BST amplifier card faceplate.

Figure 4-9 OPT-BST Faceplate



4.4.2 OPT-BST Block Diagrams

Figure 4-10 shows a simplified block diagram of the OPT-BST card's features.

Figure 4-10 OPT-BST Block Diagram

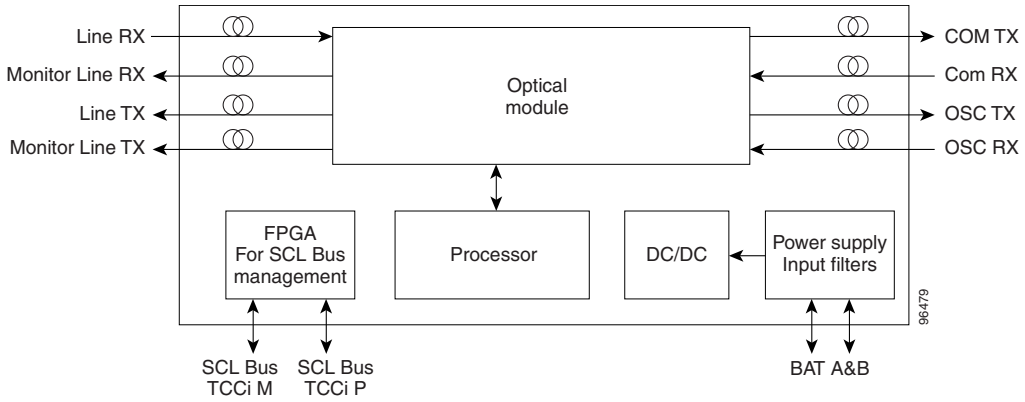
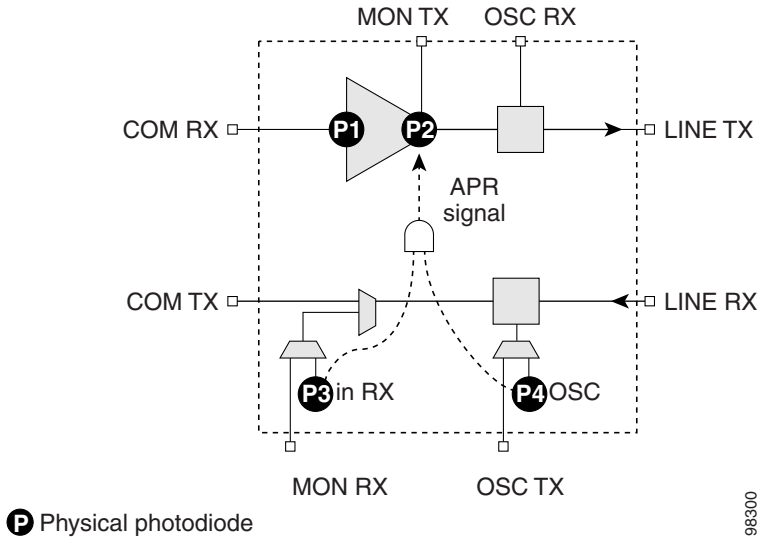


Figure 4-11 shows a block diagram of how the OPT-BST optical module functions.

Figure 4-11 OPT-BST Optical Module Functional Block Diagram



4.4.3 OPT-BST Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-BST card. Table 4-5 shows the returned power level values calibrated to each port.

Table 4-5 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)	

Table 4-5 OPT-BST Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P3	Output COM	LINE RX
P4	Output OSC	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.4.4 OPT-BST Card-Level Indicators

Table 4-6 describes the three card-level LED indicators on the OPT-BST card.

Table 4-6 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.4.5 OPT-BST Port-Level Indicators

You can determine 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.

4.5 OPT-BST-E Amplifier Card

Note For hardware specifications, see the "A.5.3 OPT-BST-E Amplifier Card Specifications" section on page A-15.

Note For OPT-BST-E safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-BST-E amplifier card is a gain-enhanced version of the OPT-BST card. It is designed to support up to 80 channels at 50-GHz channel spacing. The OPT-BST-E is a C-band, DWDM EDFA with OSC add-and-drop capability. When an OPT-BST-E installed, an OSCM card is needed to process the OSC. You can install the OPT-BST-E in Slots 1 to 6 and 12 to 17. The card's features include:

- Fixed gain mode (with programmable tilt)
- True variable gain
- Gain range of 8 to 23 dBm with the tilt managed at 0 dBm in constant gain mode and output power mode
- Enhanced gain range of 23 to 26 dBm with unmanaged tilt
- Built-in VOA to control the gain tilt
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

Note The optical splitters each have a ratio of 1:99. The result is that MON TX and MON RX port power is about 20 dB lower than COM TX and COM RX port power.

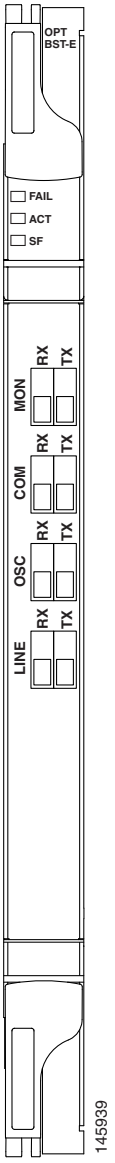
4.5.1 OPT-BST-E Faceplate Ports

The OPT-BST-E amplifier card 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.

Figure 4-12 shows the OPT-BST-E amplifier card faceplate.

Figure 4-12 OPT-BST-E Faceplate



4.5.2 OPT-BST-E Block Diagrams

Figure 4-13 shows a simplified block diagram of the OPT-BST-E card's features.

Figure 4-13 OPT-BST-E Block Diagram

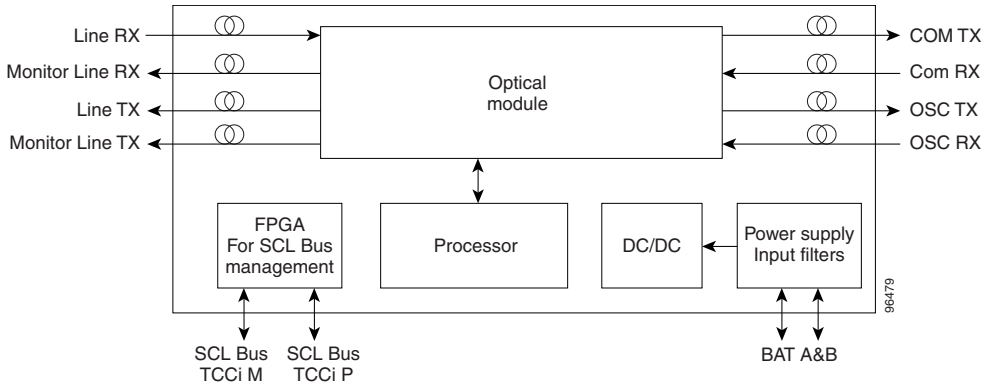
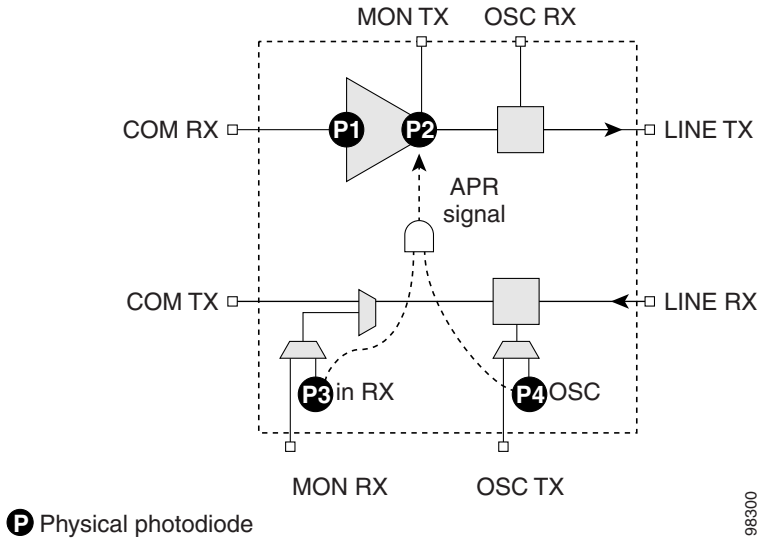


Figure 4-14 shows a block diagram of how the OPT-BST-E optical module functions.

Figure 4-14 OPT-BST-E Optical Module Functional Block Diagram



4.5.3 OPT-BST-E Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-BST-E card. Table 4-7 shows the returned power level values calibrated to each port.

Table 4-7 OPT-BST-E 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)	

Table 4-7 OPT-BST-E Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P3	Output COM	LINE RX
P4	Output OSC	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.5.4 OPT-BST-E Card-Level Indicators

Table 4-8 describes the three card-level LED indicators on the OPT-BST-E amplifier card.

Table 4-8 OPT-BST-E 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-BST-E 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.5.5 OPT-BST-E Port-Level Indicators

You can determine 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.

4.6 OPT-BST-L Amplifier Card

Note For hardware specifications, see the "A.5.4 OPT-BST-L Amplifier Card Specifications" section on page A-16.

Note For OPT-BST-L safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-BST-L is an L-band, DWDM EDFA with OSC add-and-drop capability. The card is well suited for use in networks that employ dispersion shifted (DS) fiber or SMF-28 single-mode fiber. The OPT-BST-L is designed to ultimately support 64 channels at 50-GHz channel spacing, but in

Software R8.5 and earlieris limited to 32 channels at 100-GHz spacing.When an ONS 15454 has an OPT-BST-L installed, an OSCM card is needed to process the OSC. You can install the OPT-BST-L in Slots 1 to 6 and 12 to 17. The card's features include:

- Fixed gain mode (with programmable tilt)
- Standard gain range of 8 to 20 dB in the programmable gain tilt mode
- True variable gain
- 20 to 27 dB gain range in the uncontrolled gain tilt mode
- Built-in VOA to control gain tilt
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

Note The optical splitters each have a ratio of 1:99. The result is that MON TX and MON RX port power is about 20 dB lower than COM TX and COM RX port power.

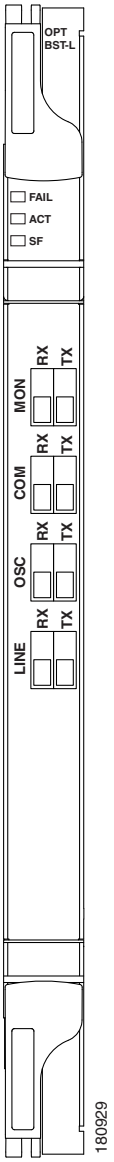
4.6.1 OPT-BST-L Faceplate Ports

The OPT-BST-L 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.

Figure 4-15 shows the OPT-BST-L card faceplate.

Figure 4-15 OPT-BST-L Faceplate



4.6.2 OPT-BST-L Block Diagrams

Figure 4-16 shows a simplified block diagram of the OPT-BST-L card's features.

Figure 4-16 OPT-BST-L Block Diagram

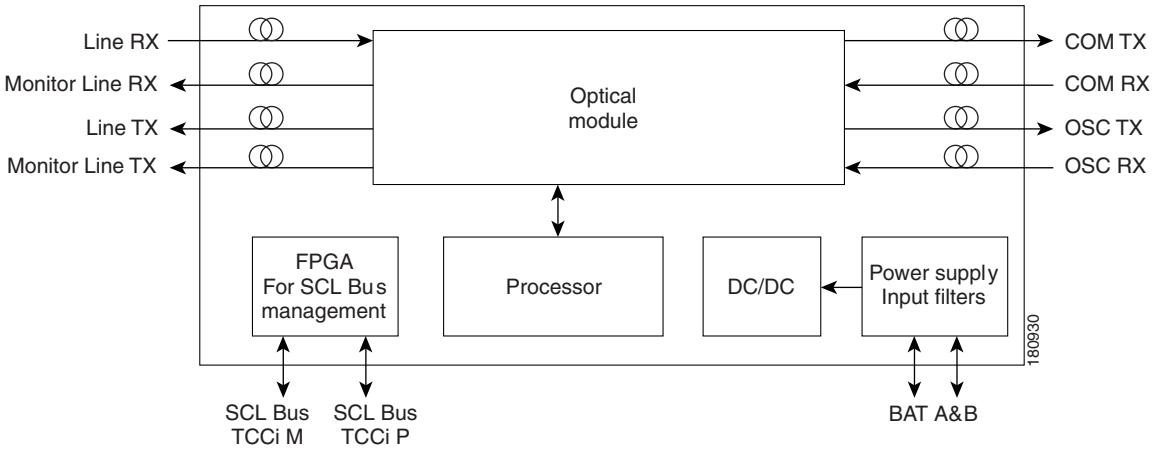
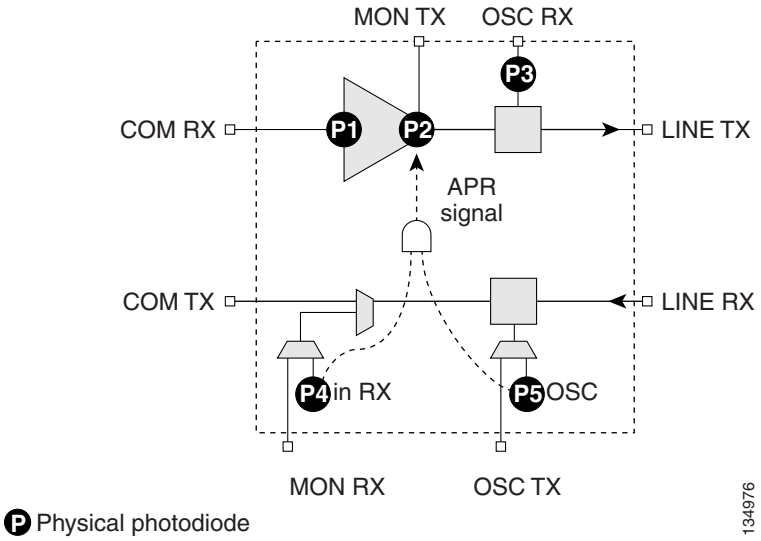


Figure 4-17 shows a block diagram of how the OPT-BST-L optical module functions.

Figure 4-17 OPT-BST-L Optical Module Functional Block Diagram



4.6.3 OPT-BST-L Power Monitoring

Physical photodiodes P1, P2, P3, P4, and P5 monitor the power for the OPT-BST-L card. Table 4-9 shows the returned power level values calibrated to each port.

Table 4-9 OPT-BST-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	Input COM	COM RX

Table 4-9 OPT-BST-L Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P2	Output Line (Total Output)	LINE TX
	Output Line (Signal Output)	
P3	Output OSC-RX	OSC-RX
P4	Output COM	LINE RX
P5	Output OSC-TX	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.6.4 OPT-BST-L Card-Level Indicators

Table 4-10 shows the three card-level LEDs on the OPT-BST-L card.

Table 4-10 OPT-BST-L 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-BST-L 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.6.5 OPT-BST-L Port-Level Indicators

You can determine 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.

4.7 OPT-AMP-L Card

Note For hardware specifications, see the "A.5.5 OPT-AMP-L Preamplifier Card Specifications" section on page A-17.

Note For OPT-AMP-L card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-AMP-L is an L-band, DWDM optical amplifier card consisting of a two-stage EDFA with midstage access loss (MSL) for an external DCU and OSC add-and-drop capability. Using CTC, the card is provisionable as a preamplifier (OPT-PRE) or booster amplifier (OPT-BST), and is well suited for use in networks that employ DS or SMF-28 fiber. The amplifier can operate up to 64 optical transmission channels at 50-GHz channel spacing in the 1570 nm to 1605 nm wavelength range.

When an OPT-AMP-L installed, an OSCM card is needed to process the OSC. You can install the two-slot OPT-AMP-L in Slots 1 to 6 and 12 to 17.

The card has the following features:

- Maximum power output of 20 dBm
- True variable gain amplifier with settable range from 12 to 24 dBm in the standard gain range and 24 dBm to 35 dbM with uncontrolled gain tilt
- Built-in VOA to control gain tilt
- Up to 12 dBm MSL for an external DCU
- Fast transient suppression; able to adjust power levels in hundreds of microseconds to avoid bit errors in failure or capacity growth situations
- Nondistorting low frequency transfer function
- Midstage access loss for dispersion compensation unit
- Constant pump current mode (test mode)
- Constant output power mode (used during optical node setup)
- Constant gain mode
- Internal ASE compensation in constant gain mode and in constant output power mode
- Full monitoring and alarm handling capability
- Optical safety support through signal loss detection and alarm at any input port, fast power down control (less than one second), and reduced maximum output power in safe power mode. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For information on using the card to implement ALS in a network, see the "10.7 Network Optical Safety" section on page 10-18.

Note Before disconnecting any OPT AMP-L fiber for troubleshooting, first make sure the OPT AMP-L card is unplugged.

4.7.1 OPT-AMP-L Faceplate Ports

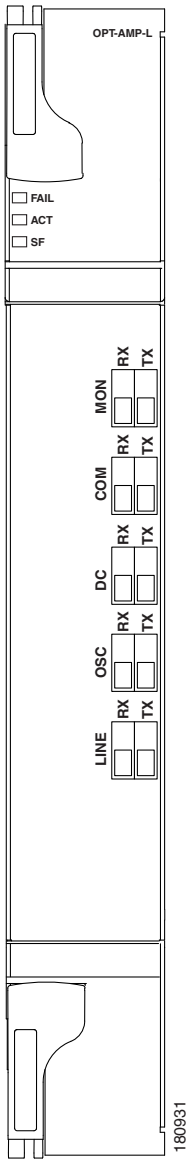
The OPT-AMP-L amplifier card has ten optical ports located on the faceplate:

- 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.
- DC TX is the output signal to the DCU.
- DC RX is the input signal from the DCU.

Figure 4-18 shows the OPT-AMP-L card faceplate.

Figure 4-18 OPT-AMP-L Faceplate



4.7.2 OPT-AMP-L Block Diagrams

Figure 4-19 shows a simplified block diagram of the OPT-AMP-L card's features.

Figure 4-19 OPT-AMP-L Block Diagram

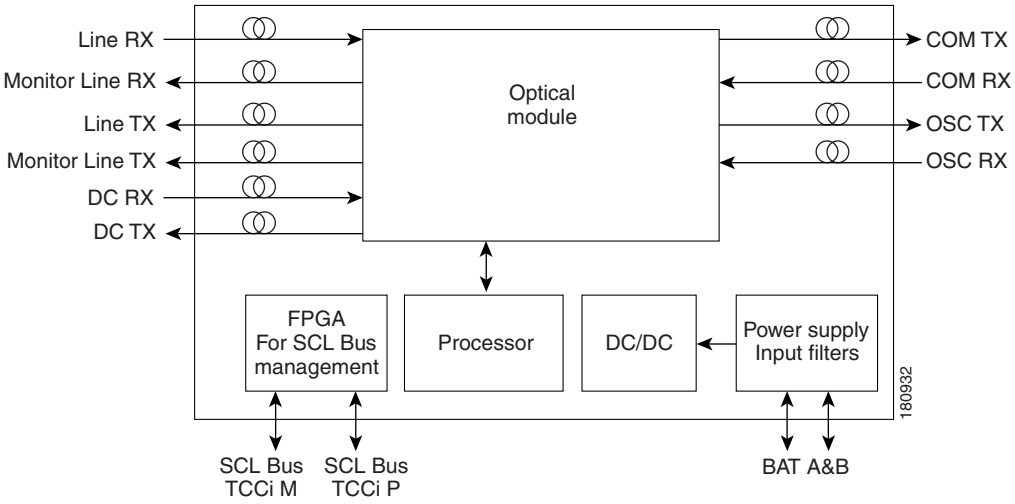
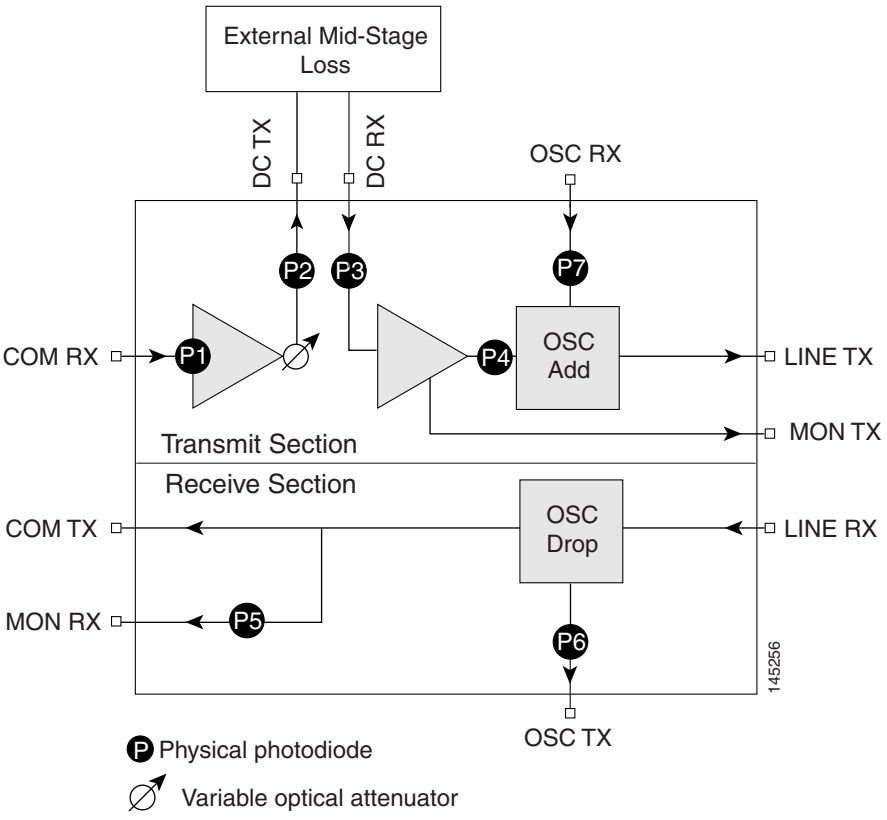


Figure 4-20 shows a block diagram of how the OPT-AMP-L optical module functions.

Figure 4-20 OPT-AMP-L Optical Module Functional Block Diagram



4.7.3 OPT-AMP-L Power Monitoring

Physical photodiodes P1 through P7 monitor the power for the OPT-AMP-L card. Table 4-11 shows the returned power level values calibrated to each port.

Table 4-11 OPT-AMP-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	Input COM Power	COM RX
P2	Output DC (total power)	DC TX
	Output DC (signal power)	
P3	Input DC (input power)	DC RX
P4	Output Line Transmit (total power)	LINE TX
	Output Line Transmit (signal power)	
P5	Input Line Receive Power	LINE RX
P6	Output OSC Receive Power	OSC RX
P7	Input OSC Transmit Power	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.7.4 OPT-AMP-L Card-Level Indicators

Table 4-12 shows the three card-level LEDs on the OPT-AMP-L card.

Table 4-12 OPT-AMP-L 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-AMP-L 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.7.5 OPT-AMP-L Port-Level Indicators

You can determine 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.

4.8 OPT-AMP-17-C Card

Note For hardware specifications, see the "A.5.6 OPT-AMP-17-C Amplifier Card Specifications" section on page A-17.

Note For OPT-AMP-17-C safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-AMP-17-C is a 17-dB gain, C-band, DWDM EDFA amplifier/preamplifier with OSC add-and-drop capability. It supports 80 channels at 50-GHz channel spacing in the C-band (that is, the 1529 nm to 1562.5 nm wavelength range). When an ONS 15454 has an OPT-AMP-17-C installed, an OSCM card is needed to process the OSC. You can install the OPT-AMP-17-C in Slots 1 to 6 and 12 to 17.

The card's features include:

- Fixed gain mode (no programmable tilt)
- Standard gain range of 14 to 20 dB at startup when configured as a preamplifier
- Standard gain range of 20 to 23 dB in the transient mode when configured as a preamplifier
- Gain range of 14 to 23 dB (with no transient gain range) when configured as a booster amplifier
- True variable gain
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

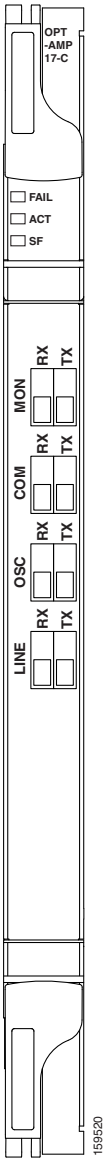
4.8.1 OPT-AMP-17-C Faceplate Ports

The OPT-AMP-17-C amplifier card 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.

Figure 4-21 shows the OPT-AMP-17-C amplifier card faceplate.

Figure 4-21 OPT-AMP-17-C Faceplate



4.8.2 OPT-AMP-17-C Block Diagrams

Figure 4-22 shows a simplified block diagram of the OPT-AMP-17C card's features.

Figure 4-22 OPT-AMP17-C Block Diagram

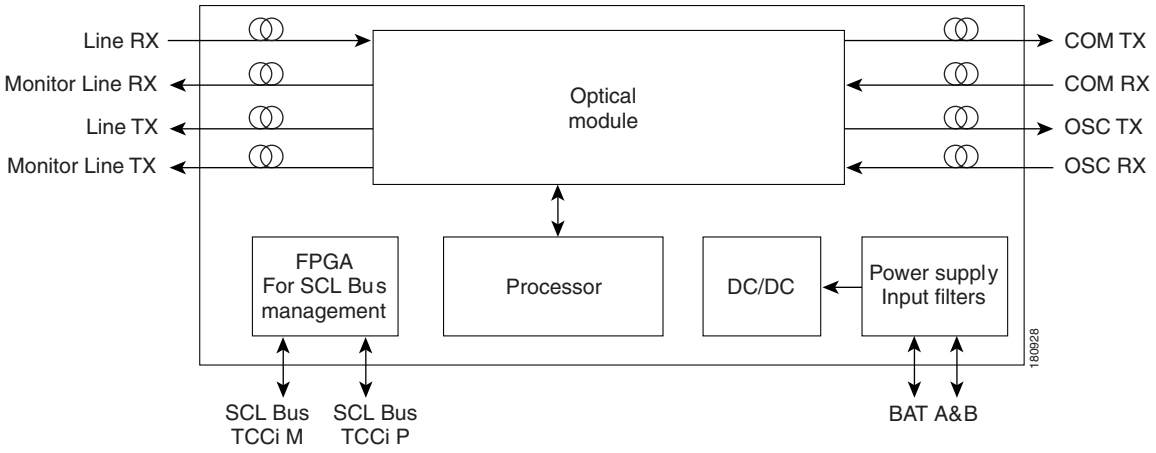
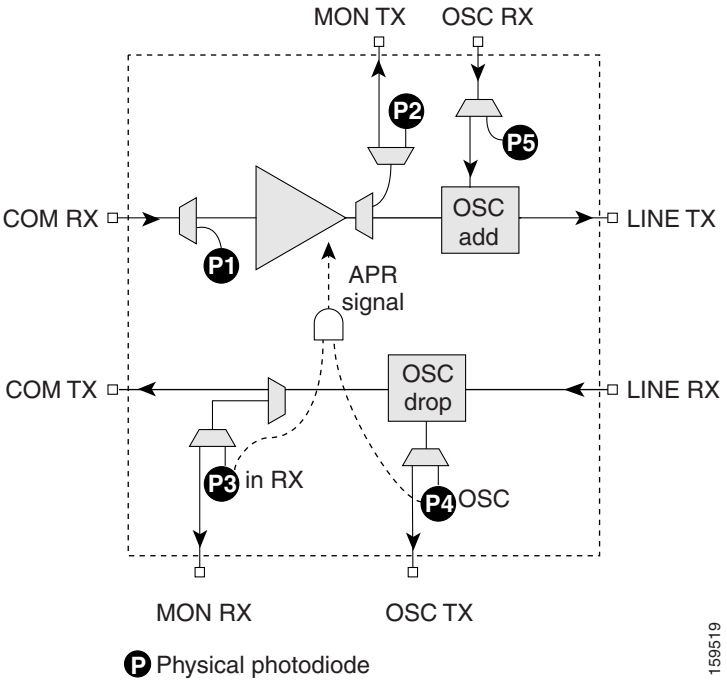


Figure 4-23 shows how the OPT-AMP-17-C optical module functions.

Figure 4-23 OPT-AMP-17-C Optical Module Functional Block Diagram



4.8.3 OPT-AMP-17-C Automatic Power Control

A transient gain range of 20 to 23 dB is available to APC in order to permit other amplifiers to reach their expected set points. However, operation in this range is not continuous. At startup, the OPT-AMP-17-C card caps the gain at a maximum of 20 dB.

Note When the OPT-AMP-17-C operates as a booster amplifier, APC does not control its gain.

4.8.4 OPT-AMP-17-C Power Monitoring

Physical photodiodes P1, P2, P3, P4, and P5 monitor power for the OPT-AMP-17-C card. Table 4-13 shows the returned power level values calibrated to each port.

Table 4-13 OPT-AMP-17-C 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)	
P5	Output OSC-RX	OSC-RX
P3	Output COM	LINE RX
P4	Output OSC-TX	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.8.5 OPT-AMP-17-C Card-Level Indicators

Table 4-14 shows the three card-level LEDs on the OPT-AMP-17-C card.

Table 4-14 OPT-AMP-17-C 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-AMP-17-C 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.8.6 OPT-AMP-17-C Port-Level Indicators

You can determine 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.

4.9 OPT-AMP-C Card

Note For hardware specifications, see the "A.5.7 OPT-AMP-C Amplifier Card Specifications" section on page A-18.

Note For OPT-AMP-C card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-3.

The OPT-AMP-C card is a 20-dB output power, C-band, DWDM EDFA amplifier/preamplifier. It contains mid-stage access loss for a Dispersion Compensation Unit (DCU). To control gain tilt, a VOA is used. The VOA can also be used to attenuate the signal to the DCU to a reference value. The amplifier module also includes the OSC add (TX direction) and drop (RX direction) optical filters.

The OPT-AMP-C card supports 80 channels at 50-GHz channel spacing in the C-band (that is, the 1529 nm to 1562.5 nm wavelength range). When an ONS 15454 has an OPT-AMP-C card installed, an OSCM card is needed to process the OSC. You can install the OPT-AMP-C card in Slots 1 to 6 and 12 to 17. Slots 2 to 6 and Slots 12 to 16 are the default slots for provisioning the OPT-AMP-C card as a preamplifier, and slots 1 and 17 are the default slots for provisioning the OPT-AMP-C card as a booster amplifier.

The card's features include:

- Fast transient suppression
- Nondistorting low-frequency transfer function
- Mid-stage access for DCU
- Constant pump current mode (test mode)
- Fixed output power mode (mode used during provisioning)
- Constant gain mode
- ASE compensation in Constant Gain and Constant Output Power modes
- Programmable tilt
- Full monitoring and alarm handling capability
- Gain range with gain tilt control of 12 to 24 dB
- Extended gain range (with uncontrolled tilt) of 24 to 35 dB
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

4.9.1 OPT-AMP-C Card Faceplate Ports

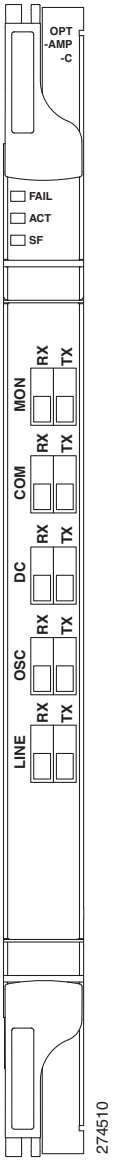
The OPT-AMP-C amplifier card has 10 optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.

- COM TX is the output signal port (receive section).
- DC RX is the input DCU port.
- DC TX is the output DCU port.
- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.
- LINE RX is the input signal port (receive section).
- LINE TX is the output signal port.

Figure 4-24 shows the OPT-AMP-C amplifier card faceplate.

Figure 4-24 OPT-AMP-C Card Faceplate



4.9.2 OPT-AMP-C Card Block Diagrams

Figure 4-25 shows a simplified block diagram of the OPT-AMP-17C card features.

Figure 4-25 OPT-AMP-C Block Diagram

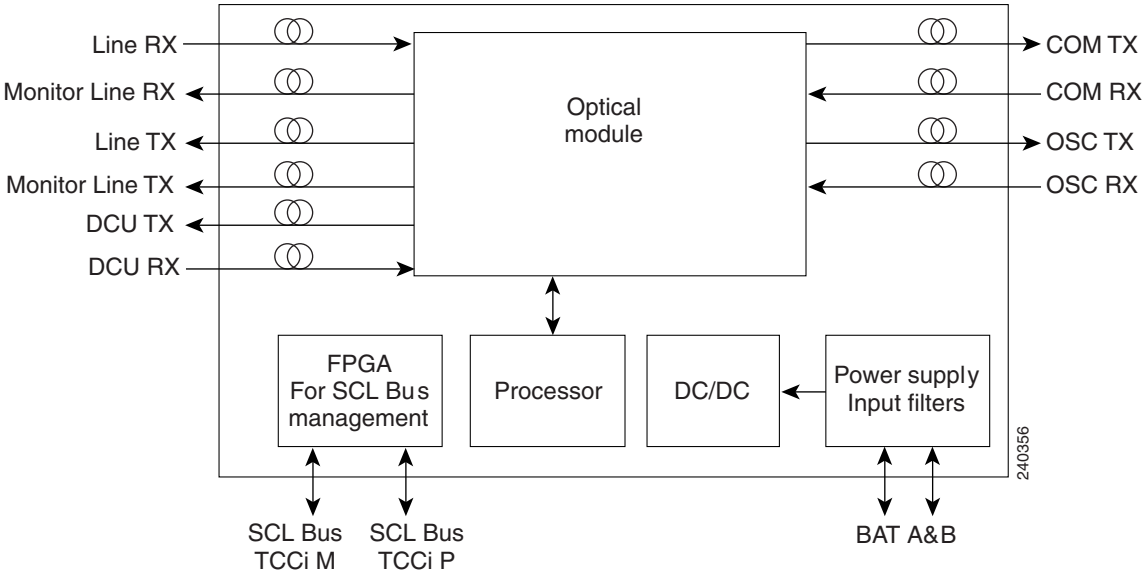
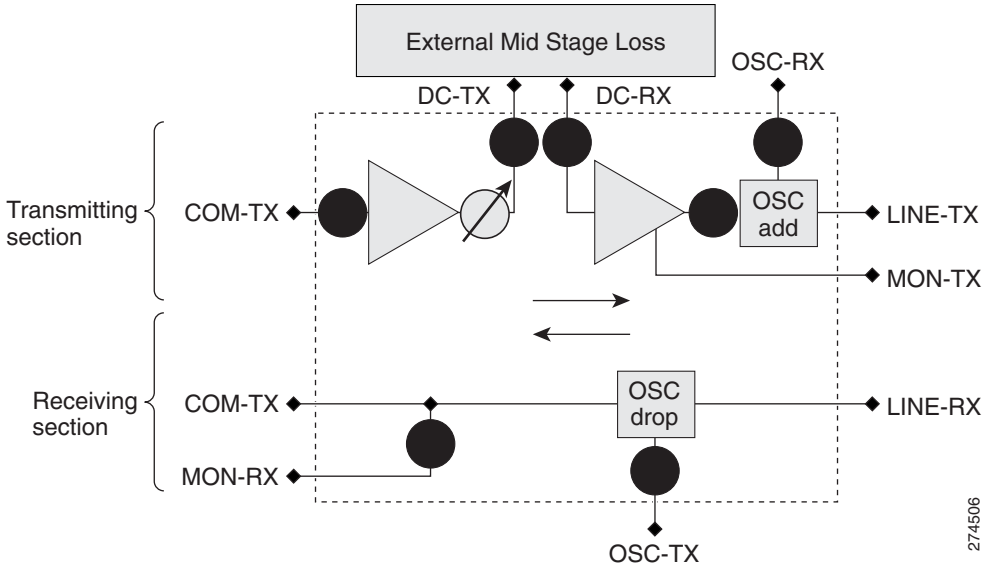


Figure 4-26 shows how the OPT-AMP-C optical module functions.

Figure 4-26 OPT-AMP-C Optical Module Functional Block Diagram



4.9.3 OPT-AMP-C Card Power Monitoring

Physical photodiodes P1 through P7 monitor the power for the OPT-AMP-C card (see Table 4-15).

Table 4-15 OPT-AMP-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	Input COM Power	COM RX
P2	Output Line Transmit (total power)	Line TX
	Output Line Transmit (signal power)	
P3	Input Line Receive Power	Line RX
P4	Input OSC Receive Power	
P5	Output OSC Transmit Power	OSC-RX
P6	Output DC Transmit (total power)	DC-TX
	Output DC Transmit (signal power)	
P7	Input DC Receive Power	DC-RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

4.9.4 OPT-AMP-C Card-Level Indicators

Table 4-14 shows the three card-level LEDs on the OPT-AMP-C card.

Table 4-16 OPT-AMP-C 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-AMP-C card 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.9.5 OPT-AMP-C Card Port-Level Indicators

You can determine 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.

CHAPTER 5

Multiplexer and Demultiplexer Cards

This chapter describes legacy multiplexer and demultiplexer cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 5.1 Card Overview, page 5-1
- 5.2 Safety Labels, page 5-8
- 5.3 32MUX-O Card, page 5-12
- 5.4 32DMX-O Card, page 5-16
- 5.5 4MD-xx.x Card, page 5-20

Note For a description of the 32DMX, 32DMX-L, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, and 40-WXC-C cards, refer to Chapter 7, "Reconfigurable Optical Add/Drop Cards."

5.1 Card Overview

The card overview section contains card summary, compatibility, interface class, and channel allocation plan information for legacy multiplexer and demultiplexer cards.

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 "1.16.1 Card Slot Requirements" section on page 1-61 for a list of slots and symbols.

5.1.1 Card Summary

Table 5-1 lists and summarizes the functions of the 32MUX-O, 32DMX-O, and 4MD-xx.x cards.

Table 5-1 Multiplexer and Demultiplexer Cards

Card	Port Description	For Additional Information
32MUX-O	The 32MUX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "5.3 32MUX-O Card" section on page 5-12.
32DMX-O	The 32DMX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	"5.4 32DMX-O Card" section on page 5-16
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 "5.5 4MD-xx.x Card" section on page 5-20.

5.1.2 Card Compatibility

Table 5-2 lists the CTC software compatibility for each card.

Table 5-2 Software Release Compatibility for Legacy Multiplexer and Demultiplexer Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5
32MUX-O	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
32DMX-O	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4MD-xx.x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

5.1.3 Interface Classes

The 32MUX-O, 32DMX-O, and 4MD-xx.x cards have different input and output optical channel signals depending on the interface card where the input signal originates. The input interface cards have been grouped in classes listed in Table 5-3. The subsequent tables list the optical performance and output power of each interface class.

Table 5-3 ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) with forward error correction (FEC) enabled and 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with FEC enabled
B	10-Gbps multirate transponder card (TXP_MR_10G) without FEC and 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_MR_10DME_C, MXP_MR_10DME_L), and ADM-10G cards with FEC disabled

Table 5-3 ONS 15454 Card Interfaces Assigned to Input Power Classes (continued)

Input Power Class	Card
C	OC-192 LR ITU cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) without FEC
D	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled
E	OC-48 100-GHz DWDM muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, with FEC disabled and retime, reshape, and regenerate (3R) mode enabled
F	2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz card
H	2/4 port GbE transponder (GBIC WDM 100GHz)
I	TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards with enhanced FEC (E-FEC) and the MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards with E-FEC enabled

Table 5-4 lists the optical performance parameters for 10-Gbps cards that provide signal input to multiplexer and demultiplexer cards.

Table 5-4 10-Gbps Interface Optical Performance

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps	10 Gbps	
Regeneration	3R		3R		3R	3R	
FEC	Yes		No		No	Yes (E-FEC)	
Threshold	Optimum		Average		Average	Optimum	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-12}	10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–22 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm		–9 dBm	–8 dBm	
Transmitted Power Range[3]							
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10G)	+2.5 to 3.5 dBm		+2.5 to 3.5 dBm		—	—	
OC-192 LR ITU	—		—		+3.0 to 6.0 dBm	—	

Table 5-4 10-Gbps Interface Optical Performance (continued)

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10E)	+3.0 to 6.0 dBm		+3.0 to 6.0 dBm		—	+3.0 to 6.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–1,000 ps/nm	+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 5-5 lists the optical interface performance parameters for 2.5-Gbps cards that provide signal input to multiplexer and demultiplexer cards.

Table 5-5 2.5-Gbps Interface Optical Performance

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps	2.5 Gbps		1.25 Gbps		2.5 Gbps
Regeneration	3R		3R		2R	3R		3R		3R
FEC	Yes		No		No	No		No		No
Threshold	Average		Average		Average	Average		Average		Average
Maximum BER	10^{-15}		10^{-12}		10^{-12}	10^{-12}		10^{-12}		10^{-12}
OSNR sensitivity	14 dB	6 dB	14 dB	10 dB	15 dB	14 dB	11 dB	13 dB	8 dB	12 dB
Power sensitivity	–31 dBm	–25 dBm	–30 dBm	–23 dBm	–24 dBm	–27 dBm	–33 dBm	–28 dBm	–18 dBm	–26 dBm
Power overload	–9 dBm		–9 dBm		–9 dBm	–9 dBm		–7 dBm		–17dBm
Transmitted Power Range[1]										
TXP_MR_2.5G	–1.0 to 1.0 dBm		–1.0 to 1.0 dBm		–1.0 to 1.0 dBm	–2.0 to 0 dBm				
TXPP_MR_2.5G	–4.5 to –2.5 dBm		–4.5 to –2.5 dBm		–4.5 to –2.5 dBm					
MXP_MR_2.5G	—		+2.0 to +4.0 dBm		—					
MXPP_MR_2.5G	—		–1.5 to +0.5 dBm		—					

Table 5-5 2.5-Gbps Interface Optical Performance (continued)

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited
2/4 port GbE Transponder (GBIC WDM 100GHz)								+2.5 to 3.5 dBm		—
Dispersion compensation tolerance	–1200 to +5400 ps/nm		–1200 to +5400 ps/nm		–1200 to +3300 ps/nm	–1200 to +3300 ps/nm		–1000 to +3600 ps/nm		–1000 to +3200 ps/nm

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

5.1.4 Channel Allocation Plan

ONS 15454 DWDM multiplexer and demultiplexer cards are designed for use with specific channels in the C band and L band. In most cases, the channels for these cards are either numbered (for example, 1 to 32 or 1 to 40) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

Table 5-6 lists the channel IDs and wavelengths assigned to the C-band DWDM channels.

Note In some cases, a card uses only one of the bands (C band or L band) and some or all of the channels listed in a band. Also, some cards use channels on the 100-GHz ITU grid while others use channels on the 50-GHz ITU grid. See the specific card description or Appendix A, "Hardware Specifications" for more details.

Table 5-6 DWDM Channel Allocation Plan (C Band)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517

Table 5-6 DWDM Channel Allocation Plan (C Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

Table 5-7 lists the channel IDs and wavelengths assigned to the L-band channels.

Table 5-7 DWDM Channel Allocation Plan (L Band)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88

Table 5-7 DWDM Channel Allocation Plan (L Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74

Table 5-7 DWDM Channel Allocation Plan (L Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

5.2 Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

5.2.1 Class 1 Laser Product Labels

The 32MUX-O card has a Class 1 laser. The labels that appear on the card are described in the following sections.

5.2.1.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in Figure 5-1.

Figure 5-1 Class 1 Laser Product Label

Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and may therefore be considered safe. However, some Class 1 laser products may contain laser systems of a higher class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

5.2.1.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 5-2.

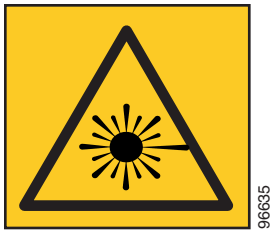
Figure 5-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

5.2.1.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 5-3.

Figure 5-3 Laser Source Connector Label

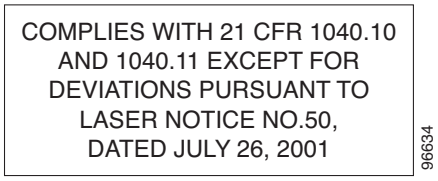


This label indicates that a laser source is present at the optical connector where the label has been placed.

5.2.1.4 FDA Statement Label

The FDA Statement label is shown in Figure 5-4.

Figure 5-4 FDA Statement Label

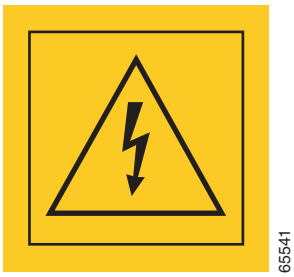


This label shows compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

5.2.1.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 5-5.

Figure 5-5 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

5.2.2 Class 1M Laser Product Cards

The 32DMX-O and 4MD-xx.x cards have Class IM lasers. The labels that appear on these cards are described in the following subsections.

5.2.2.1 Class 1M Laser Product Label

The Class 1M Laser Product label is shown in Figure 5-6.

Figure 5-6 Class 1M Laser Product Label

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

5.2.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 5-7.

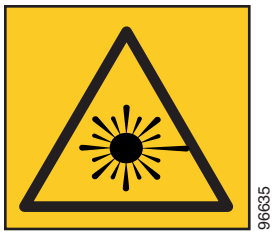
Figure 5-7 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

5.2.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 5-8.

Figure 5-8 Laser Source Connector Label

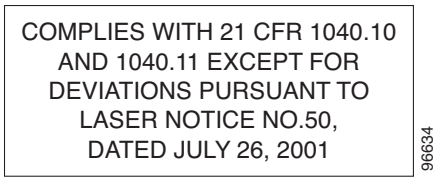


This label indicates that a laser source is present at the optical connector where the label has been placed.

5.2.2.4 FDA Statement Label

The FDA Statement label is shown in Figure 5-9.

Figure 5-9 FDA Statement Label



This label shows compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

5.2.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 5-5.

Figure 5-10 Shock Hazard Label

This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

5.3 32MUX-O Card

Note See the "A.6.1 32MUX-O Card Specifications" section on page A-19 for hardware specifications.

The 32-Channel Multiplexer (32MUX-O) card multiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32MUX-O card takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16.

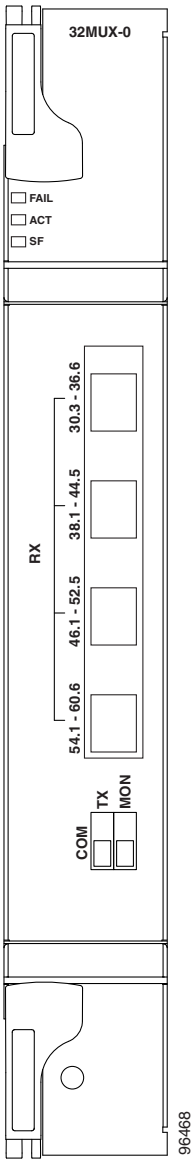
The 32MUX-O features include:

- Arrayed waveguide grating (AWG) device that 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 5-11 shows the 32MUX-O faceplate.

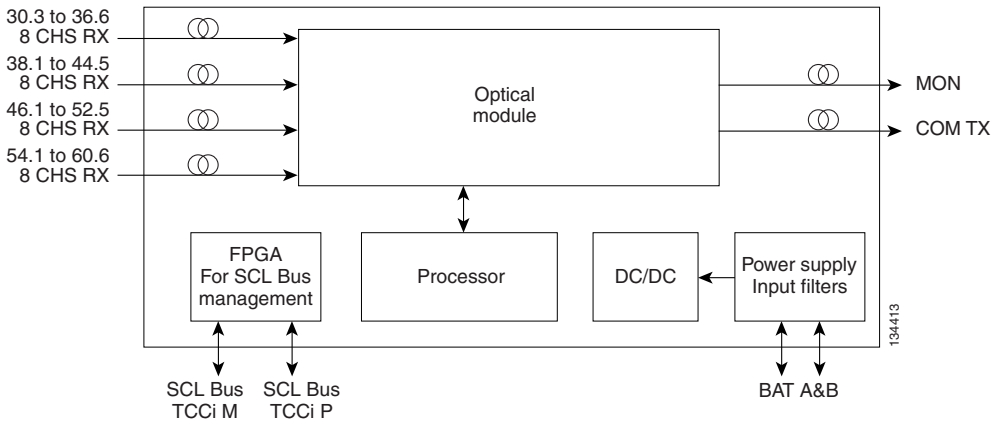
Figure 5-11 32MUX-O Faceplate



For information on safety labels for the card, see the "5.2.1 Class 1 Laser Product Labels" section on page 5-8.

Figure 5-12 shows a block diagram of the 32MUX-O card.

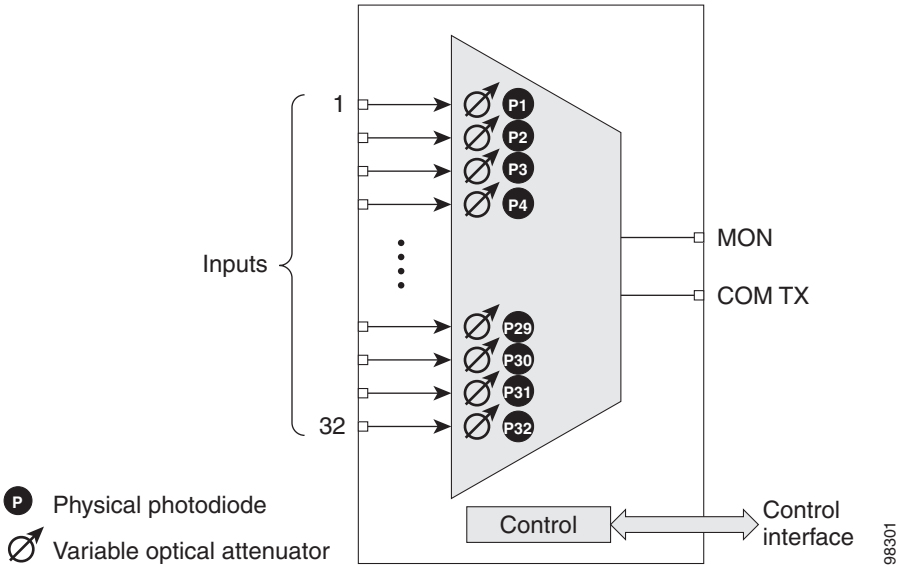
Figure 5-12 32MUX-O Block Diagram



The 32MUX-O card has four receive connectors that accept multifiber push-on (MPO) cables on its front panel for the client input interfaces. MPO cables break out into eight separate cables. The 32MUX-O card also has two LC-PC-II optical connectors, one for the main output and the other for the monitor port.

Figure 5-13 shows the 32MUX-O optical module functional block diagram.

Figure 5-13 32MUX-O Optical Module Functional Block Diagram



5.3.1 Channel Plan

The 32MUX-O is typically used in hub nodes and provides the multiplexing of 32 channels, spaced at 100 GHz, into one fiber before their amplification and transmission along the line. The channel plan is shown in Table 5-8.

Table 5-8 32MUX-O Channel Plan

Channel Number[1]	Channel ID	Frequency (GHz)	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
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

1. The Channel Number column is only for reference purposes. The channel ID is consistent with the ONS 15454 and is used in card identification.

5.3.2 Power Monitoring

Physical photodiodes P1 through P32 monitor the power for the 32MUX-O card. The returned power level values are calibrated to the ports as shown in Table 5-9.

Table 5-9 32MUX-O Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	ADD	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

5.3.3 32MUX-O Card-Level Indicators

The 32MUX-O card has three card-level LED indicators, described in Table 5-10.

Table 5-10 32MUX-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 32MUX-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.

5.3.4 32MUX-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 32MUX-O card has five sets of ports located on the faceplate.

COM TX is the line output. COM MON is the optical monitoring port. The xx.x to yy.y RX ports represent the four groups of eight channels ranging from wavelength xx.x to wavelength yy.y, according to the channel plan.

5.4 32DMX-O Card

Note See the "A.6.2 32DMX-O Card Specifications" section on page A-19 for hardware specifications.

The 32-Channel Demultiplexer (32DMX-O) card demultiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32DMX-O takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16.

The 32DMX-O features include:

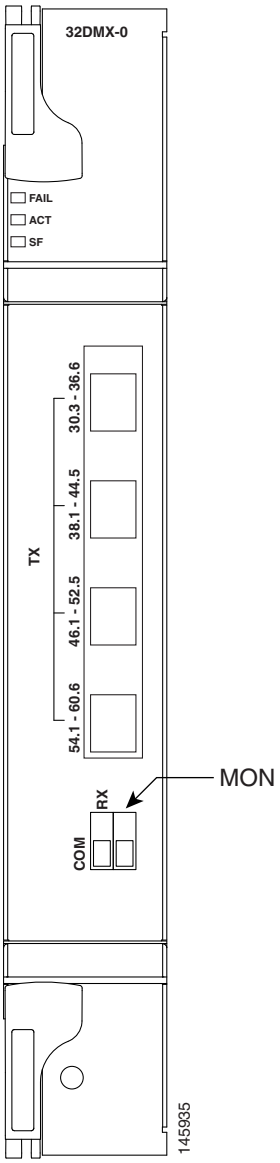
- AWG that enables channel demultiplexing functions.
- Each single-channel port is equipped with VOAs for automatic optical power regulation after demultiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- The 32DXM-O has four physical receive connectors that accept MPO cables on its front panel for the client input interfaces. MPO cables break out into eight separate cables.

Note In contrast, the single-slot 32DMX card does not have VOAs on each drop port for optical power regulation. The 32DMX optical demultiplexer module is used in conjunction with the 32WSS card in ONS 15454 Multiservice Transport Platform (MSTP) nodes.

- Each single-channel port is monitored using a photodiode to enable automatic power regulation.

Figure 5-14 shows the 32DMX-O card faceplate.

Figure 5-14 32DMX-O Faceplate



For information on safety labels for the card, see the "5.2.2 Class 1M Laser Product Cards" section on page 5-10.

Figure 5-15 shows a block diagram of the 32DMX-O card.

Figure 5-15 32DMX-O Block Diagram

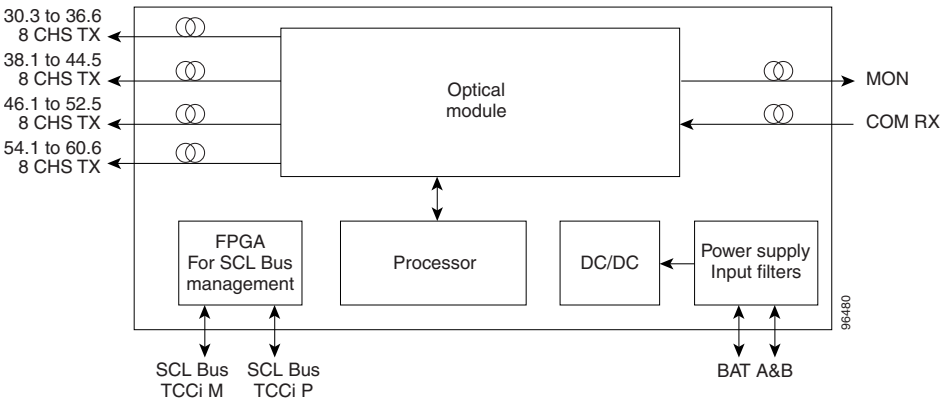
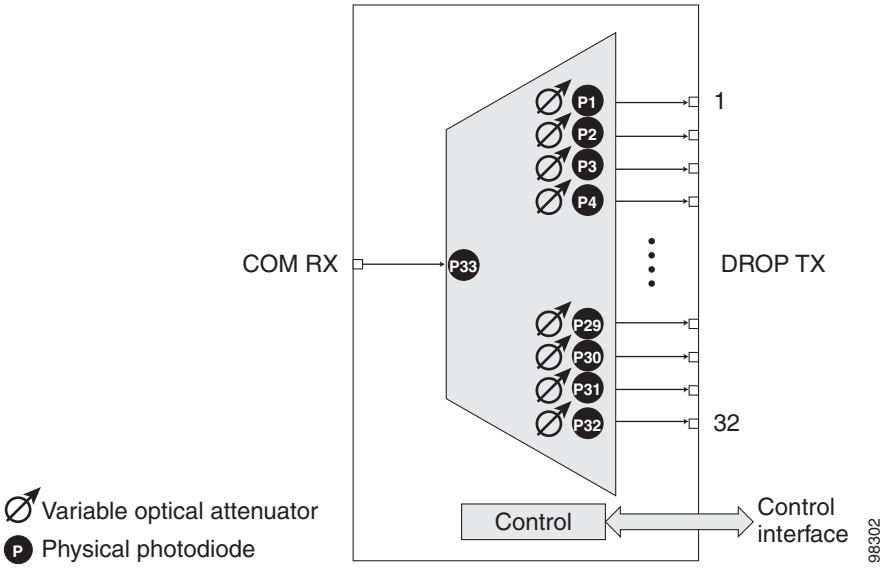


Figure 5-16 shows the 32DMX-O optical module functional block diagram.

Figure 5-16 32DMX-O Optical Module Functional Block Diagram



5.4.1 Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX-O card. The returned power level values are calibrated to the ports as shown in Table 5-11.

Table 5-11 32DMX-O Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	DROP	DROP TX
P33	INPUT COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

5.4.2 32DMX-O Card-Level Indicators

The 32DMX-O card has three card-level LED indicators, described in Table 5-12.

Table 5-12 32DMX-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 32DMX-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.

5.4.3 32DMX-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 32DMX-O card has five sets of ports located on the faceplate. MON is the output monitor port. COM RX is the line input. The xx.x to yy.y TX ports represent the four groups of eight channels ranging from wavelength xx.x to wavelength yy.y according to the channel plan.

5.5 4MD-xx.x Card

Note See the "A.6.3 4MD-xx.x Card Specifications" section on page A-20 for hardware specifications.

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).

The card is bidirectional. The demultiplexer and multiplexer functions are implemented in two different sections of the same card. In this way, the same card can manage signals flowing in opposite directions.

There are eight versions of this card that correspond with the eight sub-bands specified in Table 5-13 on page 5-23. The 4MD-xx.x can be installed in Slots 1 to 6 and 12 to 17.

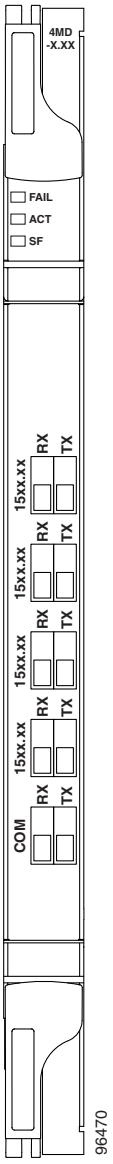
The 4MD-xx.x has the following features implemented inside a plug-in optical module:

- Passive cascade of interferential filters perform the channel multiplex/demultiplex function.
- Software-controlled VOAs at every port of the multiplex section 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.

Figure 5-17 shows the 4MD-xx.x faceplate.

Figure 5-17 4MD-xx.x Faceplate



For information on safety labels for the card, see the "5.2.2 Class 1M Laser Product Cards" section on page 5-10.

Figure 5-18 shows a block diagram of the 4MD-xx.x card.

Figure 5-18 4MD-xx.x Block Diagram

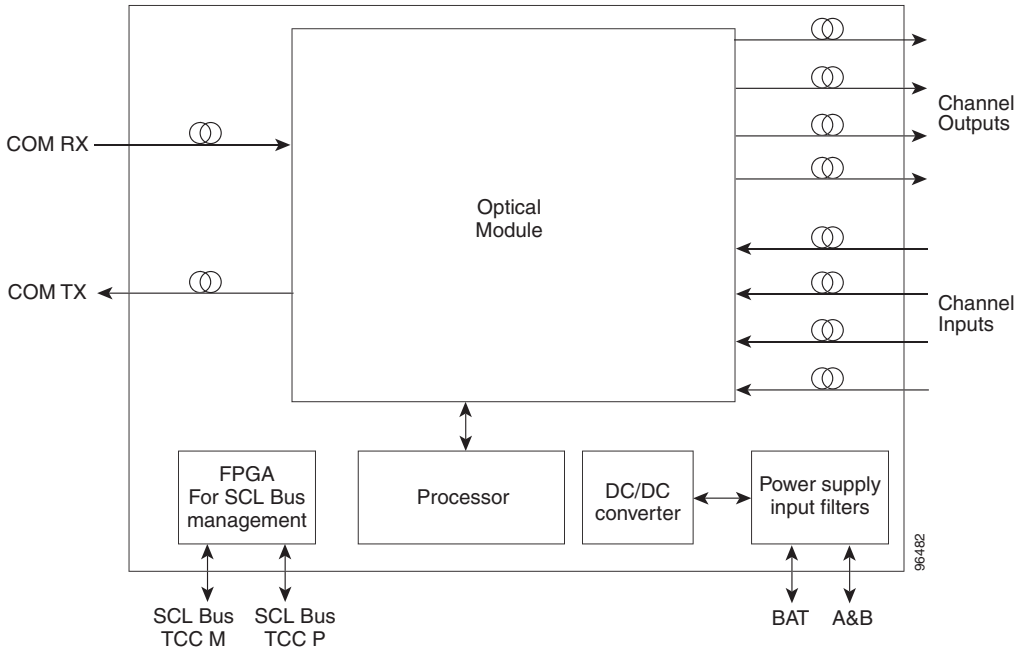
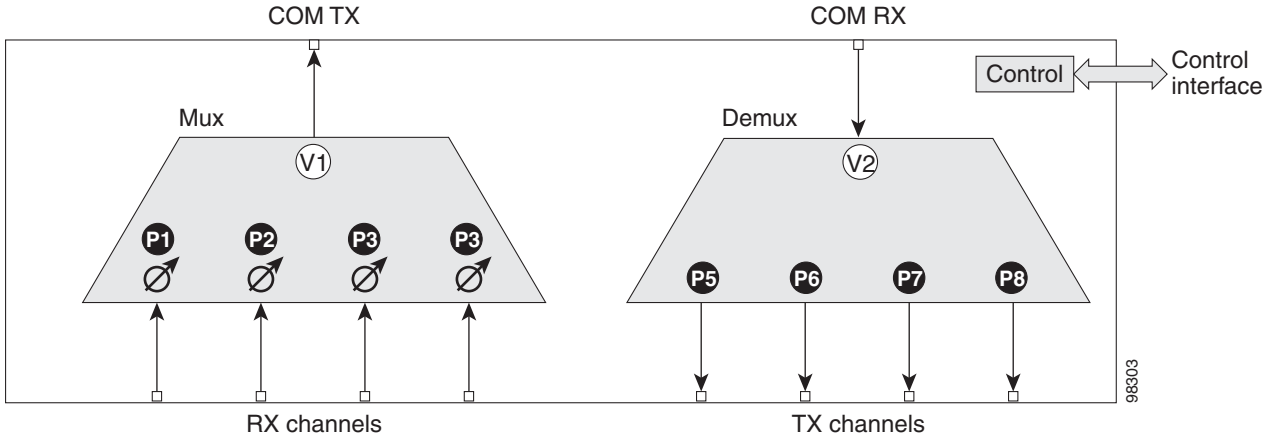


Figure 5-19 shows the 4MD-xx.x optical module functional block diagram.

Figure 5-19 4MD-xx.x Optical Module Functional Block Diagram



The optical module shown in Figure 5-19 is optically passive and consists of a cascade of interferential filters that perform the channel multiplexing and demultiplexing 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) and then providing the TCC2/TCC2P card with the obtained value.

5.5.1 Wavelength Pairs

Table 5-13 shows the band IDs and the add/drop channel IDs for the 4MD-xx.x card.

Table 5-13 4MD-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

5.5.2 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 5-14.

Table 5-14 4MD-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P4	ADD	COM TX
P5–P8	DROP	DROP TX
V1	OUT COM	COM TX
V2	IN COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

5.5.3 4MD-xx.x Card-Level Indicators

The 4MD-xx.x card has three card-level LED indicators, described in Table 5-15.

Table 5-15 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.

5.5.4 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.

CHAPTER 6

Optical Add/Drop Cards

This chapter describes optical add/drop cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 6.1 Card Overview, page 6-1
- 6.2 Class 1M Laser Product Safety Lasers, page 6-7
- 6.3 AD-1C-xx.x Card, page 6-9
- 6.4 AD-2C-xx.x Card, page 6-12
- 6.5 AD-4C-xx.x Card, page 6-16
- 6.6 AD-1B-xx.x Card, page 6-20
- 6.7 AD-4B-xx.x Card, page 6-23

6.1 Card Overview

The card overview section contains card overview, software compatibility, interface class, and channel allocation information for optical add/drop cards.

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 "1.16.1 Card Slot Requirements" section on page 1-61 for a list of slots and symbols.

Optical add/drop cards are divided into two groups: band optical add/drop multiplexer (OADM) cards and channel OADM cards. Band OADM cards add and drop one or four bands of adjacent channels. The cards in this chapter, including the 4-Band OADM (AD-4B-xx.x) and the 1-Band OADM (AD-1B-xx.x) are utilized only in the C band. 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).

Note For information about L band add and drop capability, see Chapter 7, "Reconfigurable Optical Add/Drop Cards."

6.1.1 Card Summary

Table 6-1 lists and summarizes the functions of the optical add/drop cards.

Table 6-1 Optical Add/Drop Cards

Card	Port Description	For Additional Information
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 "6.3 AD-1C-xx.x Card" section on page 6-9.
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 "6.4 AD-2C-xx.x Card" section on page 6-12.
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 "6.5 AD-4C-xx.x Card" section on page 6-16.
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 "6.6 AD-1B-xx.x Card" section on page 6-20.
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 "6.7 AD-4B-xx.x Card" section on page 6-23.

6.1.2 Card Compatibility

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

Table 6-2 Software Release Compatibility for Optical Add/Drop Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5
AD-1C-xx.x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AD-2C-xx.x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AD-4C-xx.x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AD-1B-xx.x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AD-4B-xx.x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

6.1.3 Interface Classes

The AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, and AD-4B-xx.x cards have different input and output optical channel signals depending on the interface card where the input signal originates. The input interface cards have been grouped in classes listed in Table 6-3. The subsequent tables list the optical performances and output power of each interface class.

Table 6-3 ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) with forward error correction (FEC) enabled and 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with FEC enabled
B	10-Gbps multirate transponder card (TXP_MR_10G) without FEC and the 10-Gbps muxponder card (MXP_2.5G_10G, MXP_MR_10DME_C, MXP_MR_10DME_L) and ADM-10G cards with FEC disabled
C	OC-192 LR ITU cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) without FEC
D	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled
E	OC-48 100-GHz DWDM muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC disabled and retime, reshape, and regenerate (3R) mode enabled
F	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz card
H	2/4 port GbE transponder (GBIC WDM 100GHz)
I	TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards with enhanced FEC (E-FEC) and the MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards with E-FEC enabled

10-Gbps cards that provide signal input to the optical add/drop cards have the optical performance parameters listed in Table 6-4.

Table 6-4 10-Gbps Interface Optical Performance

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps	10 Gbps	
Regeneration	3R		3R		3R	3R	
FEC	Yes		No		No	Yes (E-FEC)	
Threshold	Optimum		Average		Average	Optimum	

Table 6-4 10-Gbps Interface Optical Performance (continued)

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)
Maximum BER[2]	10^{-15}		10^{-12}		10^{-12}	10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–22 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm		–9 dBm	–8 dBm	
Transmitted Power Range[3]							
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10G)	+2.5 to 3.5 dBm		+2.5 to 3.5 dBm		—	—	
OC-192 LR ITU	—		—		+3.0 to 6.0 dBm	—	
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10E)	+3.0 to 6.0 dBm		+3.0 to 6.0 dBm		—	+3.0 to 6.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–1,000 ps/nm	+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

2.5-Gbps cards that provide signal input to the optical add/drop cards have the interface performance parameters listed in Table 6-5.

Table 6-5 2.5-Gbps Interface Optical Performance

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	Power Limited
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps	2.5 Gbps		1.25 Gbps		2.5 Gbps
Regeneration	3R		3R		2R	3R		3R		3R
FEC	Yes		No		No	No		No		No
Threshold	Average		Average		Average	Average		Average		Average
Maximum BER	10^{-15}		10^{-12}		10^{-12}	10^{-12}		10^{-12}		10^{-12}
OSNR sensitivity	14 dB	6 dB	14 dB	10 dB	15 dB	14 dB	11 dB	13 dB	8 dB	12 dB

Table 6-5 2.5-Gbps Interface Optical Performance (continued)

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	Power Limited
Power sensitivity	–31 dBm	–25 dBm	–30 dBm	–23 dBm	–24 dBm	–27 dBm	–33 dBm	–28 dBm	–18 dBm	–26 dBm
Power overload	–9 dBm		–9 dBm		–9 dBm	–9 dBm		–7 dBm		–17dBm
Transmitted Power Range[1]										
TXP_MR_2.5G	–1.0 to 1.0 dBm		–1.0 to 1.0 dBm		–1.0 to 1.0 dBm	–2.0 to 0 dBm		—		—
TXPP_MR_2.5G	–4.5 to –2.5 dBm		–4.5 to –2.5 dBm		–4.5 to –2.5 dBm					
MXP_MR_2.5G	—		+2.0 to +4.0 dBm		—					
MXPP_MR_2.5G	—		–1.5 to +0.5 dBm		—					
2/4 port GbE Transponder (GBIC WDM 100GHz)	—		—		—	—		+2.5 to 3.5 dBm		—
Dispersion compensation tolerance	–1200 to +5400 ps/nm		–1200 to +5400 ps/nm		–1200 to +3300 ps/nm	–1200 to +3300 ps/nm		–1000 to +3600 ps/nm		–1000 to +3200 ps/nm

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

6.1.4 DWDM Card Channel Allocation Plan

ONS 15454 DWDM channel OADM and band OADM cards are designed for use with specific channels in the C band. In most cases, the channels for these cards are either numbered (for example, 1 to 32) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

Table 6-6 lists the channel IDs and wavelengths assigned to the C-band DWDM channels.

Note In some cases, a card uses only some or all of the channels listed in a band. Also, some cards use channels on the 100-GHz ITU-T grid while others use channels on the 50-GHz ITU-T grid. See specific card descriptions in Appendix A, "Hardware Specifications," for more details.

Table 6-6 DWDM Channel Allocation Plan (C Band)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518

Table 6-6 DWDM Channel Allocation Plan (C Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606

Table 6-6 DWDM Channel Allocation Plan (C Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

6.2 Class 1M Laser Product Safety Lasers

This section lists the safety labels attached to the AD-1C-xx.x, AD-2C-xx.x, AD-4c-xx.x, AD-1B-xx.x, and AD-4B-xx.xx cards.

6.2.1 Class 1M Laser Product Label

The Class 1M Laser Product label is shown in Figure 6-1.

Figure 6-1 Class 1M Laser Product Label

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

6.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 6-2.

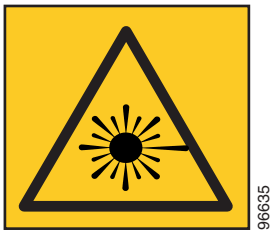
Figure 6-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

6.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 6-3.

Figure 6-3 Laser Source Connector Label

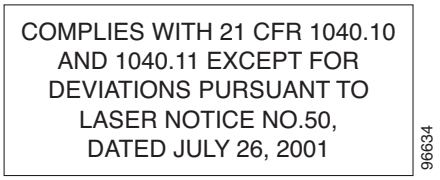


This label indicates that a laser source is present at the optical connector where the label has been placed.

6.2.4 FDA Statement Label

The FDA Statement label is shown in Figure 6-4.

Figure 6-4 FDA Statement Label

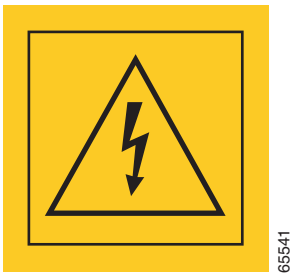


This label shows compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

6.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 6-5.

Figure 6-5 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

6.3 AD-1C-xx.x Card

Note See the "A.8.1 AD-1C-xx.x Card Specifications" section on page A-38 for hardware specifications.

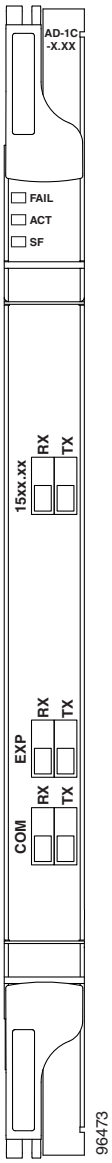
The 1-Channel OADM (AD-1C-xx.x) card passively adds or drops one of the 32 channels utilized within the 100-GHz-spacing of the DWDM card system. Thirty-two versions of this card—each designed only for use with one wavelength—are used in the ONS 15454 DWDM system. Each wavelength version of the card has 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 cascaded passive optical interferential filters perform the channel add and drop functions.
- One software-controlled variable optical attenuator (VOA) regulates the optical power of the inserted channel.
- Software-controlled VOA regulates the insertion loss of the express optical path.
- VOA settings and functions, photodiode detection, and alarm thresholds, are internally controlled.
- Virtual photodiodes (firmware calculations of port optical power) at the common DWDM output and input ports are monitored within the software.

Figure 6-6 shows the AD-1C-xx.x faceplate.

Figure 6-6 AD-1C-xx.x Faceplate



For information on safety labels for the card, see the "6.2 Class 1M Laser Product Safety Lasers" section on page 6-7.

Figure 6-7 shows a block diagram of the AD-1C-xx.x card.

Figure 6-7 AD-1C-xx.x Block Diagram

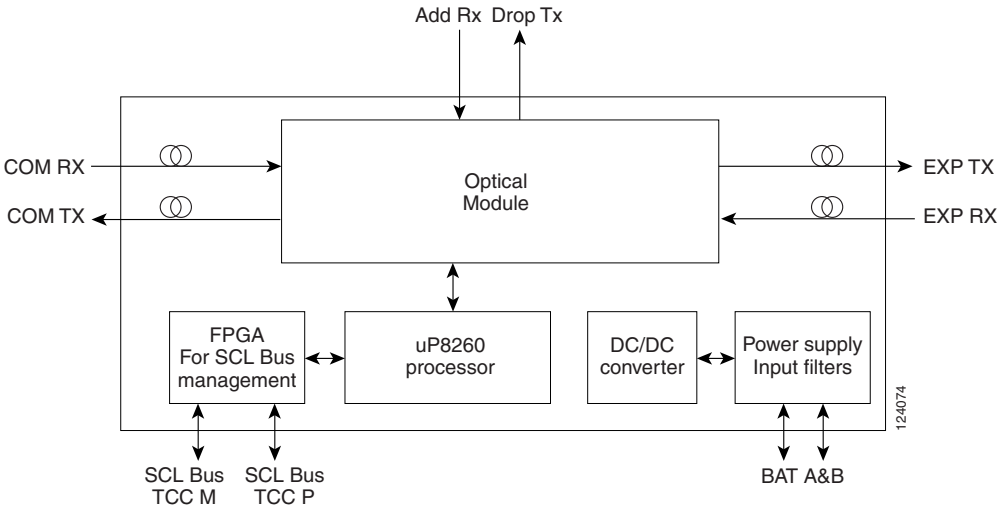
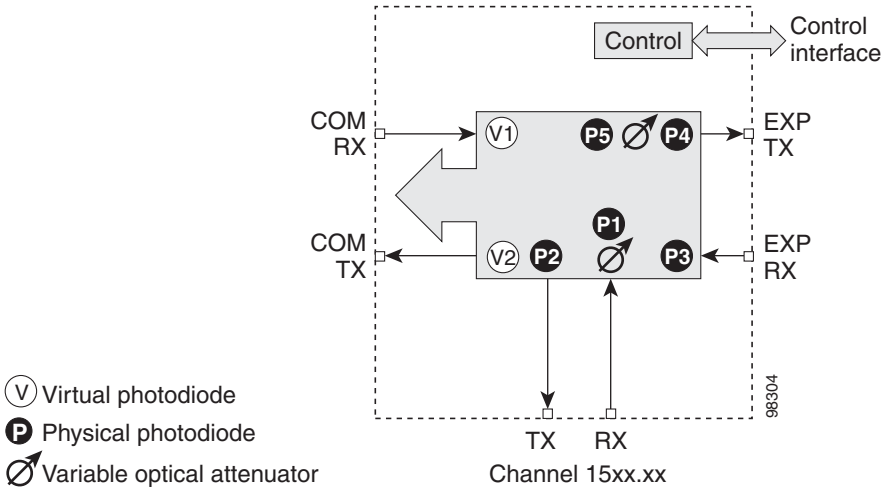


Figure 6-8 shows the AD-1C-xx.x optical module functional block diagram.

Figure 6-8 AD-1C-xx.x Optical Module Functional Block Diagram



6.3.1 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 6-7.

Table 6-7 AD-1C-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	ADD	DROP RX
P2	DROP	DROP TX

Table 6-7 AD-1C-xx.x Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P3	IN EXP	EXP RX
P4	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

6.3.2 AD-1C-xx.x Card-Level Indicators

The AD-1C-xx.x card has three card-level LED indicators, described in Table 6-8.

Table 6-8 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.

6.3.3 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.

6.4 AD-2C-xx.x Card

Note See the "A.8.2 AD-2C-xx.x Card Specifications" section on page A-39 for hardware specifications.

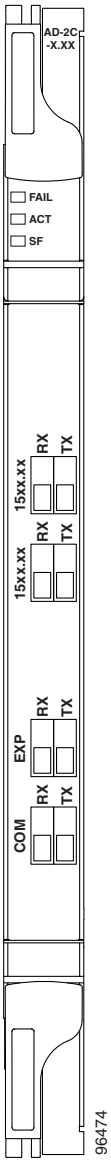
The 2-Channel OADM (AD-2C-xx.x) card passively adds or drops two adjacent 100-GHz channels within the same band. Sixteen versions of this card—each designed for use with one pair of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on 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.
- VOA settings and functions, photodiode detection, and alarm thresholds are internally controlled.
- Virtual photodiodes (firmware calculation of port optical power) at the common DWDM output and input ports are monitored within the software.

Figure 6-9 shows the AD-2C-xx.x faceplate.

Figure 6-9 AD-2C-xx.x Faceplate



For information on safety labels for the card, see the "6.2 Class 1M Laser Product Safety Lasers" section on page 6-7.

Figure 6-10 shows a block diagram of the AD-2C-xx.x card.

Figure 6-10 AD-2C-xx.x Block Diagram

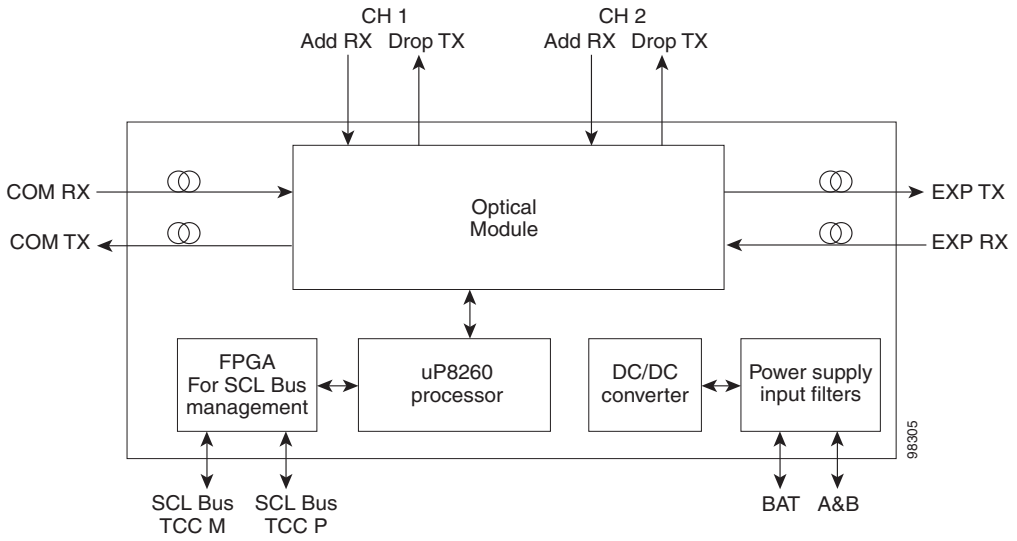
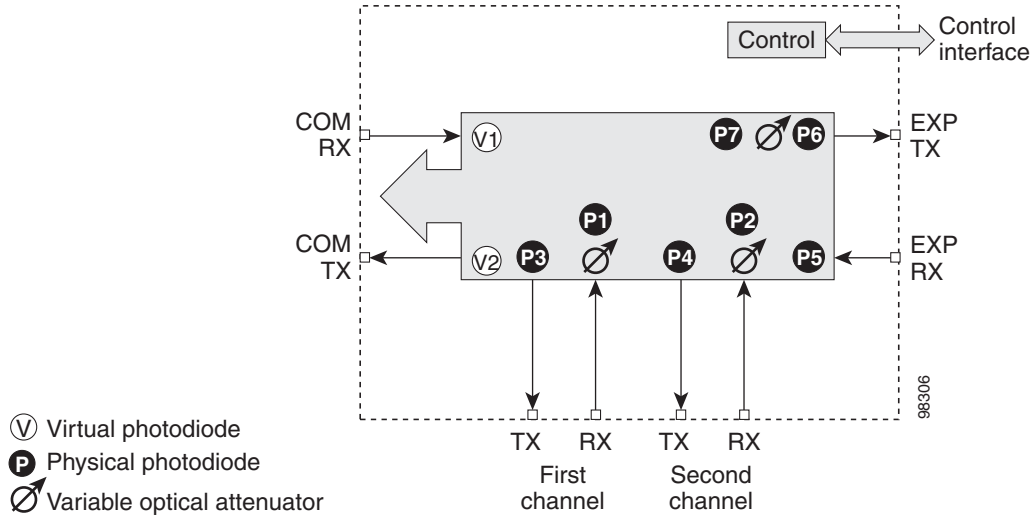


Figure 6-11 shows the AD-2C-xx.x optical module functional block diagram.

Figure 6-11 AD-2C-xx.x Optical Module Functional Block Diagram



6.4.1 Wavelength Pairs

The AD-2C-xx.x cards are provisioned for the wavelength pairs listed in Table 6-9. In this table, channel IDs are given rather than wavelengths. To compare channel IDs with the actual wavelengths they represent, see wavelengths in Table 6-6 on page 6-5.

Table 6-9 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

6.4.2 Power Monitoring

Physical photodiodes P1 through P10 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 6-10.

Table 6-10 AD-2C-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P2	ADD	COM TX
P3–P4	DROP	DROP TX
P5	IN EXP	EXP RX
P6	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

6.4.3 AD-2C-xx.x Card-Level Indicators

The AD-2C-xx.x card has three card-level LED indicators, described in Table 6-11.

Table 6-11 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.

6.4.4 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.

6.5 AD-4C-xx.x Card

Note See the "A.8.3 AD-4C-xx.x Card Specifications" section on page A-40 for hardware specifications.

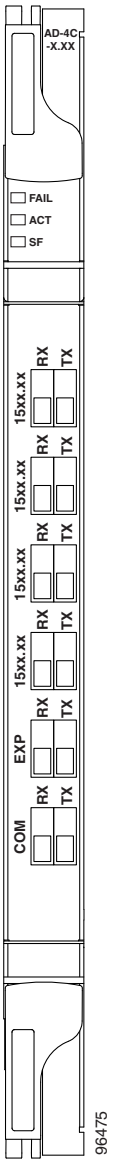
The 4-Channel OADM (AD-4C-xx.x) card passively adds or drops all four 100-GHz-spaced channels within the same band. Eight versions of this card—each designed for use with one band of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on 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.

Figure 6-12 shows the AD-4C-xx.x faceplate.

Figure 6-12 AD-4C-xx.x Faceplate



For information on safety labels for the card, see the "6.2 Class 1M Laser Product Safety Lasers" section on page 6-7.

Figure 6-13 shows a block diagram of the AD-4C-xx.x card.

Figure 6-13 AD-4C-xx.x Block Diagram

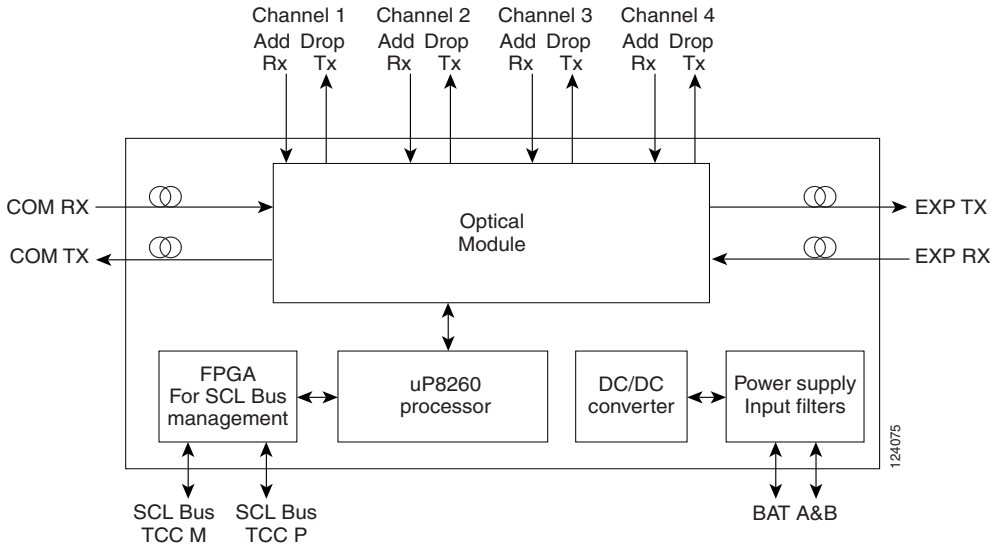
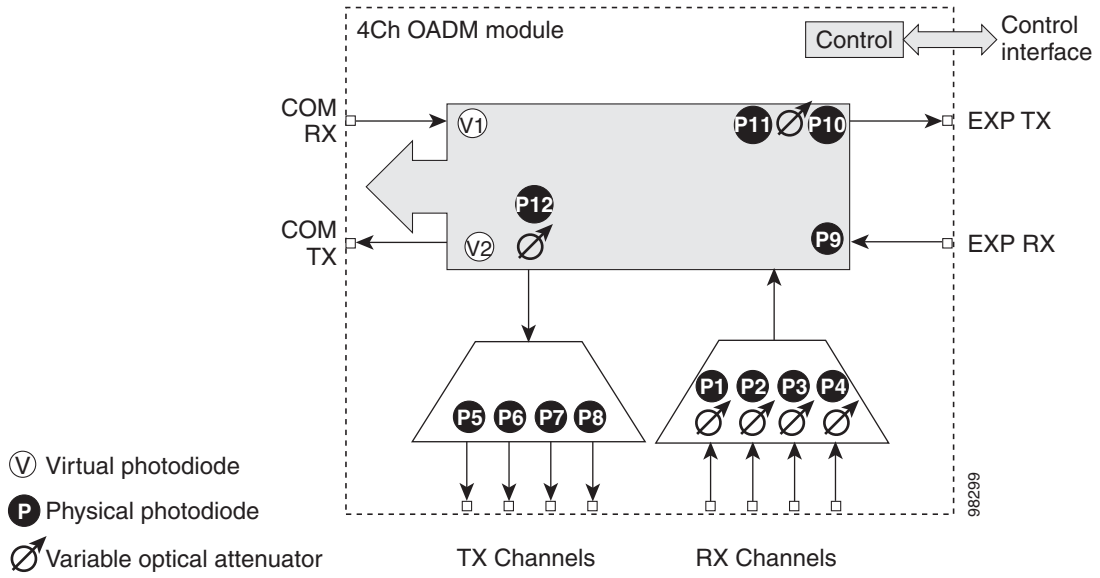


Figure 6-14 shows the AD-4C-xx.x optical module functional block diagram.

Figure 6-14 AD-4C-xx.x Optical Module Functional Block Diagram



6.5.1 Wavelength Sets

The AD-4C-xx.x cards are provisioned for the sets of four 100-GHz-spaced wavelengths shown Table 6-12 on page 6-19.

Table 6-12 AD-4C-xx.x Channel Sets

Band ID	Add/Drop Wavelengths
Band 30.3 (A)	1530.3, 1531.2, 1531.9, 1532.6
Band 34.2 (B)	1534.2, 1535.0, 1535.8, 1536.6
Band 38.1 (C)	1538.1, 1538.9, 1539.7, 1540.5
Band 42.1 (D)	1542.1, 1542.9, 1543.7, 1544.5
Band 46.1 (E)	1546.1, 1546.9, 1547.7, 1548.5
Band 50.1 (F)	1550.1, 1550.9, 1551.7, 1552.5
Band 54.1 (G)	1554.1, 1554.9, 1555.7, 1556.5
Band 58.1 (H)	1558.1, 1558.9, 1559.7, 1560.6

6.5.2 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 6-13.

Table 6-13 AD-4C-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P4	ADD	COM TX
P5–P8	DROP	DROP TX
P9	IN EXP	EXP RX
P10	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

6.5.3 AD-4C-xx.x Card-Level Indicators

The AD-4C-xx.x card has three card-level LED indicators, described in Table 6-14.

Table 6-14 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.

Table 6-14 AD-4C-xx.x Card-Level Indicators (continued)

Card-Level Indicators	Description
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.

6.5.4 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.

6.6 AD-1B-xx.x Card

Note See the "A.8.4 AD-1B-xx.x Card Specifications" section on page A-41 for hardware specifications.

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 and has the following features:

- Passive cascaded 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.
- VOA settings and functions, photodiode detection, and alarm thresholds are internally controlled.
- Virtual photodiode (firmware calculation of port optical power) at the common DWDM output are monitored within the software.

Figure 6-15 shows the AD-1B-xx.x faceplate.

Figure 6-15 AD-1B-xx.x Faceplate

For information on safety labels for the card, see the "6.2 Class 1M Laser Product Safety Lasers" section on page 6-7.

Figure 6-16 shows a block diagram of the AD-1B-xx.x card.

Figure 6-16 AD-1B-xx.x Block Diagram

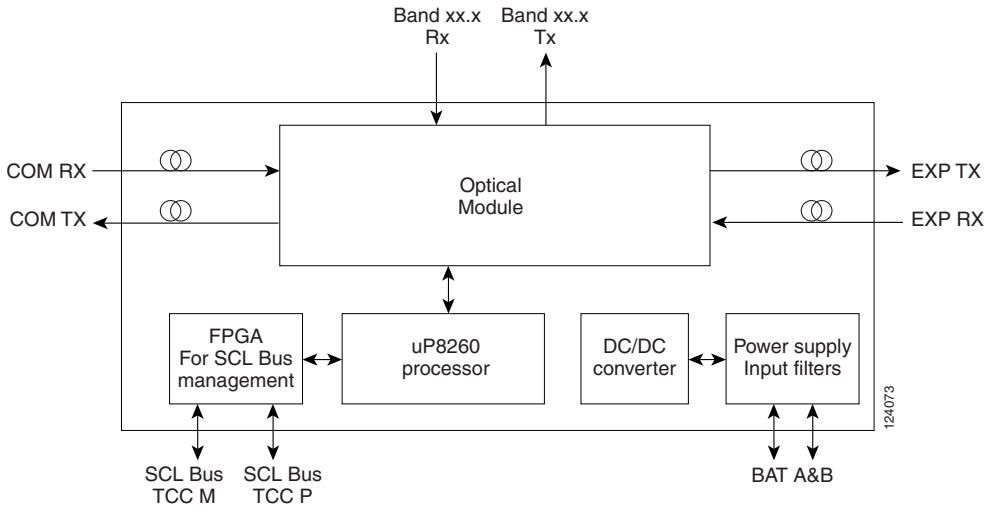
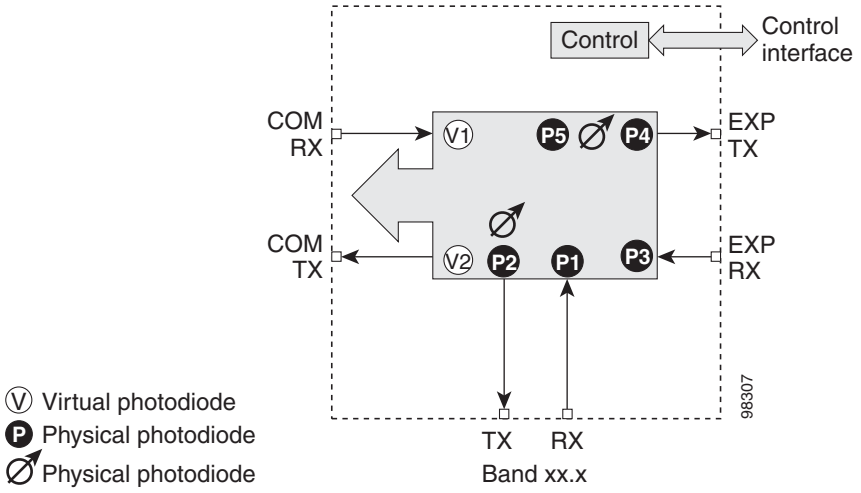


Figure 6-17 shows the AD-1B-xx.x optical module functional block diagram.

Figure 6-17 AD-1B-xx.x Optical Module Functional Block Diagram



6.6.1 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 6-15.

Table 6-15 AD-1B-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	ADD	BAND RX
P2	DROP	BAND TX

Table 6-15 AD-1B-xx.x Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P3	IN EXP	EXP RX
P4	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

6.6.2 AD-1B-xx.x Card-Level Indicators

The AD-1B-xx.x card has three card-level LED indicators, described in Table 6-16.

Table 6-16 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.

6.6.3 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.

6.7 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.

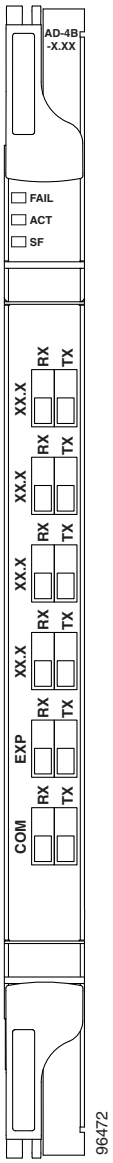
The AD1B-xx.x can be installed in Slots 1 to 6 and 12 to 17 and has the following features:

- 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.
- VOA settings and functions, photodiode detection, and alarm thresholds are internally controlled.
- Virtual photodiode (firmware calculation of port optical power) at the common DWDM output port are monitored within the software.

Figure 6-18 shows the AD-4B-xx.x faceplate.

Figure 6-18 AD-4B-xx.x Faceplate



For information on safety labels for the card, see the "6.2 Class 1M Laser Product Safety Lasers" section on page 6-7.

Figure 6-19 shows a block diagram of the AD-4B-xx.x card.

Figure 6-19 AD-4B-xx.x Block Diagram

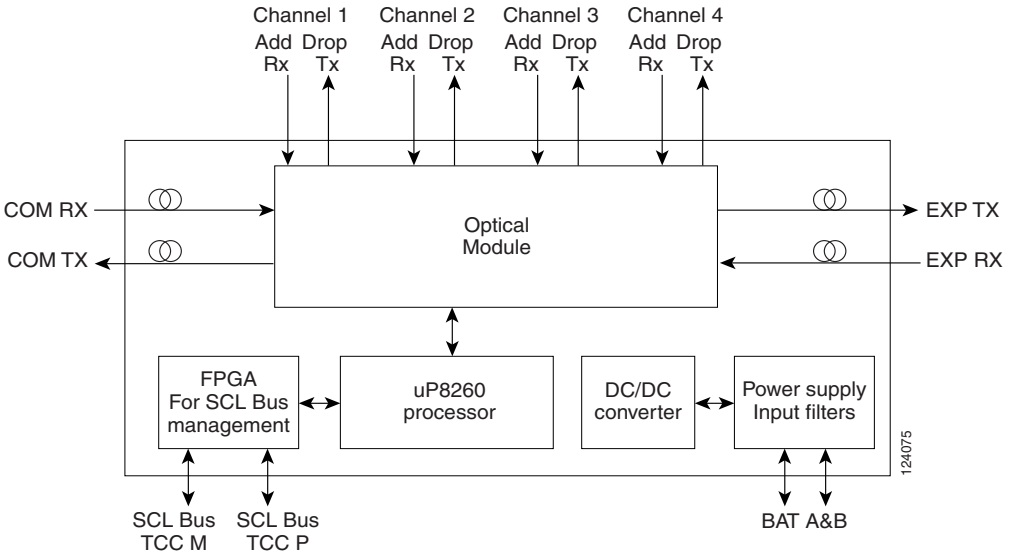
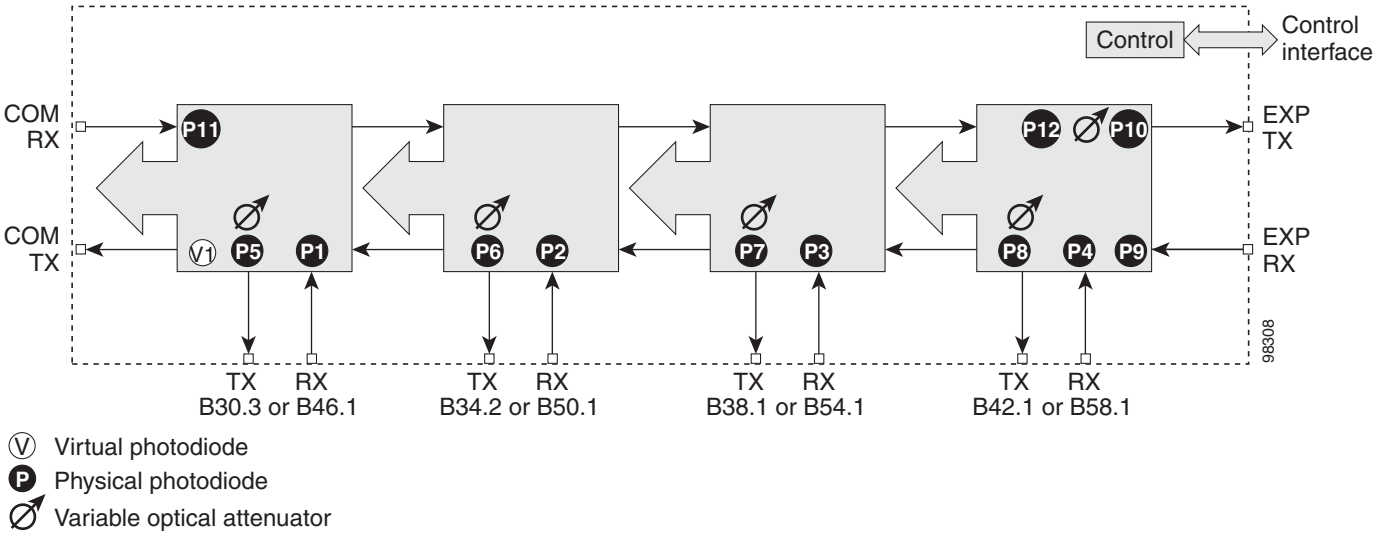


Figure 6-20 shows the AD-4B-xx.x optical module functional block diagram.

Figure 6-20 AD-4B-xx.x Optical Module Functional Block Diagram



6.7.1 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 6-17.

Table 6-17 AD-4B-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P4	ADD	COM TX
P5–P8	DROP	DROP TX
P9	IN EXP	EXP RX
P10	OUT EXP	EXP TX
P11	IN COM	COM RX
V1	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 8.5*.

6.7.2 AD-4B-xx.x Card-Level Indicators

The AD-4B-xx.x card has three card-level LED indicators, described in Table 6-18.

Table 6-18 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.

6.7.3 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.

CHAPTER 7

Reconfigurable Optical Add/Drop Cards

This chapter describes the Cisco ONS 15454 cards deployed in reconfigurable optical add/drop (ROADM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 7.1 Card Overview, page 7-2
- 7.2 Safety Labels for Class 1M Laser Product Cards, page 7-9
- 7.3 32WSS Card, page 7-12
- 7.4 32WSS-L Card, page 7-18
- 7.5 32DMX Card, page 7-25
- 7.6 32DMX-L Card, page 7-30
- 7.7 40-DMX-C Card, page 7-35
- 7.8 40-DMX-CE Card, page 7-40
- 7.9 40-MUX-C Card, page 7-45
- 7.10 40-WSS-C Card, page 7-50
- 7.11 40-WSS-CE Card, page 7-56
- 7.12 40-WXC-C Card, page 7-63
- 7.13 MMU Card, page 7-69

Note This chapter contains information about cards that perform mesh topology functions. Multiplexer and demultiplexer cards that do not perform these functions are described in Chapter 5, "Multiplexer and Demultiplexer Cards."

7.1 Card Overview

The ROADM cards include six add drop cards utilized in the C band (32WSS, 32DMX, 32DMX-C, 40-MUX-C, 40-WXC-C, and MMU) and two add drop cards utilized for the L band (32WSS-L, and 32DMX-L).

This section provides card summary, compatibility, channel allocation, and safety information.

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 that have the same symbols. See the "1.16.1 Card Slot Requirements" section on page 1-61 for a list of slots and symbols.

7.1.1 Card Summary

Table 7-1 lists and summarizes information about each ROADM card.

Table 7-1 ROADM Card Summary

Card	Port Description	For Additional Information
32WSS	The 32WSS card has seven sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "7.3 32WSS Card" section on page 7-12
32WSS-L	The 32WSS-L card has seven sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "7.4 32WSS-L Card" section on page 7-18
32DMX	The 32DMX has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "7.5 32DMX Card" section on page 7-25
32DMX-L	The 32DMX-L has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "7.6 32DMX-L Card" section on page 7-30
40-DMX-C	The 40-DMX-C has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "7.7 40-DMX-C Card" section on page 7-35
40-DMX-CE	The 40-DMX-CE has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "7.8 40-DMX-CE Card" section on page 7-40
40-MUX-C	The 40-MUX-C has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "7.9 40-MUX-C Card" section on page 7-45.
40-WSS-C	The 40-WSS-C card has eight sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "7.10 40-WSS-C Card" section on page 7-50
40-WSS-CE	The 40-WSS-CE card has eight sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "7.11 40-WSS-CE Card" section on page 7-56

Table 7-1 ROADM Card Summary (continued)

Card	Port Description	For Additional Information
40-WXC-C	The 40-WXC-C card has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "7.12 40-WXC-C Card" section on page 7-63
MMU	The MMU card has six sets of ports located on the faceplate, It operates in Slots 1 to 6 and 12 to 17.	See the "7.13 MMU Card" section on page 7-69

7.1.2 Card Compatibility

Table 7-2 lists the Cisco Transport Controller (CTC) software compatibility for the ROADM cards.

Table 7-2 Software Release Compatibility for ROADM Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5
32WSS	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
32WSS-L	No	No	No	No	No	Yes	Yes	Yes	Yes
40-WSS-C	No	No	No	No	No	No	No	Yes	Yes
40-WSS-CE	No	No	No	No	No	No	No	Yes	Yes
32DMX	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
32DMX-L	No	No	No	No	No	Yes	Yes	Yes	Yes
40-DMX-C	No	No	No	No	No	No	No	Yes	Yes
40-DMX-CE	No	No	No	No	No	No	No	Yes	Yes
40-MUX-C	No	No	No	No	No	No	No	Yes	Yes
40-WXC-C	No	No	No	No	No	No	No	Yes	Yes
MMU	No	No	No	No	No	Yes	Yes	Yes	Yes

7.1.3 Interface Classes

The 40-MUX-C, 32DMX, 32DMX-L, 40-DMX-C, 40-DMX-CE, 32WSS, and 32WSS-L cards have different input and output optical channel signals depending on the interface card originating the input signal. The input interface cards have been grouped in classes listed in Table 7-3. The subsequent tables list the optical performance and output power of each interface class.

Table 7-3 Cisco ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) with forward error correction (FEC) enabled and 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with FEC enabled
B	10-Gbps multirate transponder card (TXP_MR_10G) without FEC, 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_MR_10DME_C, and MXP_MR_10DME_L), and ADM-10G cards with FEC disabled
C	OC-192 LR ITU cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) without FEC
D	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled
E	OC-48 100-GHz dense wavelength division multiplexing (DWDM) muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected; FEC disabled; and retime, reshape, and regenerate (3R) mode enabled
F	2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz card
H	2/4 port GbE transponder (GBIC WDM 100GHz)
I	TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards with enhanced FEC (E-FEC) and the MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards with E-FEC enabled

Table 7-4 lists the optical performance parameters for 10-Gbps cards that provide signal input to the following multiplexer cards and demultiplexer cards:

- 32DMX
- 32DMX-L
- 32DMX-O
- 32MUX-O1
- 40-DMX-C
- 40-DMX-CE
- 40-MUX-C
- 40-WSS-C
- 40-WSS-CE
- 40-WXC-C
- 4MD-xx.x

Table 7-4 10-Gbps Interface Optical Performance

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps	10 Gbps	
Regeneration	3R		3R		3R	3R	
FEC	Yes		No		No	Yes (E-FEC)	
Threshold	Optimum		Average		Average	Optimum	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-12}	10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–22 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm		–9 dBm	–8 dBm	
Transmitted Power Range[3]							
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10G)	+2.5 to 3.5 dBm		+2.5 to 3.5 dBm		—	—	
OC-192 LR ITU	—		—		+3.0 to 6.0 dBm	—	
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10E)	+3.0 to 6.0 dBm		+3.0 to 6.0 dBm		—	+3.0 to 6.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–1,000 ps/nm	+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the optical add drop multiplexer (OADM) cards.

- Table 7-5 lists the optical interface performance parameters for 2.5-Gbps cards that provide signal input to the following multiplexer and demultiplexer cards:
- 32DMX
- 32DMX-L
- 32DMX-O
- 32MUX-O1
- 40-DMX-C
- 40-DMX-CE
- 40-MUX-C
- 40-WSS-C
- 40-WSS-CE

- 40-WXC-C
- 4MD-xx.x

Table 7-5 2.5-Gbps Interface Optical Performance

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps	2.5 Gbps		1.25 Gbps		2.5 Gbps
Regeneration	3R		3R		2R	3R		3R		3R
FEC	Yes		No		No	No		No		No
Threshold	Average		Average		Average	Average		Average		Average
Maximum BER	10^{-15}		10^{-12}		10^{-12}	10^{-12}		10^{-12}		10^{-12}
OSNR sensitivity	14 dB	6 dB	14 dB	10 dB	15 dB	14 dB	11 dB	13 dB	8 dB	12 dB
Power sensitivity	–31 dBm	–25 dBm	–30 dBm	–23 dBm	–24 dBm	–27 dBm	–33 dBm	–28 dBm	–18 dBm	–26 dBm
Power overload	–9 dBm		–9 dBm		–9 dBm	–9 dBm		–7 dBm		–17dBm
Transmitted Power Range[1]										
TXP_MR_2.5G	–1.0 to 1.0 dBm		–1.0 to 1.0 dBm		–1.0 to 1.0 dBm	–2.0 to 0 dBm		—		—
TXPP_MR_2.5G	–4.5 to –2.5 dBm		–4.5 to –2.5 dBm		–4.5 to –2.5 dBm					
MXP_MR_2.5G	—		+2.0 to +4.0 dBm		—					
MXPP_MR_2.5G	—		–1.5 to +0.5 dBm		—					
2/4 port GbE Transponder (GBIC WDM 100GHz)	—		—		—	—		+2.5 to 3.5 dBm		—
Dispersion compensation tolerance	–1200 to +5400 ps/nm		–1200 to +5400 ps/nm		–1200 to +3300 ps/nm	–1200 to +3300 ps/nm		–1000 to +3600 ps/nm		–1000 to +3200 ps/nm

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

7.1.4 Channel Allocation Plans

ONS 15454 DWDM ROADM cards are designed for use with specific channels in the C band and L band. In most cases, the channels for these cards are either numbered (for example, 1 to 32 or 1 to 40) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

. The following cards operate in the C band:

- 32WSS
- 32DMX
- 32DMX-C
- 40-MUX-C

- 40-WXC-C
- MMU

Table 7-6 lists the C band channel IDs and wavelengths at ITU-T 50-GHz intervals. This is a comprehensive C band channel table that encompasses future card capability as well as present capabilities.

Table 7-6 DWDM C[1] Band Channel Allocation Plan with 50-GHz Spacing

Channel Number	Frequency (THz)	Wavelength (nm)		Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55		42	193.95	1545.72
2	195.95	1529.94		43	193.90	1546.119
3	195.90	1530.334		44	193.85	1546.518
4	195.85	1530.725		45	193.80	1546.917
5	195.80	1531.116		46	193.75	1547.316
6	195.75	1531.507		47	193.70	1547.715
7	195.70	1531.898		48	193.65	1548.115
8	195.65	1532.290		49	193.60	1548.515
9	195.60	1532.681		50	193.55	1548.915
10	195.55	1533.073		51	193.50	1549.32
11	195.50	1533.47		52	193.45	1549.71
12	195.45	1533.86		53	193.40	1550.116
13	195.40	1534.250		54	193.35	1550.517
14	195.35	1534.643		55	193.30	1550.918
15	195.30	1535.036		56	193.25	1551.319
16	195.25	1535.429		57	193.20	1551.721
17	195.20	1535.822		58	193.15	1552.122
18	195.15	1536.216		59	193.10	1552.524
19	195.10	1536.609		60	193.05	1552.926
20	195.05	1537.003		61	193.00	1553.33
21	195.00	1537.40		62	192.95	1553.73
22	194.95	1537.79		63	192.90	1554.134
23	194.90	1538.186		64	192.85	1554.537
24	194.85	1538.581		65	192.80	1554.940
25	194.80	1538.976		66	192.75	1555.343
26	194.75	1539.371		67	192.70	1555.747
27	194.70	1539.766		68	192.65	1556.151
28	194.65	1540.162		69	192.60	1556.555
29	194.60	1540.557		70	192.55	1556.959
30	194.55	1540.953		71	192.50	1557.36

Table 7-6 DWDM C[1] Band Channel Allocation Plan with 50-GHz Spacing (continued)

Channel Number	Frequency (THz)	Wavelength (nm)		Channel Number	Frequency (THz)	Wavelength (nm)
31	194.50	1541.35		72	192.45	1557.77
32	194.45	1541.75		73	192.40	1558.173
33	194.40	1542.142		74	192.35	1558.578
34	194.35	1542.539		75	192.30	1558.983
35	194.30	1542.936		76	192.25	1559.389
36	194.25	1543.333		77	192.20	1559.794
37	194.20	1543.730		78	192.15	1560.200
38	194.15	1544.128		79	192.10	1560.606
39	194.10	1544.526		80	192.05	1561.013
40	194.05	1544.924		81	192.00	1561.42
41	194.00	1545.32		82	191.95	1561.83

1. Channels on the C band are 4-skip-1, starting at 1530.33 nm.

The following add drop cards utilize the L band DWDM channels:

- 32WSS-L
- 32DMX-L

Table 7-7 lists the L band channel IDs and wavelengths at ITU-T 50-GHz intervals. This is a comprehensive L band channel table that encompasses future card capability as well as present capabilities.

Table 7-7 DWDM L Band[1] Channel Allocation Plan at 50 GHz Spacing

Channel Number	Frequency (THz)	Wavelength (nm)		Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83		41	188.85	1587.46
2	190.8	1571.24		42	188.8	1587.88
3	190.75	1571.65		43	188.75	1588.30
4	190.7	1572.06		44	188.7	1588.73
5	190.65	1572.48		45	188.65	1589.15
6	190.6	1572.89		46	188.6	1589.57
7	190.55	1573.30		47	188.55	1589.99
8	190.5	1573.71		48	188.5	1590.41
9	190.45	1574.13		49	188.45	1590.83
10	190.4	1574.54		50	188.4	1591.26
11	190.35	1574.95		51	188.35	1591.68
12	190.3	1575.37		52	188.3	1592.10
13	190.25	1575.78		53	188.25	1592.52

Table 7-7 DWDM L Band[1] Channel Allocation Plan at 50 GHz Spacing (continued)

Channel Number	Frequency (THz)	Wavelength (nm)		Channel Number	Frequency (THz)	Wavelength (nm)
14	190.2	1576.20		54	188.2	1592.95
15	190.15	1576.61		55	188.15	1593.37
16	190.1	1577.03		56	188.1	1593.79
17	190.05	1577.44		57	188.05	1594.22
18	190	1577.86		58	188	1594.64
19	189.95	1578.27		59	187.95	1595.06
20	189.9	1578.69		60	187.9	1595.49
21	189.85	1579.10		61	187.85	1595.91
22	189.8	1579.52		62	187.8	1596.34
23	189.75	1579.93		63	187.75	1596.76
24	189.7	1580.35		64	187.7	1597.19
25	189.65	1580.77		65	187.65	1597.62
26	189.6	1581.18		66	187.6	1598.04
27	189.55	1581.60		67	187.55	1598.47
28	189.5	1582.02		68	187.5	1598.89
29	189.45	1582.44		69	187.45	1599.32
30	189.4	1582.85		70	187.4	1599.75
31	189.35	1583.27		71	187.35	1600.17
32	189.3	1583.69		72	187.3	1600.60
33	189.25	1584.11		73	187.25	1601.03
34	189.2	1584.53		74	187.2	1601.46
35	189.15	1584.95		75	187.15	1601.88
36	189.1	1585.36		76	187.1	1602.31
37	189.05	1585.78		77	187.05	1602.74
38	189	1586.20		78	187	1603.17
39	188.95	1586.62		79	186.95	1603.60
40	188.9	1587.04		80	186.9	1604.03

1. Channels on the L band are contiguous, starting at 1577.86 nm. The channels listed in this table begin with 1570.83 nm for backward compatibility with other ONS products.

7.2 Safety Labels for Class 1M Laser Product Cards

This section explains the significance of the safety labels attached to some of the cards. The card faceplates are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

The 32DMX, 32DMX-L, 40-MUX-C, 40-DMX-C, 40-DMX-CE, 32WSS, 32WSS-L, 40-WSS-C, 40-WSS-CE, and 40-WXC-C cards have Class IM lasers. The labels that appear on these cards are described in the following subsections.

7.2.1 Class 1M Laser Product Label

Figure 7-1 shows the Class 1M Laser Product label.

Figure 7-1 Class 1M Laser Product Label

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

7.2.2 Hazard Level 1M Label

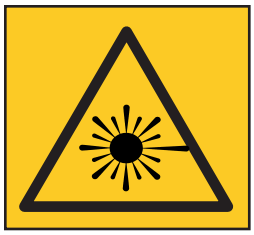
Figure 7-2 shows the Hazard Level 1M label. The Hazard Level label warns users against exposure to laser radiation by Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

Figure 7-2 Hazard Level Label

7.2.3 Laser Source Connector Label

Figure 7-3 shows the Laser Source Connector label. This label indicates that a laser source is present at the optical connector where the label is located.

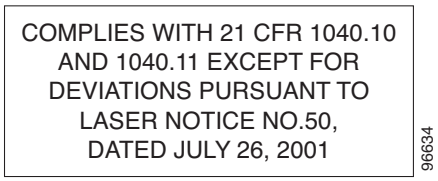
Figure 7-3 Laser Source Connector Label



7.2.4 FDA Statement Label

Figure 7-4 shows the FDA Statement label. This label shows compliance to FDA standards and indicates that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

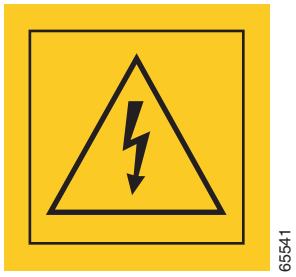
Figure 7-4 FDA Statement Label



7.2.5 Shock Hazard Label

Figure 7-5 shows the Shock Hazard label. This label alerts you to electrical hazards within a card. A shock hazard exists when you remove adjacent cards during maintenance, or when you touch exposed electrical circuitry on the card itself.

Figure 7-5 Shock Hazard Label



7.3 32WSS Card

Note See the "A.7.3 32WSS Card Specifications" section on page A-25 for hardware specifications.

Note For information 32WSS card safety labels, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The two-slot 32-Channel Wavelength Selective Switch (32WSS) card performs channel add/drop processing within the ONS 15454 DWDM node. The 32WSS card can be installed in the following pairs of slots:

- Slots 1 and 2
- Slots 3 and 4
- Slots 5 and 6
- Slots 12 and 13
- Slots 14 and 15
- Slots 16 and 17

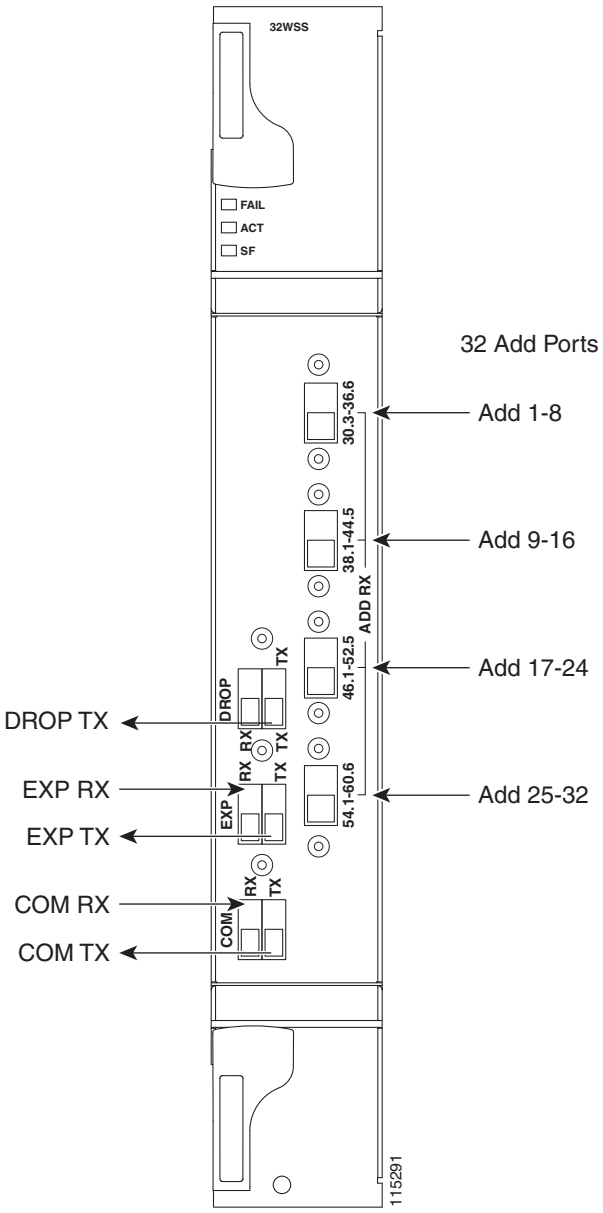
7.3.1 32WSS Faceplate Ports

The 32WSS has six types of ports:

- ADD RX ports (1 to 32): These ports are used for adding channels (listed in Table 7-9 on page 7-16). Each add channel is associated with an individual switch element that selects whether that channel is added. Each add port has optical power regulation provided by a variable optical attenuator (VOA). The 32WSS has four physical receive connectors that accept multifiber push-on (MPO) cables on its front panel for the client input interfaces.Each MPO cable breaks out into eight separate cables.
- EXP RX port: The EXP RX port receives an optical signal from another 32WSS card in the same network element (NE).
- EXP TX port: The EXP TX port sends an optical signal to the other 32WSS card within the NE.
- COM TX port: The COM TX (line input) port sends an aggregate optical signal to a booster amplifier card (for example, OPT-BST) for transmission outside of the NE.
- COM RX port: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- DROP TX port: The DROP TX port sends the split-off optical signal containing drop channels to the 32DMX card, where the channels are further processed and dropped.

Figure 7-6 shows the 32WSS card front panel and identifies the traffic flow through the ports.

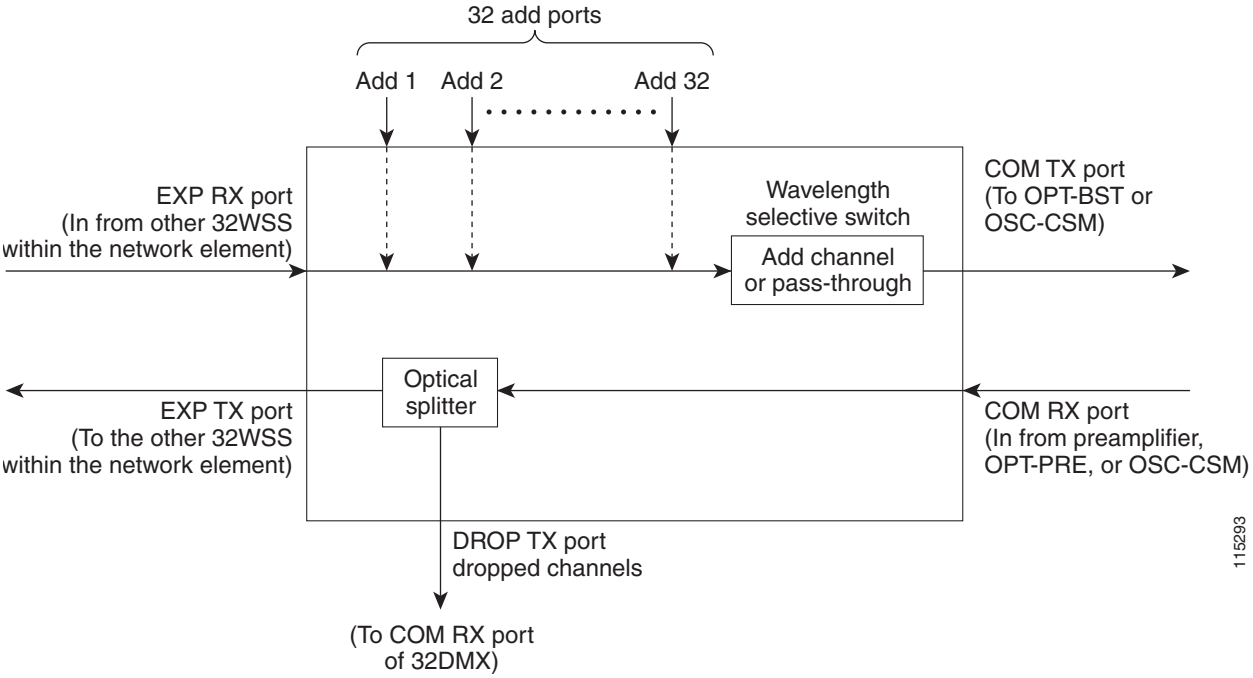
Figure 7-6 32WSS Faceplate and Ports



7.3.2 32WSS Block Diagram

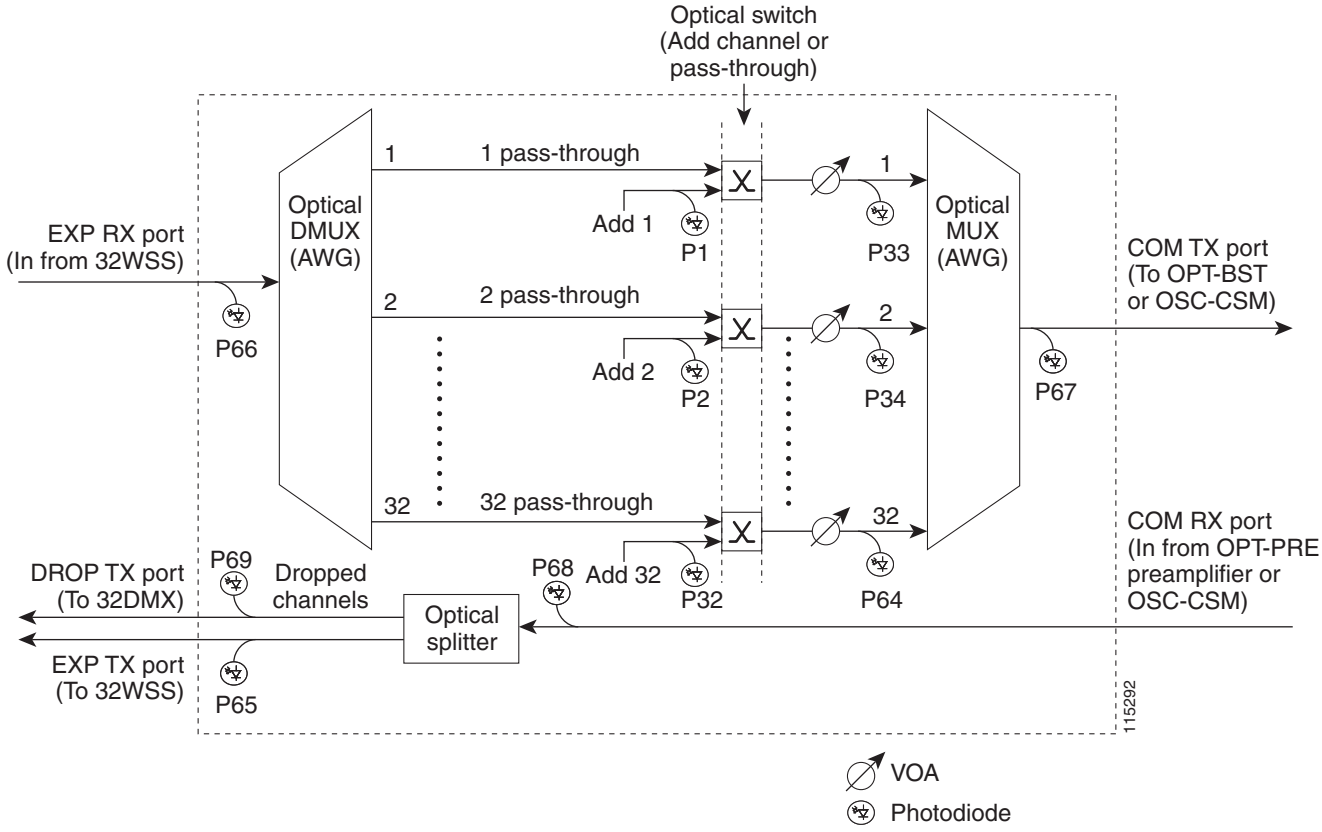
Figure 7-7 provides a high-level functional block diagram of the 32WSS card and Figure 7-8 on page 7-15 shows how optical signals are processed on the EXP RX and COM RX ports.

Figure 7-7 32WSS Block Diagram



Aggregate optical signals that enter the EXP RX and COM RX port are processed in two ways: Add channel/pass-through and optical splitter processing. The optical processing stages are shown in Figure 7-8, which provides a detailed optical functional diagram of the 32WSS card.

Figure 7-8 32WSS Optical Block Diagram



The EXP RX PORT and COM RX PORT operate as follows:

- EXP RX Port Add Channel/Pass-through Processing

  The incoming optical signal is received at the EXP RX port from the other 32WSS card within the NE. The incoming aggregate optical signal is demultiplexed into 32 individual wavelengths, or channels. Each channel is then individually processed by the optical switch, which performs add/pass-through processing. By using software controls, the switch either selects the optical channel coming in from the demultiplexer (that is, the pass-through channel) or it selects the external ADD channel. If the ADD port channel is selected this channel is transmitted and the optical signal coming from the demultiplexer is blocked.

  After the optical switch stage, all of the channels are multiplexed into an aggregate optical signal, which is sent out on the COM TX port. The output is typically connected to an OPT-BST or OPT-BST-E card (in the event a booster amplifier is needed) or to an OSC-CSM card (if no amplification is needed).

- COM RX Port Optical Splitter Processing

  The COM RX port receives the incoming optical signal and directs it to the 32WSS card's optical splitter. The splitter optically diverts channels that are designated to be dropped to the DROP TX port. The DROP TX port is typically connected to the COM RX port of the 32DMX where the drop channels are being dropped. Channels that are not dropped pass through the optical splitter and flow out of the 32WSS card EXP TX port. Typically, this optical signal is connected to the other 32WSS module within the NE.

7.3.3 32WSS ROADM Functionality

The 32WSS card works in combination with the 32DMX card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and Cisco Transport Manager (CTM). ROADM functionality using the 32WSS card requires two 32DMX single-slot cards and two 32WSS double-slot cards (totalling six slots needed in the ONS 15454 chassis).

For other cards' ROADM functionality, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

Note A terminal site can be configured using only a 32WSS card and a 32DMX card plugged into the east or west side of the shelf.

7.3.4 32WSS Power Monitoring

Physical photodiodes P1 through P69 monitor the power for the 32WSS card. Table 7-8 shows how the returned power level values are calibrated to each port.

Table 7-8 32WSS Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	ADD (Power ADD)	ADD RX
P33–P64[1]	PASS THROUGH	COM TX
	ADD (Power)	COM TX
P65	OUT EXP	EXP TX
P66	IN EXP	EXP RX
P67	OUT COM	COM TX
P68	IN COM	COM RX
P69	DROP	DROP TX

1. P33–P64 monitor either ADD or PASSTHROUGH power, depending on the state of the optical switch

7.3.5 32WSS Channel Allocation Plan

The 32WSS Card's channel labels, frequencies, and wavelengths are listed in Table 7-9.

Table 7-9 32WSS Channel Allocation Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68

Table 7-9 32WSS Channel Allocation Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.1	195.1	1536.61
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.87
	39.7	194.7	1539.77
	40.5	194.6	1540.46
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61

7.3.6 32WSS Card-Level Indicators

Table 7-10 describes the three card-level LED indicators on the 32WSS card.

Table 7-10 32WSS 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 32WSS 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.

7.3.7 32WSS Port-Level Indicators

You can find the alarm status of the 32WSS card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.4 32WSS-L Card

Note See the "A.7.4 32WSS-L Card Specifications" section on page A-27 for hardware specifications.

Note For 32WSS-L safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The two-slot 32-Channel Wavelength Selective Switch L-Band (32WSS-L) card performs channel add/drop processing within the ONS 15454 DWDM node. The 32WSS-L card is particularly well suited for use in networks that employ DS fiber or SMF-28 single-mode fiber.The 32WSS-L card can be installed in the following pairs of slots:

- Slots 1 and 2
- Slots 3 and 4
- Slots 5 and 6
- Slots 12 and 13
- Slots 14 and 15
- Slots16 and 17

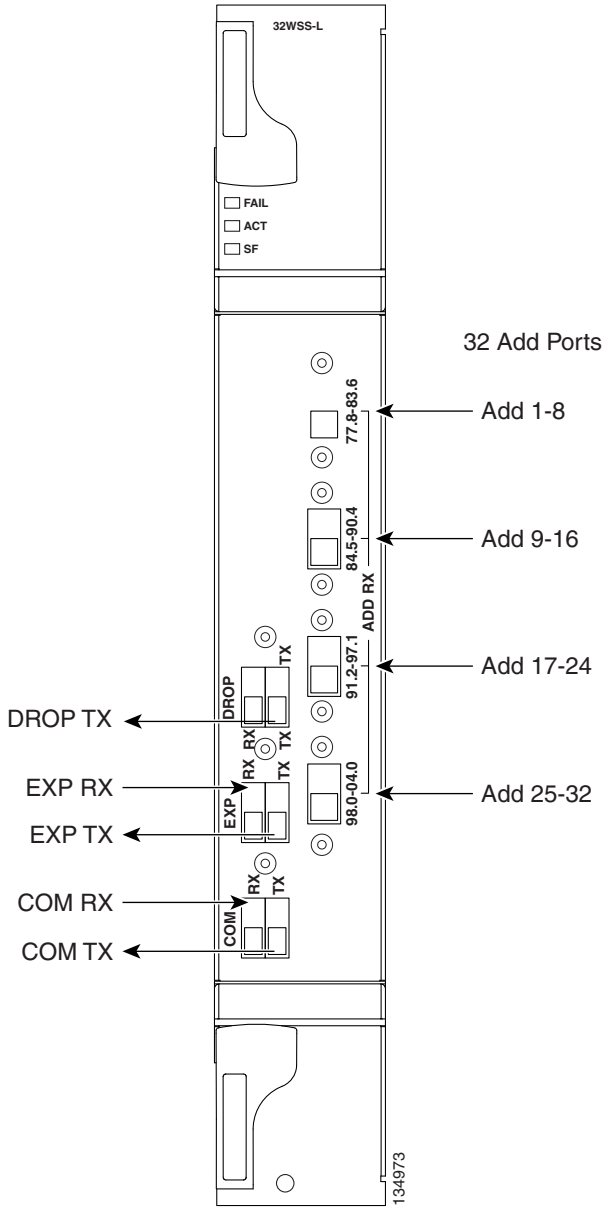
7.4.1 32WSS-L Faceplate Ports

The 32WSS-L card faceplate has six types of ports:

- ADD RX ports (1 to 32): These ports are used for adding channels (which are listed in Table 7-12 on page 7-23). Each add channel is associated with an individual switch element that selects whether the channel is added. Each add port has optical power regulation provided by a VOA.
- EXP RX port: The EXP RX port receives an optical signal from another 32WSS-L card in the same NE.
- EXP TX port: The EXP TX port sends an optical signal to the other 32WSS-L card within the NE.
- COM TX port: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- COM RX port: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- DROP TX port: The DROP TX port sends the split-off optical signal with drop channels to the 32DMX-L card, where the channels are further processed and dropped.

Figure 7-9 shows the 32WSS-L module front panel and identifies the traffic flow through the ports.

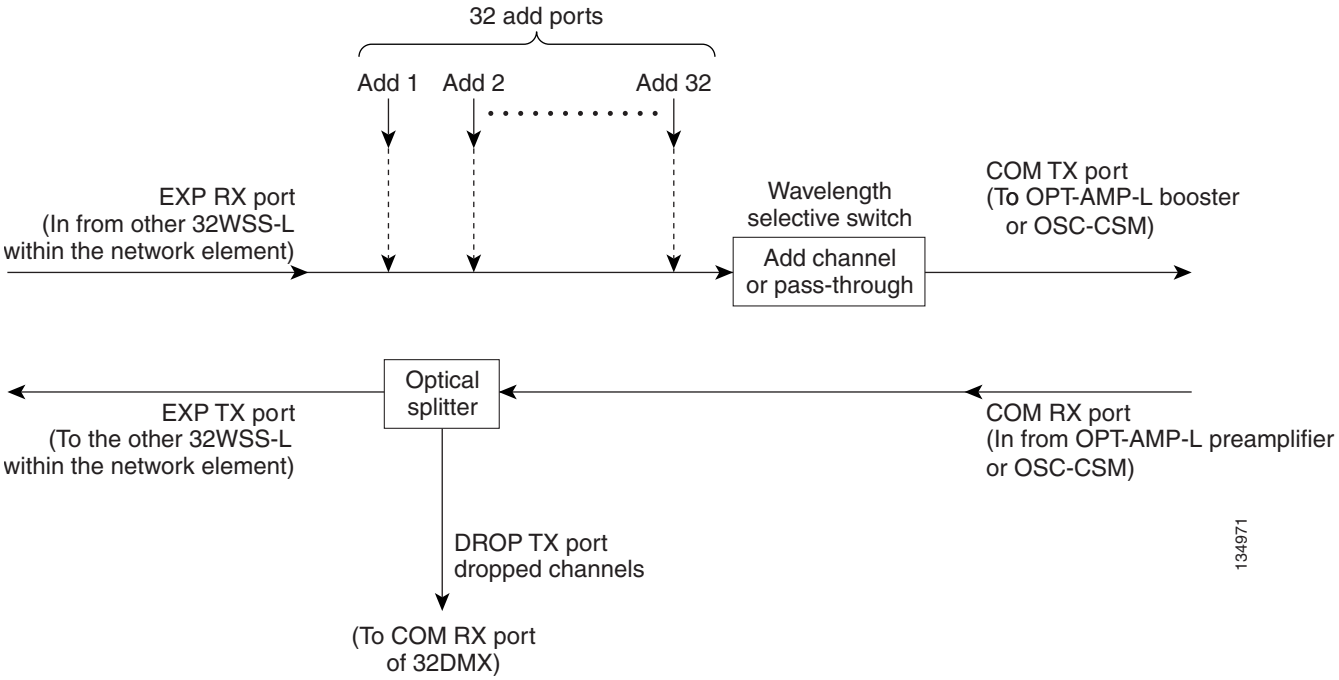
Figure 7-9 32WSS-L Faceplate and Ports



7.4.2 32WSS-L Block Diagram

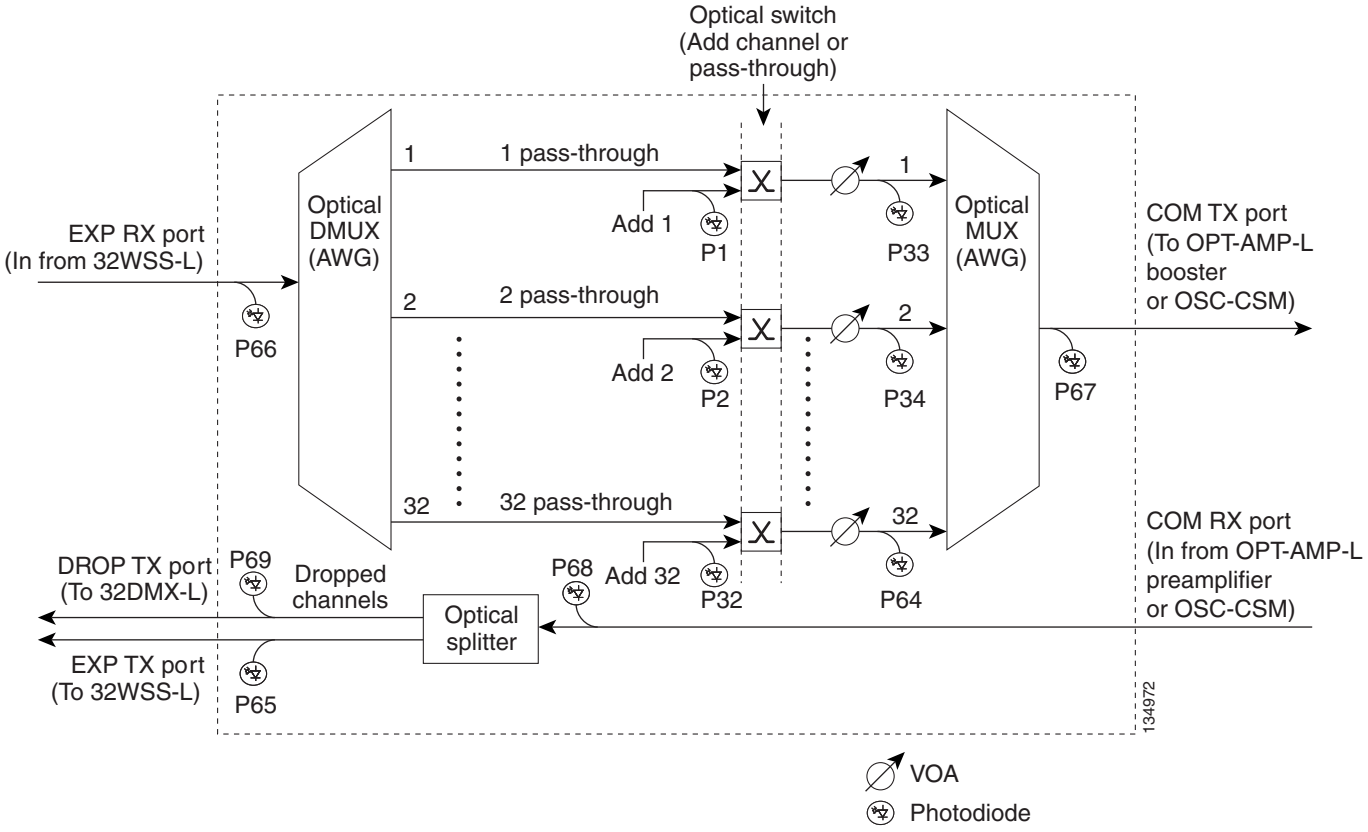
Figure 7-10 provides a high-level functional block diagram of the 32WSS-L card and Figure 7-11 on page 7-22 shows how optical signals are processed on the EXP RX and COM RX ports.

Figure 7-10 32WSS-L Block Diagram



Aggregate optical signals that enter the EXP RX and COM RX ports are processed in two ways: add channel/pass-through and optical splitter processing. The optical processing stages are shown in Figure 7-11, which provides a detailed optical functional diagram of the 32WSS-L card.

Figure 7-11 32WSS-L Optical Block Diagram



The EXP RX PORT and COM RX PORT operate as follows:

- EXP RX Port Add Channel/Pass-through Processing

  The incoming optical signal is received at the EXP RX port from the other 32WSS-L card within the NE. The incoming aggregate optical signal is demultiplexed into 32 individual wavelengths, or channels. Each channel is then individually processed by the optical switch, which performs add/pass-through processing. By using software controls, the switch either selects the optical channel coming in from the demultiplexer (that is, the pass-through channel) or it selects the external ADD channel. If the ADD port channel is selected this channel is transmitted and the optical signal coming from the demultiplexer is blocked.

  After the optical switch stage, all of the channels are multiplexed into an aggregate optical signal, which is sent out on the COM TX port. The output is typically connected to an OPT-AMP-L or OPT-BST-E card (in the event a booster amplifier is needed) or to an OSC-CSM card (if no amplification is needed).

- COM RX Port Optical Splitter Processing

  The COM RX port receives the incoming optical signal and directs it to the 32WSS-L card's optical splitter. The splitter optically diverts channels that are designated to be dropped to the DROP TX port. The DROP TX port is typically connected to the COM RX port of the 32DMX-L where the drop channels are being dropped. Channels that are not dropped pass through the optical splitter and flow out of the 32WSS-L card EXP TX port. Typically, this optical signal is connected to the other 32WS-L module within the NE.

7.4.3 32WSS-L ROADM Functionality

The 32WSS-L works in combination with the 32DMX-L to implement L band (1570 to 1620 nm) functionality. As a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 32WSS-L card requires two 32DMX-L single-slot cards and two 32WSS-L double-slot cards (totalling six slots needed in the ONS 15454 chassis).

For other cards' ROADM functionality, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

Note A terminal site can be configured using a 32WSS-L card and a 32DMX-L card plugged into the east or west side of the shelf.

7.4.4 32WSS-L Power Monitoring

Physical photodiodes P1 through P69 monitor the power for the 32WSS-L card. Table 7-11 shows the returned power level values calibrated to each port.

Table 7-11 32WSS-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	ADD (Power ADD)	ADD RX
P33–P64[1]	PASS THROUGH	COM TX
	ADD (Power)	COM TX
P65	OUT EXP	EXP TX
P66	IN EXP	EXP RX
P67	OUT COM	COM TX
P68	IN COM	COM RX
P69	DROP	DROP TX

1. P33–P64 monitor either ADD or PASSTHROUGH power, depending on the state of the optical switch

7.4.5 32WSS-L Channel Plan

The 32WSS-L card uses 32 banded channels on the ITU-T 100-GHz grid, as shown in Table 7-12.

Table 7-12 32WSS-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35

Table 7-12 32WSS-L Channel Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

7.4.6 32WSS-L Card-Level Indicators

Table 7-13 describes the three card-level LED indicators on the 32WSS-L card.

Table 7-13 32WSS-L 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32WSS-L 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.5 32DMX Card

Note See the "A.7.1 32DMX Card Specifications" section on page A-21 for hardware specifications.

Note For 32DMX card safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The single-slot 32-Channel Demultiplexer (32DMX) card is an optical demultiplexer. The card receives an aggregate optical signal on its COM RX port and demultiplexes it into to (32) ITU-T 100-GHz-spaced channels. The 32DMX card can be installed in Slots 1 to 6 and in Slots 12 to 17.

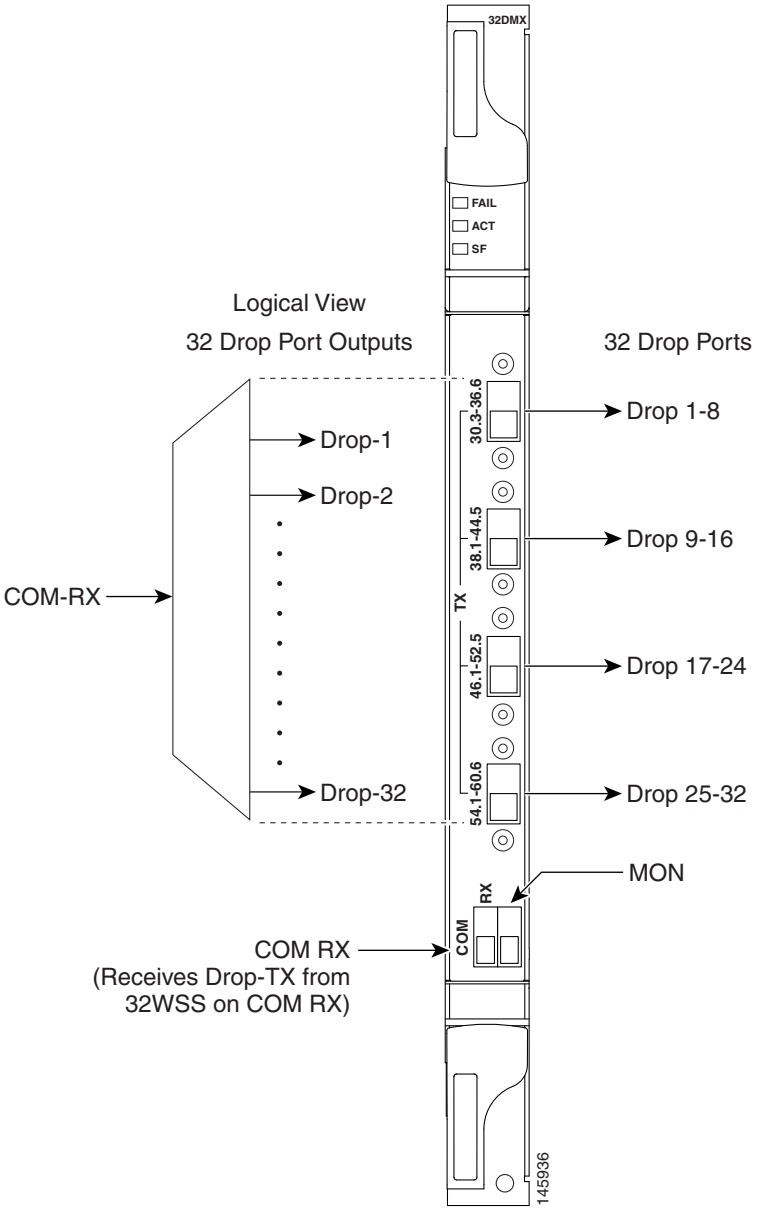
7.5.1 32DMX Faceplate Ports

The 32DMX card has two types of ports:

- COM RX port: COM RX is the input port for the aggregate optical signal being demultiplexed. This port is supported by a VOA for optical power regulation and a photodiode for optical power monitoring.
- DROP TX ports (1 to 32): On its output, the 32DMX provides 32 drop ports (listed in Table 7-15 on page 7-28) that are typically used for dropping channels within the ROADM node. These ports are connected using four 8-fiber MPO ribbon connectors. The incoming optical signal to the demultiplexer comes into the COM RX port. This input port is connected using a single LC duplex optical connector.Each drop port has a photodiode for optical power monitoring. Unlike the two-slot 32DMX-O demultiplexer, the drop ports on the 32DMX do not have a VOA per channel for optical power regulation. For a description of the 32DMX-O card, see the "5.4 32DMX-O Card" section on page 5-16.

Figure 7-12 shows the 32DMX card front panel and the basic traffic flow through the ports.

Figure 7-12 32DMX Faceplate and Ports



7.5.2 32DMX Block Diagram

A block diagram of the 32DMX card is shown in Figure 7-13.

Figure 7-13 32DMX Block Diagram

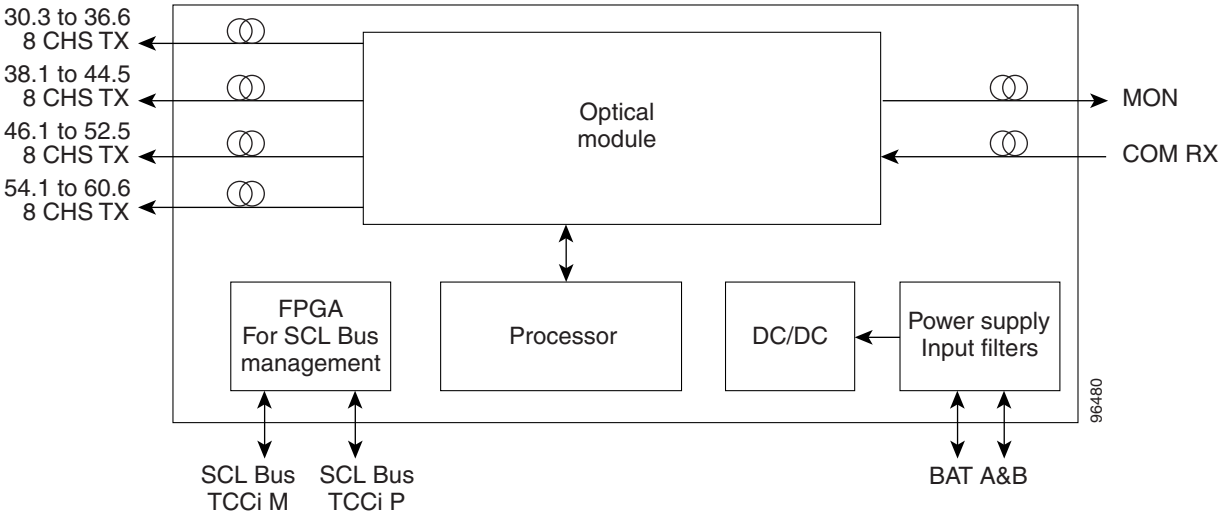
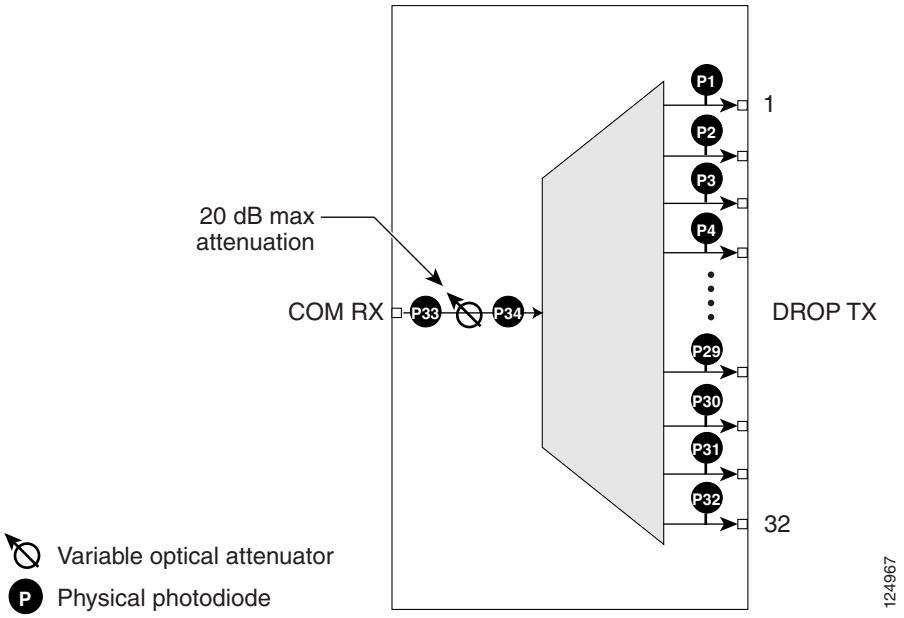


Figure 7-14 shows the 32DMX optical module functional block diagram.

Figure 7-14 32DMX Optical Module Functional Block Diagram



7.5.3 32DMX ROADM Functionality

The 32DMX card works in combination with the 32WSS card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 32DMX card requires two 32DMX single-slot cards and two 32WSS double-slot cards (for six slots total in the ONS 15454 chassis).

For information about the ROADM functionality for other cards, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

Note A terminal site can be configured using only a 32WSS card and a 32DMX card plugged into the east or west side of the shelf.

7.5.4 32DMX Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX card. The returned power level values are calibrated to the ports as shown in Table 7-14.

Table 7-14 32DMX Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	DROP	DROP TX
P33	INPUT COM	COM RX

7.5.5 32DMX Channel Allocation Plan

The 32DMX card's channel labels, frequencies, and wavelengths are listed in Table 7-15.

Table 7-15 32DMX Channel Allocation Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.1	195.1	1536.61
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.87
	39.7	194.7	1539.77
	40.5	194.6	1540.46
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53

Table 7-15 32DMX Channel Allocation Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61

7.5.6 32DMX Card-Level Indicators

Table 7-16 describes the three card-level LED indicators on the 32DMX card.

Table 7-16 32DMX 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32DMX 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.5.7 32DMX Port-Level Indicators

You can find the alarm status of the 32DMX card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.6 32DMX-L Card

Note See the "A.7.2 32DMX-L Card Specifications" section on page A-23 for hardware specifications.

Note For 32DMX-L safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The single-slot 32-Channel Demultiplexer L-Band card (32DMX-L) is an L band optical demultiplexer. The card receives an aggregate optical signal on its COM RX port and demultiplexes it into to (32) 100-GHz-spaced channels. The 32DMX-L card is particularly well suited for use in networks that employ DS fiber or SMF-28 single-mode fiber. The 32DMX-L card can be installed in Slots 1 to 6 and in Slots 12 to 17.

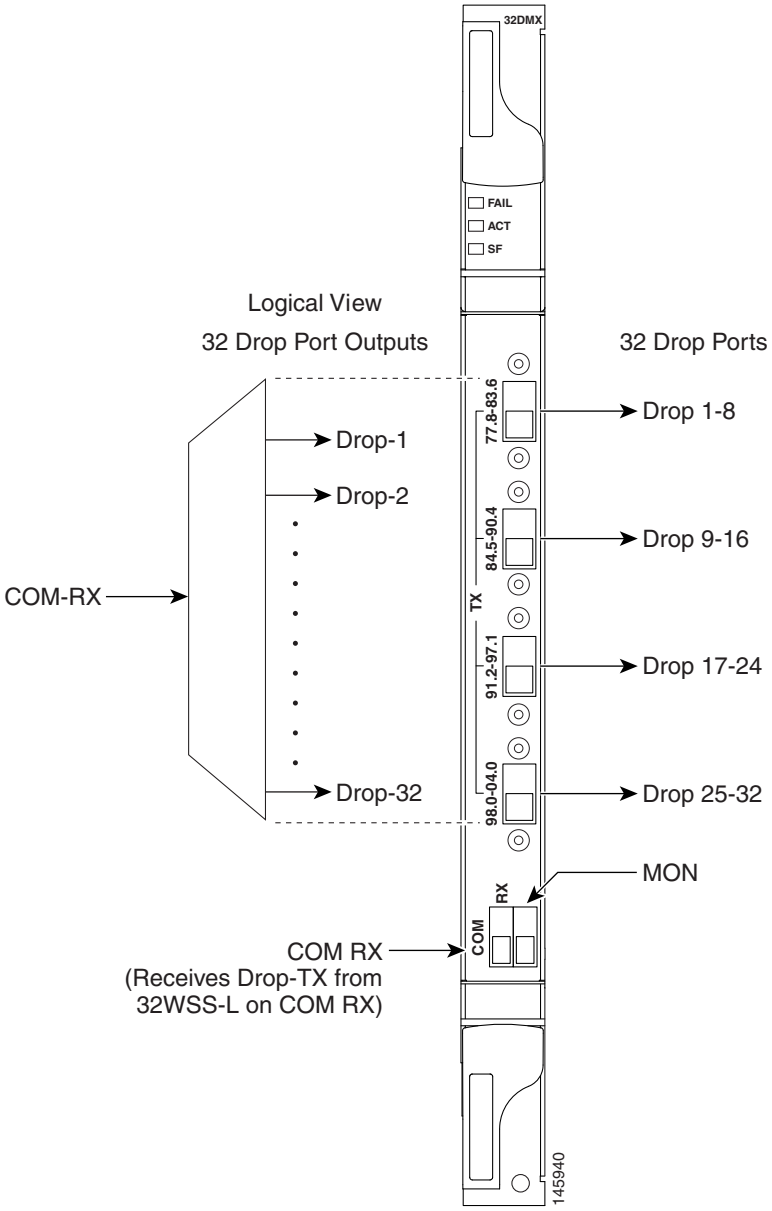
7.6.1 32DMX-L Faceplate Ports

The 32DMX-L card has two types of ports:

- COM RX port: COM RX is the input port for the aggregate optical signal being demultiplexed. This port is supported by both a VOA for optical power regulation and a photodiode for optical power monitoring.
- DROP TX ports (1 to 32): On its output, the 32DMX-L card provides 32 drop ports (listed in Table 7-21 on page 7-38) that are typically used for dropping channels within the ROADM node. These ports are connected using four 8-fiber MPO ribbon connectors. Each drop port has a photodiode for optical power monitoring. Unlike the two-slot 32DMX-O demultiplexer, the drop ports on the 32DMX-L do not have a VOA per channel for optical power regulation. For a description of the 32DMX-O card, see the "5.4 32DMX-O Card" section on page 5-16.

Figure 7-15 shows the 32DMX-L card front panel and the basic traffic flow through the ports.

Figure 7-15 32DMX-L Faceplate and Ports



7.6.2 32DMX-L Block Diagram

Figure 7-16 shows a block diagram of the 32DMX-L card.

Figure 7-16 32DMX-L Block Diagram

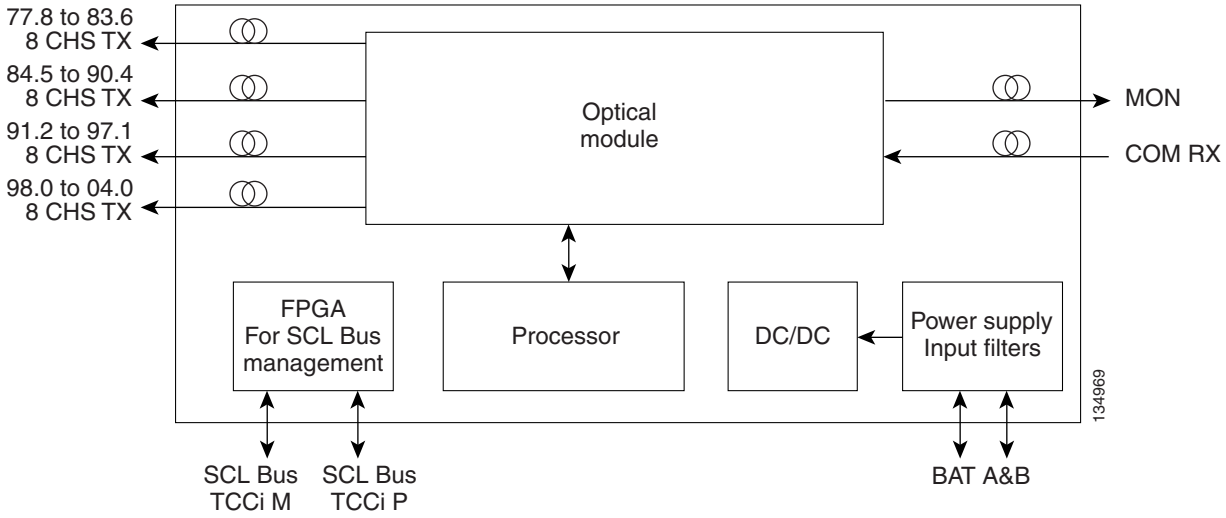
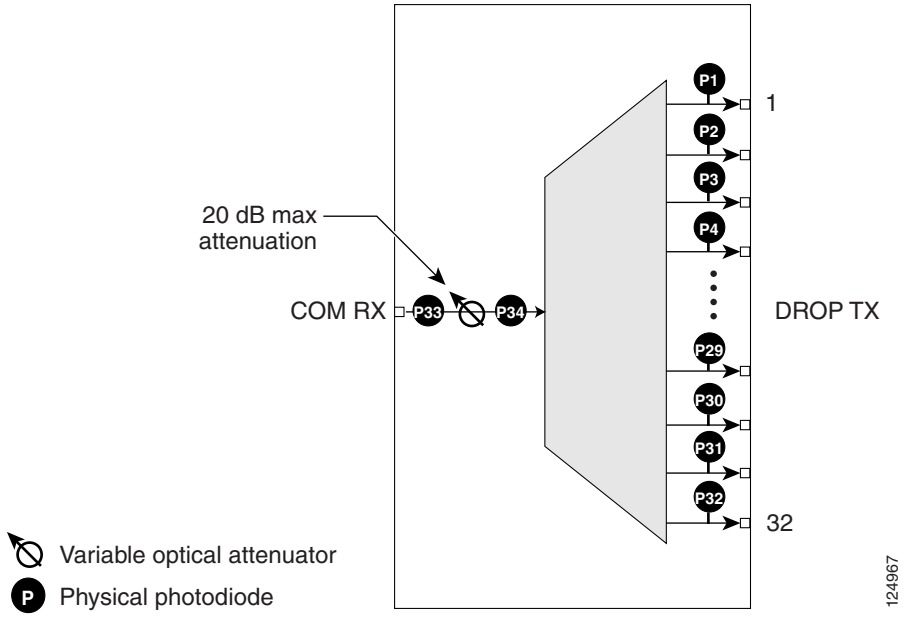


Figure 7-17 shows the 32DMX-L optical module functional block diagram.

Figure 7-17 32DMX-L Optical Module Functional Block Diagram



7.6.3 32DMX-L ROADM Functionality

The 32DMX-L card works in combination with the 32WSS-L card to implement ROADM functionality. AS a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 32DMX-L card requires two 32DMX-L single-slot cards and two 32WSS-L double-slot cards (for a total of six slots in the ONS 15454 chassis).

For information about ROADM functionality for other cards, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

Note A terminal site can be configured using only a 32WSS-L card and a 32DMX-L card plugged into the east or west side of the shelf.

7.6.4 32DMX-L Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX-L card. The returned power level values are calibrated to the ports as shown in Table 7-17.

Table 7-17 32DMX-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	DROP	DROP TX
P33	INPUT COM	COM RX

7.6.5 32DMX-L Channel Plan

The 32DMX-L card uses 32 banded channels on the ITU-T 100-GHz grid, as shown in Table 7-18.

Table 7-18 32DMX-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41

Table 7-18 32DMX-L Channel Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B91.2	91.2	188.4	1591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

7.6.6 32DMX-L Card-Level Indicators

Table 7-19 describes the three card-level LED indicators on the 32DMX-L card.

Table 7-19 32DMX-L 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32DMX-L 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.6.7 32DMX-L Port-Level Indicators

You can find the alarm status of the 32DMX-L card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.7 40-DMX-C Card

Note See the "A.7.6 40-DMX-C Card Specifications" section on page A-29 for hardware specifications.

Note For 40-DMX-C safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The single-slot 40-Channel Demultiplexer C-band (40-DMX-C) card demultiplexes 40 100-GHz-spaced channels identified in the channel plan (Table 7-21 on page 7-38), and sends them to dedicated output ports. The overall optical power can be adjusted using a single VOA that is common to all channels. The 40-DMX-C card is unidirectional, optically passive, and can be installed in Slots 1 to 6 and 12 to 17.

7.7.1 40-DMX-C Faceplate Ports

The 40-DMX-C has two types of ports:

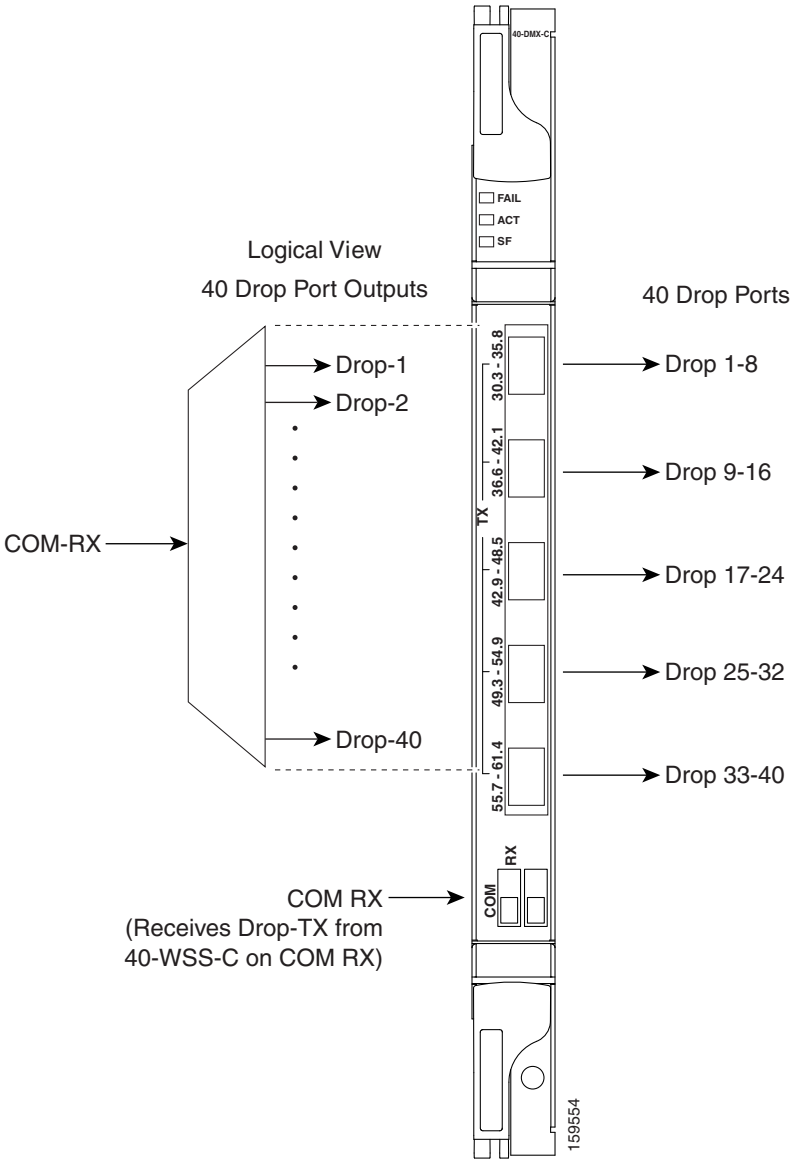
- COM RX port: COM RX is the line input port for the aggregate optical signal being demultiplexed. This port is supported by a VOA for optical power regulation and a photodiode for per-channel optical power monitoring.

  Note By default, the VOA is set to its maximum attenuation for safety purposes (for example, electrical power failure). A manual VOA setting is also available.

- DROP TX ports (1 to 40): On its output, the 40-DMX-C card provides 40 drop ports that are typically used for dropping channels within the ROADM node. These ports are connected using five physical connectors on the front panel that accept MPO client input cables. (MPO cables break out into eight separate cables.) The 40-DMX-C card also has one LC-PC-II optical connector for the main input.

Figure 7-18 shows the 40-DMX-C card faceplate.

Figure 7-18 40-DMX-C Faceplate



7.7.2 40-DMX-C Block Diagram

Figure 7-19 shows a block diagram of the 40-DMX-C card.

Figure 7-19 40-DMX-C Block Diagram

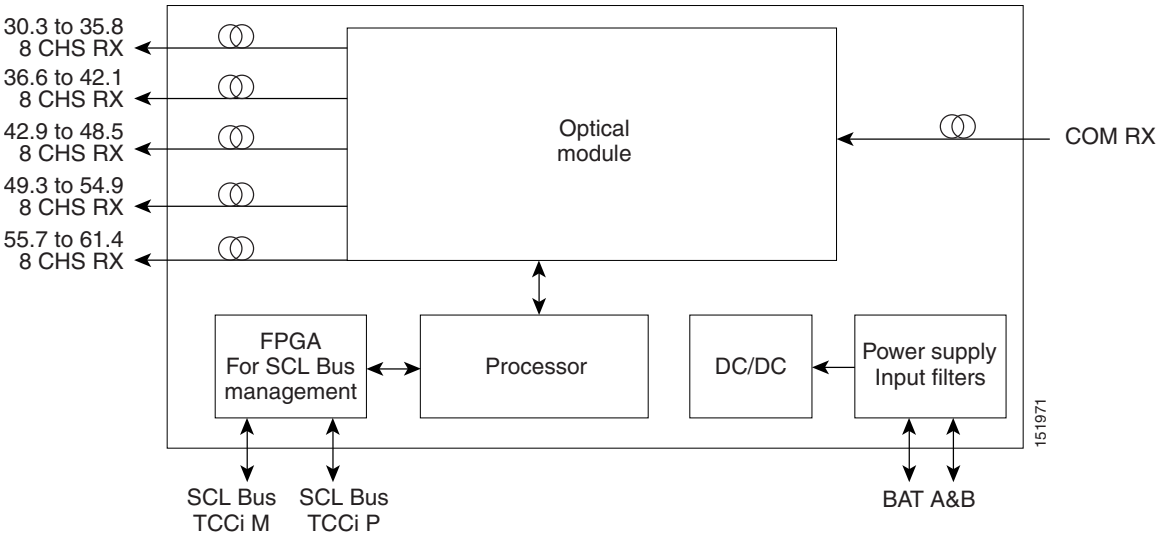
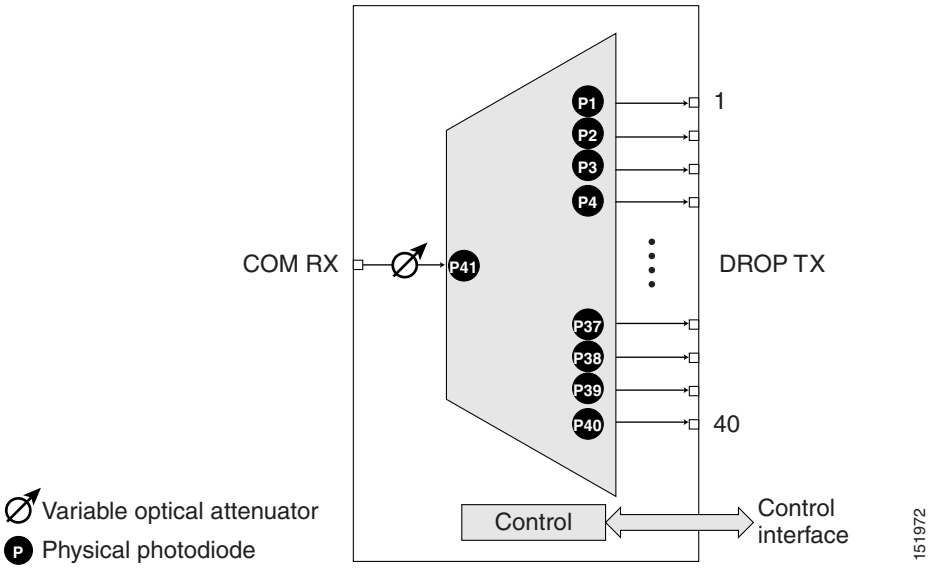


Figure 7-20 shows the 40-DMX-C optical module functional block diagram.

Figure 7-20 40-DMX-C Optical Module Functional Block Diagram



7.7.3 40-DMX-C ROADM Functionality

The 40-DMX-C card works in combination with the 40-WSS-C card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-DMX-C card requires two single-slot 40-DMX-C cards and two 40-WSS-C double-slot cards (for a total of six slots in the ONS 15454 chassis).

For other cards' ROADM functionality, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

7.7.4 40-DMX-C Power Monitoring

Physical photodiodes P1 through P40 monitor the power at the outputs of the 40-DMX-C card. P41 monitors the total multiplexed power at the input, calibrated to the COM-RX port. Table 7-20 shows the returned power level values calibrated to each port.

Table 7-20 40-DMX-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P40	DROP	DROP TX
P41	INPUT COM	COM RX

7.7.5 40-DMX-C Channel Plan

Table 7-21 shows the 40 ITU-T 100-GHz-spaced, C band channels (wavelengths) that are demultiplexed by the 40-DMX-C card.

Table 7-21 40-DMX-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35

Table 7-21 40-DMX-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

7.7.6 40-DMX-C Card-Level Indicators

The 40-DMX-C card has three card-level LED indicators, described in Table 7-22.

Table 7-22 40-DMX-C 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-DMX-C 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.7.7 40-DMX-C Port-Level Indicators

You can find the alarm status of the 40-DMX-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.8 40-DMX-CE Card

Note See the "A.7.7 40-DMX-CE Card Specifications" section on page A-30 for hardware specifications.

Note For 40-DMX-CE card safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The single-slot 40-Channel Demultiplexer C-band, even channels (40-DMX-CE) card demultiplexes 40 100-GHz-spaced even-numbered channels identified in the channel plan (Table 7-24 on page 7-43), and sends them to dedicated output ports. The overall optical power can be adjusted using a single VOA that is common to all channels. The 40-DMX-CE card is unidirectional, optically passive, and can be installed in Slots 1 to 6 and 12 to 17.

7.8.1 40-DMX-CE Card Faceplate Ports

The 40-DMX-CE card has two types of ports:

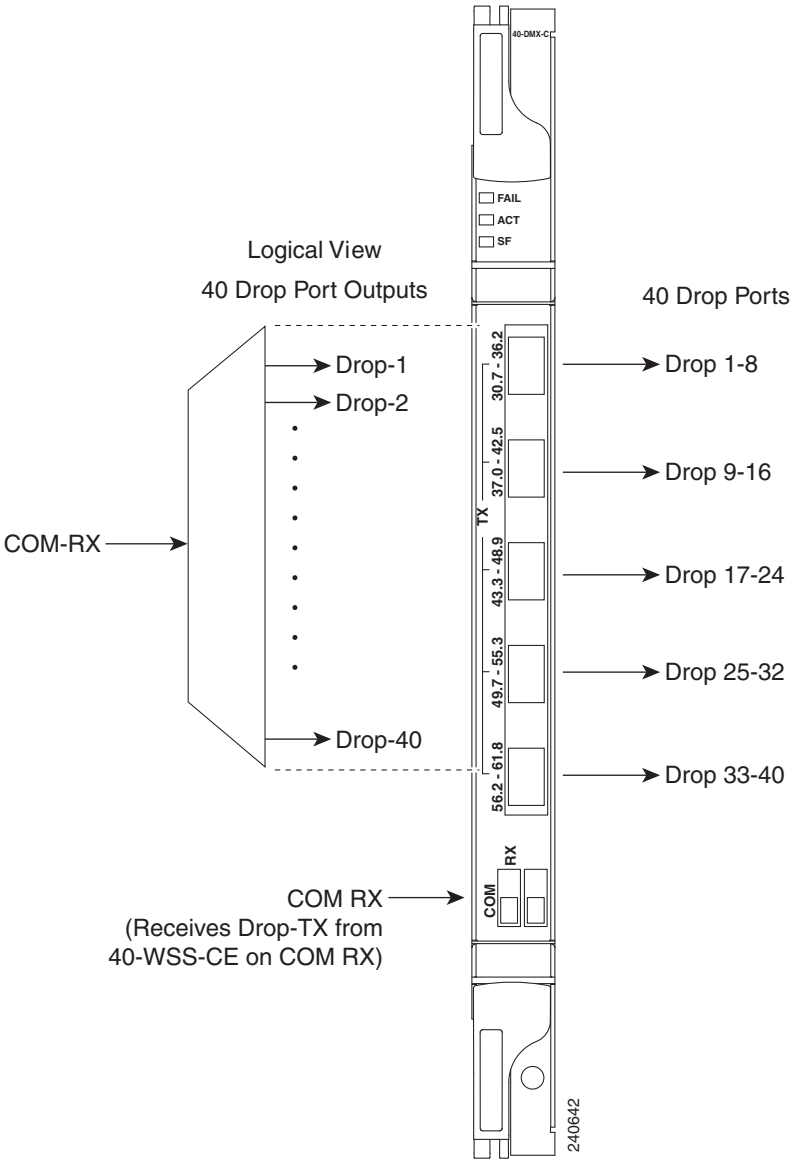
- COM RX port: COM RX is the line input port for the aggregate optical signal being demultiplexed. This port is supported by a VOA for optical power regulation and a photodiode for per-channel optical power monitoring.

Note By default, the VOA is set to its maximum attenuation for safety purposes (for example, electrical power failure). A manual VOA setting is also available.

- DROP TX ports (1 to 40): On its output, the 40-DMX-CE card provides 40 drop ports that are typically used for dropping channels within the ROADM node. These ports are connected using five physical connectors on the front panel that accept MPO client input cables. (MPO cables break out into eight separate cables.) The 40-DMX-CE card also has one LC-PC-II optical connector for the main input.

Figure 7-21 shows the 40-DMX-CE card faceplate.

Figure 7-21 40-DMX-CE Card Faceplate



7.8.2 40-DMX-CE Card Block Diagram

Figure 7-22 shows a block diagram of the 40-DMX-CE card.

Figure 7-22 40-DMX-CE Card Block Diagram

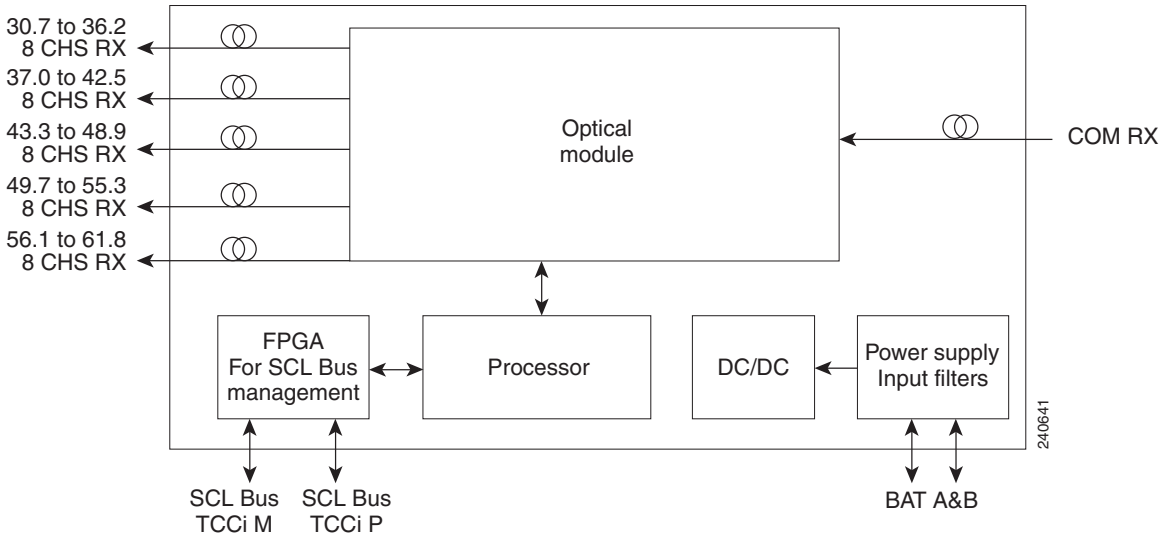
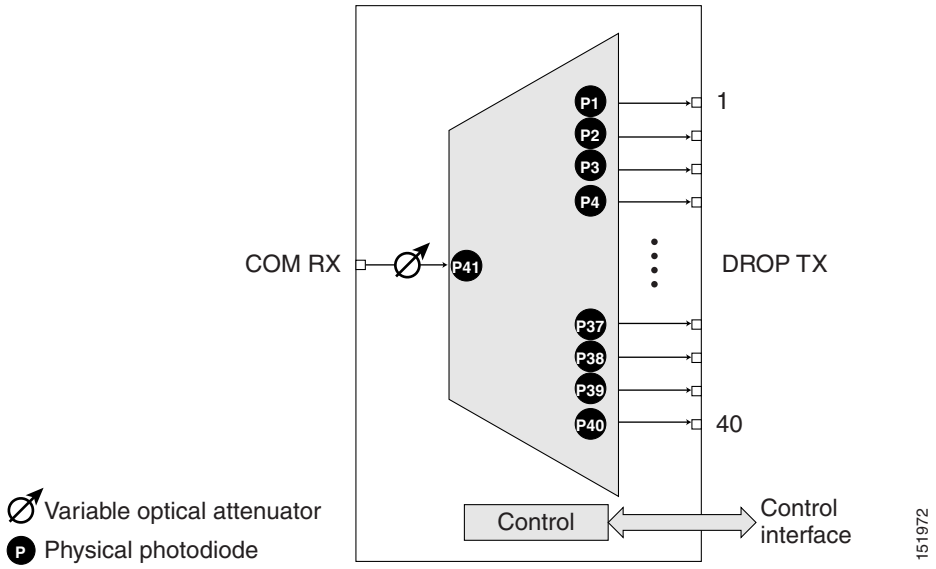


Figure 7-23 shows the 40-DMX-CE card optical module functional block diagram.

Figure 7-23 40-DMX-CE Card Optical Module Functional Block Diagram



7.8.3 40-DMX-CE Card ROADM Functionality

The 40-DMX-CE card works in combination with the 40-WSS-CE card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-DMX-CE card requires two single-slot 40-DMX-CE cards and two 40-WSS-CE double-slot cards (for a total of six slots in the ONS 15454 chassis).

For the ROADM functionality of other cards, see the description of that card in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

7.8.4 40-DMX-CE Card Power Monitoring

Physical photodiodes P1 through P40 monitor the power at the outputs of the 40-DMX-CE card. P41 monitors the total multiplexed power at the input, calibrated to the COM-RX port. Table 7-23 shows the returned power level values calibrated to each port.

Table 7-23 40-DMX-CE Card Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P40	DROP	DROP TX
P41	INPUT COM	COM RX

7.8.5 40-DMX-CE Card Channel Plan

Table 7-24 shows the 40 ITU-T 100-GHz-spaced, C band channels (wavelengths) that are demultiplexed by the 40-DMX-CE card.

Table 7-24 40-DMX-CE Card Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.7	30.7	195.85	1530.72
	31.5	195.75	1531.51
	32.3	195.65	1532.29
	33.1	195.55	1533.07
	33.9	195.45	1533.86
B34.6	34.6	195.35	1534.64
	35.4	195.25	1535.43
	36.2	195.15	1536.22
	37.0	195.05	1537.00
	37.8	194.95	1537.79
B38.6	38.6	194.85	1538.58
	39.4	194.75	1539.37
	40.1	194.65	1540.16
	40.9	194.55	1540.95
	41.8	194.45	1541.75

Table 7-24 40-DMX-CE Card Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B42.5	42.5	194.35	1542.54
	43.3	194.25	1543.33
	44.1	194.15	1544.13
	44.9	194.05	1544.92
	45.7	193.95	1545.72
B46.5	46.5	193.85	1546.52
	47.3	193.75	1547.32
	48.1	193.65	1548.11
	48.9	193.55	1548.91
	49.7	193.45	1549.72
B50.5	50.5	193.35	1550.52
	51.3	193.25	1551.32
	52.1	193.15	1552.12
	52.9	193.05	1552.93
	53.7	192.95	1553.73
B54.4	54.4	192.85	1554.54
	55.3	192.75	1555.34
	56.1	192.65	1556.15
	56.9	192.55	1556.96
	57.8	192.45	1557.77
B58.6	58.6	192.35	1558.58
	59.4	192.25	1559.39
	60.2	192.15	1560.20
	61.0	192.05	1561.01
	61.8	191.95	1561.83

7.8.6 40-DMX-CE Card-Level Indicators

The 40-DMX-CE card has three card-level LED indicators, described in Table 7-25.

Table 7-25 40-DMX-CE 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.

Table 7-25 40-DMX-CE Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the 40-DMX-CE 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.8.7 40-DMX-CE Card Port-Level Indicators

You can find the alarm status of the 40-DMX-CE card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to the "Manage Alarms" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.9 40-MUX-C Card

Note See the "A.7.5 40-MUX-C Card Specifications" section on page A-29 for hardware specifications.

Note For 40-MUX-C card safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The single-slot 40-Channel Multiplexer C-band (40-MUX-C) card multiplexes forty ITU-T 100-GHz-spaced channels identified in the channel plan in Table 7-21 on page 7-38. The 40-MUX-C card can be installed in Slots 1 to 6 and 12 to 17. The 40-MUX-C card is typically used in hub nodes.

7.9.1 40-MUX-C Card Faceplate Ports

The 40-MUX-C card has two types of ports:

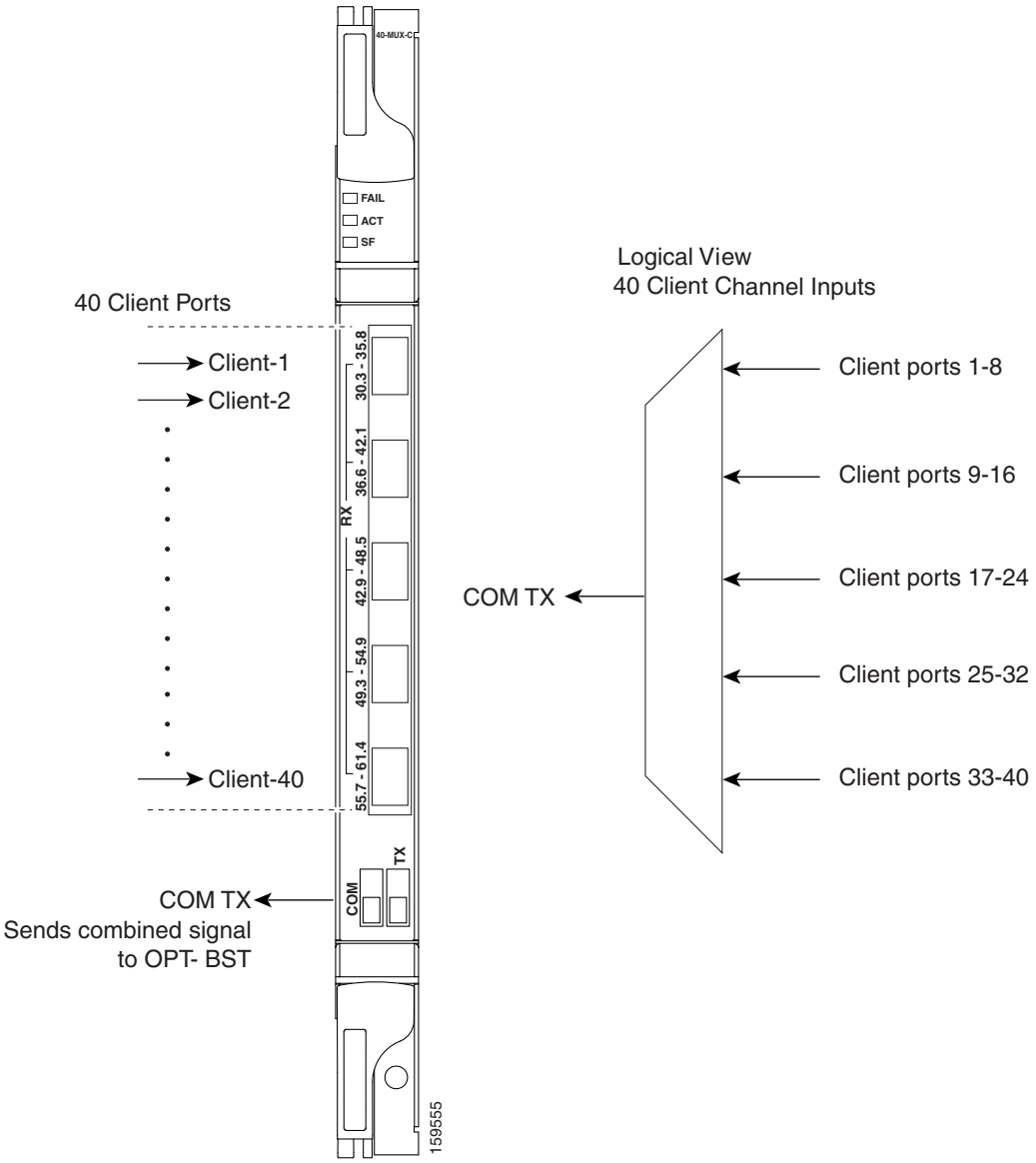
- COM TX port: COM TX is the line output port for the aggregate optical signal being multiplexed. This port is supported by both a VOA for optical power regulation and a photodiode for per-channel optical power monitoring.

  Note By default, the VOA is set to its maximum attenuation for safety purposes (for example, electrical power failure). A manual VOA setting is also available.

- DROP RX ports (1 to 40): The 40-MUX-C card provides 40 input optical channels. These ports are connected using five physical receive connectors on the card's front panel that accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-DMX-C card also has one LC-PC-II optical connector for the main output. For the wavelength range, see Table 7-21 on page 7-38.

Figure 7-24 shows the 40-MUX-C card faceplate.

Figure 7-24 40-MUX-C Card Faceplate



7.9.2 40-MUX-C Card Block Diagram

Figure 7-25 shows a block diagram of the 40-MUX-C card.

Figure 7-25 40-MUX-C Card Block Diagram

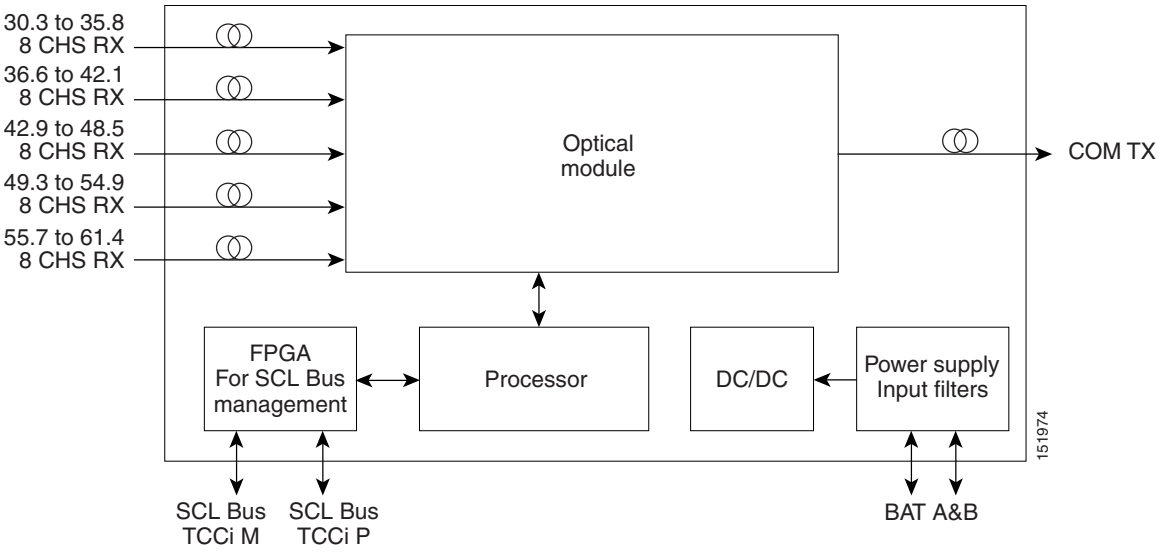
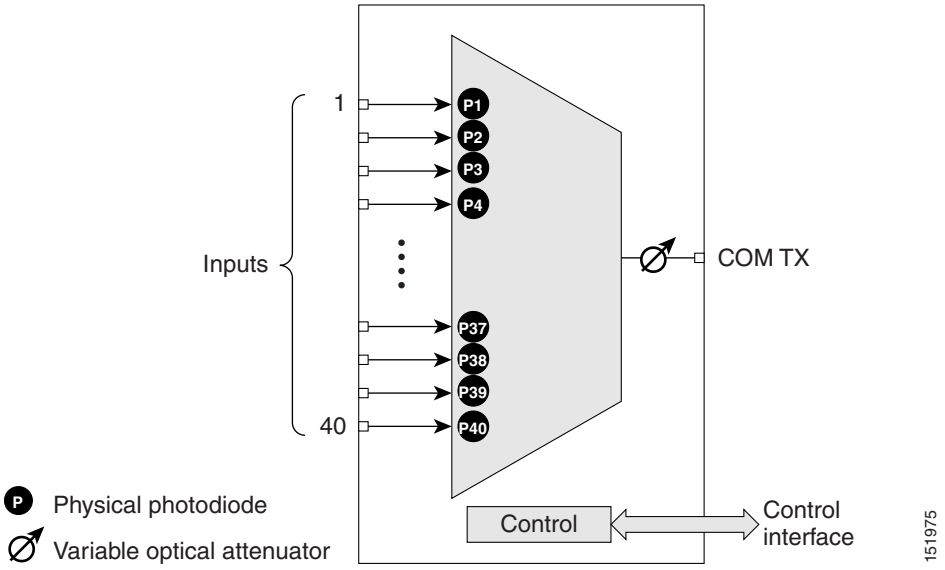


Figure 7-26 shows the 40-MUX-C optical module functional block diagram.

Figure 7-26 40-MUX-C Optical Module Functional Block Diagram



7.9.3 40-MUX-C Card Power Monitoring

Physical photodiodes P1 through P40 monitor the power of the individual input ports to the 40-MUX-C card. P41 monitors the total multiplexed output power, calibrated to the COM-TX port. Table 7-26 shows the returned power level values calibrated to each port.

Table 7-26 40-MUX-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P40	ADD	ADD RX
P41	OUTPUT COM	COM-TX

7.9.4 40-MUX-C Card Channel Plan

Table 7-27 shows the 40 ITU-T 100-GHz-spaced, C band channels (wavelengths) that are multiplexed by the 40-MUX-C card.

Table 7-27 40-MUX-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32

Table 7-27 40-MUX-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

7.9.5 40-MUX-C Card-Level Indicators

The 40-MUX-C card has three card-level LED indicators, described in Table 7-28.

Table 7-28 40-MUX-C 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-MUX-C 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.9.6 40-MUX-C Port-Level Indicators

You can find the alarm status of the 40-MUX-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.10 40-WSS-C Card

Note See the "A.7.8 40-WSS-C Card Specifications" section on page A-31 for hardware specifications.

Note For 40-WSS-C safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The double-slot 40-channel Wavelength Selective Switch C-Band (40-WSS-C) card switches 40 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 7-21 on page 7-38) and sends them to dedicated output ports. The 40-WSS-C card is bidirectional and optically passive. The card can be installed in Slots 1 to 6 and 12 to 17

The 40-WSS-C features include:

- Receipt of an aggregate DWDM signal into 40 output optical channels from the Line receive port (EXP RX) in one direction and from the COM-RX port in the other direction.
- Per-channel optical power monitoring using photodiodes.
- Signal splitting in a 70%-to-30% ratio, sent to the 40-DMX-C for dropping signals, then to the other 40-WSS-C card.
- Aggregate DWDM signal monitoring and control through a variable optical attenuator (VOA). 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.

Within the 40-WSS-C card, the first AWG opens the spectrum and each wavelength is directed to one of the ports of a 1x2 optical switch. The same wavelength can be passed through or stopped. If the pass-through wavelength is stopped, a new channel can be added at the ADD port. The card's second AWG multiplexes all of the wavelengths, and the aggregate signal is output through the COM-TX port.

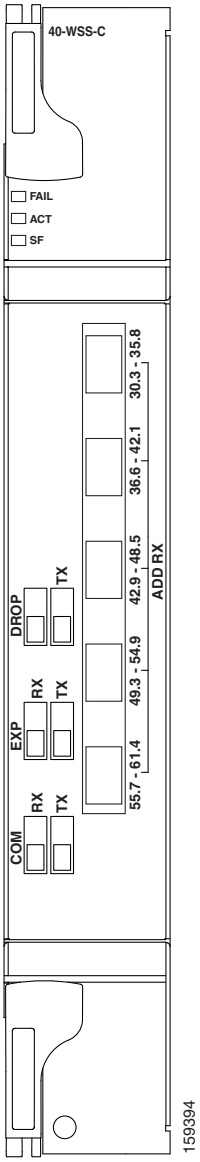
7.10.1 40-WSS-C Faceplate Ports

The 40-WSS-C has eight types of ports:

- ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C card also has one LC-PC-II optical connector for the main input.
- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C card in the same NE.
- EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C card within the NE.
- DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C card, where the channels are further processed and dropped.

Figure 7-27 shows the 40-WSS-C card faceplate.

Figure 7-27 40-WSS-C Faceplate



7.10.2 40-WSS-C Block Diagram

Figure 7-28 shows a block diagram of the 40-WSS-C card.

Figure 7-28 40-WSS-C Block Diagram

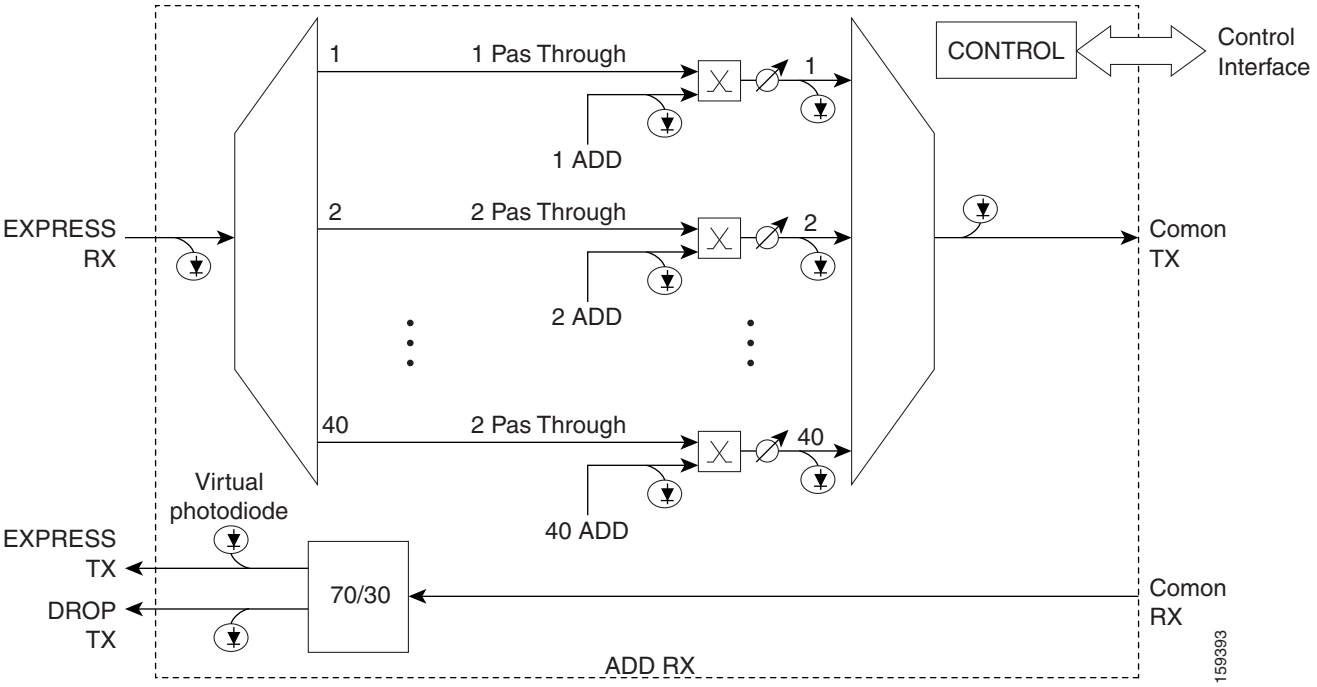
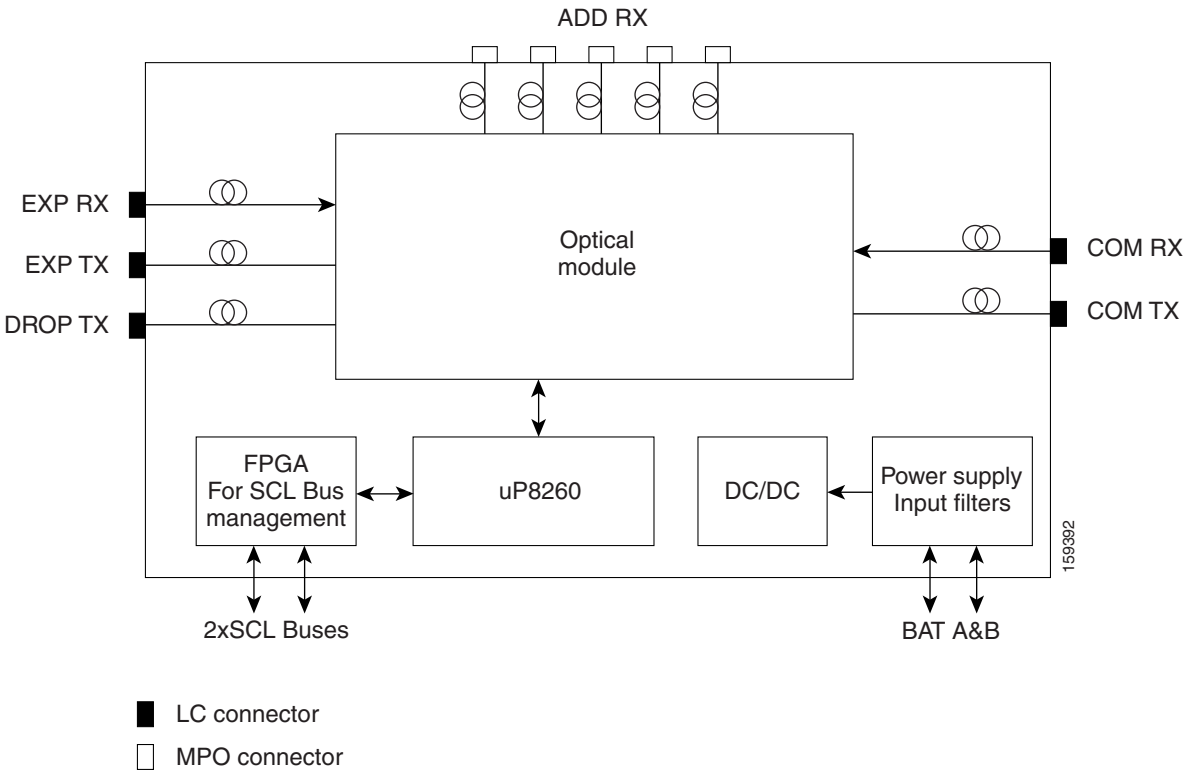


Figure 7-29 shows the 40-WSS-C optical module functional block diagram.

Figure 7-29 40-WSS-C Optical Module Functional Block Diagram



7.10.3 40-WSS-C ROADM Functionality

The 40-WSS-C card works in combination with the 40-DMX-C card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-WSS-C card requires two 40-WSS-C double-slot cards and two 40-DMX-C single-slot cards (for a total of six slots in the ONS 15454 chassis).

For information about ROADM functionality for other cards, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

7.10.4 40-WSS-C Power Monitoring

The 40-WSS-C has physical diodes that monitor power at various locations on the card. Table 7-29 lists the physical diode descriptions.

Table 7-29 40-WSS-C Physical Photodiode Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
P1	DROP	DROP TX
P2	EXP	EXP RX

Table 7-29 40-WSS-C Physical Photodiode Port Calibration (continued)

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD*i*3[1]	RX	Add *i* RX ports (that is, channel input Add *i* RX power), up to 40 ports and therefore 40 PDs[1]
PD*i*4[1]	TX	COM TX port (that is, per-channel output COM TX power) up to 40 channels and therefore 40 PDs
PD5	COM	COM TX port (that is, total output COM TX power)

1. *i* indicates any channel from 01 through 40.

Additionally, the 40-WSS-C has two virtual diodes. Virtual diodes are monitor points for each physical photodiode; they are identified with a physical diode relative to the way that the physical diode is identified with one of the two interlink (ILK) ports. Table 7-30 lists the virtual diodes.

Table 7-30 40-WSS-C Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD1	COM	COM RX port (total input COM RX power)
VPD2	EXP	EXP TX port (total output EXP TX power)

7.10.5 40-WSS-C Channel Plan

Table 7-31 shows the 40 ITU-T 100-GHz-spaced, C band channels (wavelengths) that are switched by the 40-WSS-C card.

Table 7-31 40-WSS-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35

Table 7-31 40-WSS-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

7.10.6 40-WSS-C Card-Level Indicators

The 40-WSS-C card has three card-level LED indicators, described in Table 7-32.

Table 7-32 40-WSS-C 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.

Table 7-32 40-WSS-C Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the 40-WSS-C 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.10.7 40-WSS-C Port-Level Indicators

You can find the alarm status of the 40-WSS-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to the "Manage Alarms" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.11 40-WSS-CE Card

Note See the "A.7.9 40-WSS-CE Card Specifications" section on page A-33 for hardware specifications.

Note For 40-WSS-CE card afety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The double-slot 40-channel Wavelength Selective Switch Even-Channel C-Band (40-WSS-CE) card switches 40 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 7-35 on page 7-61) and sends them to dedicated output ports. The 40-WSS-CE card is bidirectional and optically passive. The card can be installed in Slots 1 to 6 and 12 to 17.

The 40-WSS-CE features include:

- Receipt of an aggregate DWDM signal into 40 output optical channels from the Line receive port (EXP RX) in one direction and from the COM-RX port in the other direction.
- Per-channel optical power monitoring using photodiodes.
- Signal splitting in a 70-to-30 percent ratio, sent to the 40-DMX-CE card for dropping signals, then to the other 40-WSS-CE card.
- Aggregate DWDM signal monitoring and control through a VOA. 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.

Within the 40-WSS-CE card, the first AWG opens the spectrum and each wavelength is directed to one of the ports of a 1x2 optical switch. The same wavelength can be passed through or stopped. If the pass-through wavelength is stopped, a new channel can be added at the ADD port. The card's second AWG multiplexes all of the wavelengths, and the aggregate signal is output through the COM-TX port.

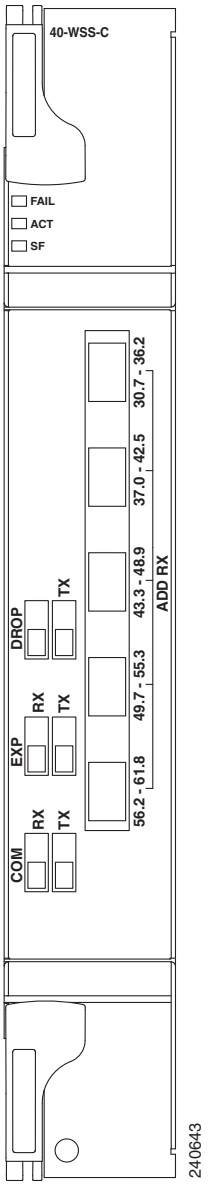
7.11.1 40-WSS-CE Faceplate Ports

The 40-WSS-CE card has eight types of ports:

- ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-CE card also has one LC-PC-II optical connector for the main input.
- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-CE card in the same NE.
- EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-CE card within the NE.
- DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C card, where the channels are further processed and dropped.

Figure 7-30 shows the 40-WSS-CE card faceplate.

Figure 7-30 40-WSS-CE Faceplate



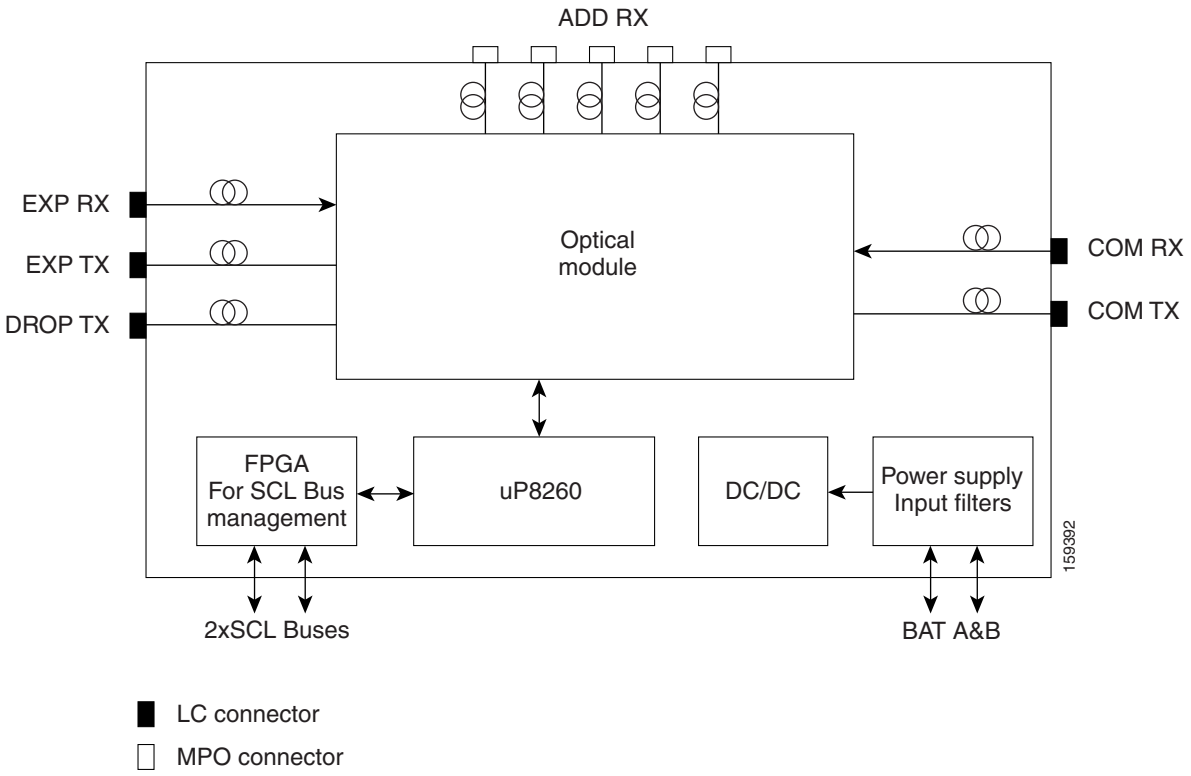
7.11.2 40-WSS-CE Card Block Diagram

Figure 7-31 shows a block diagram of the 40-WSS-CE card.

Figure 7-31 40-WSS-CE Block Diagram

Figure 7-32 shows the 40-WSS-CE optical module functional block diagram.

Figure 7-32 40-WSS-CE Card Optical Module Functional Block Diagram



7.11.3 40-WSS-CE Card ROADM Functionality

The 40-WSS-CE card works in combination with the 40-DMX-CE card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-WSS-CE card requires two 40-WSS-CE double-slot cards and two 40-DMX-CE single-slot cards (for a total of six slots in the ONS 15454 chassis).

For information about ROADM functionality for another cards, see the description of that card in this chapter. For a diagram of a typical ROADM configuration, see the "9.1.4 ROADM Node" section on page 9-12.

7.11.4 40-WSS-CE Card Power Monitoring

The 40-WSS-CE card has physical diodes that monitor power at various locations on the card. Table 7-33 lists the physical diode descriptions.

Table 7-33 40-WSS-CE Physical Photodiode Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
P1	DROP	DROP TX
P2	EXP	EXP RX

Table 7-33 40-WSS-CE Physical Photodiode Port Calibration (continued)

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD*i*3[1]	RX	Add *i* RX ports (that is, channel input Add *i* RX power), up to 40 ports and therefore 40 PDs[1]
PD*i*4[1]	TX	COM TX port (that is, per-channel output COM TX power) up to 40 channels and therefore 40 PDs
PD5	COM	COM TX port (that is, total output COM TX power)

1. *i* indicates any channel from 01 through 40.

Additionally, the 40-WSS-CE card has two virtual diodes. Virtual diodes are monitor points for each physical photodiode; they are identified with a physical diode relative to the way that the physical diode is identified with one of the two interlink (ILK) ports. Table 7-34 lists the virtual diodes.

Table 7-34 40-WSS-CE Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD1	COM	COM RX port (total input COM RX power)
VPD2	EXP	EXP TX port (total output EXP TX power)

7.11.5 40-WSS-CE Card Channel Plan

Table 7-35 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are switched by the 40-WSS-CE card.

Table 7-35 40-WSS-CE Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.7	30.7	195.85	1530.72
	31.5	195.75	1531.51
	32.3	195.65	1532.29
	33.1	195.55	1533.07
	33.9	195.45	1533.86
B34.6	34.6	195.35	1534.64
	35.4	195.25	1535.43
	36.2	195.15	1536.22
	37.0	195.05	1537.00
	37.8	194.95	1537.79
B38.6	38.6	194.85	1538.58
	39.4	194.75	1539.37
	40.1	194.65	1540.16
	40.9	194.55	1540.95
	41.8	194.45	1541.75

Table 7-35 40-WSS-CE Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B42.5	42.5	194.35	1542.54
	43.3	194.25	1543.33
	44.1	194.15	1544.13
	44.9	194.05	1544.92
	45.7	193.95	1545.72
B46.5	46.5	193.85	1546.52
	47.3	193.75	1547.32
	48.1	193.65	1548.11
	48.9	193.55	1548.91
	49.7	193.45	1549.72
B50.5	50.5	193.35	1550.52
	51.3	193.25	1551.32
	52.1	193.15	1552.12
	52.9	193.05	1552.93
	53.7	192.95	1553.73
B54.4	54.4	192.85	1554.54
	55.3	192.75	1555.34
	56.1	192.65	1556.15
	56.9	192.55	1556.96
	57.8	192.45	1557.77
B58.6	58.6	192.35	1558.58
	59.4	192.25	1559.39
	60.2	192.15	1560.20
	61.0	192.05	1561.01
	61.8	191.95	1561.83

7.11.6 40-WSS-CE Card-Level Indicators

The 40-WSS-CE card has three card-level LED indicators, described in Table 7-36.

Table 7-36 40-WSS-CE 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.

Table 7-36 40-WSS-CE Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the 40-WSS-CE 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.11.7 40-WSS-CE Card Port-Level Indicators

You can find the alarm status of the 40-WSS-CE card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to the "Manage Alarms" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.12 40-WXC-C Card

Note See the "A.7.10 40-WXC-C Card Specifications" section on page A-36 or hardware specifications.

Note For 40-WXC-C safety label information, see the "7.2 Safety Labels for Class 1M Laser Product Cards" section on page 7-9.

The double-slot 40-channel Wavelength Cross-Connect C Band (40-WXC-C) card selectively sends any wavelength combination coming from nine input ports to a common output port. The device can manage up to 41 channels spaced at 100GHz on each port according to the channel grid in Table 7-6 on page 7-7. Each channel can be selected from any input. The card is optically passive and provides bidirectional capability. It can be installed in Slots 1 to 6 and 12 to 17.

.The 40-WXC-C card provides the following features:

- Demultiplexing, selection, and multiplexing of DWDM aggregate signal from input ports to common output port.
- Aggregate DWDM signal monitoring and control through a VOA.
- VOAs are deployed in every channel path in order to regulate the channel's optical power. In the case of an electrical power failure, VOAs are set to their maximum attenuation value, or to a fixed and configurable one. The VOA can also be set manually.
- Per-channel optical power monitoring using photodiodes.

The 40-WXC-C card acts as a selector element with the following characteristics:

- It is able to select a wavelength from one input port and pass the wavelength through to the common out port. Simultaneously, the card can block the same wavelength coming from the other eight input ports.
- It is able to stop wavelengths from all nine inputs.

- It is able to monitor optical power and control path attenuation using per-channel VOA independently of the wavelength input-to-out port connection.

7.12.1 40-WXC-C Faceplate Ports

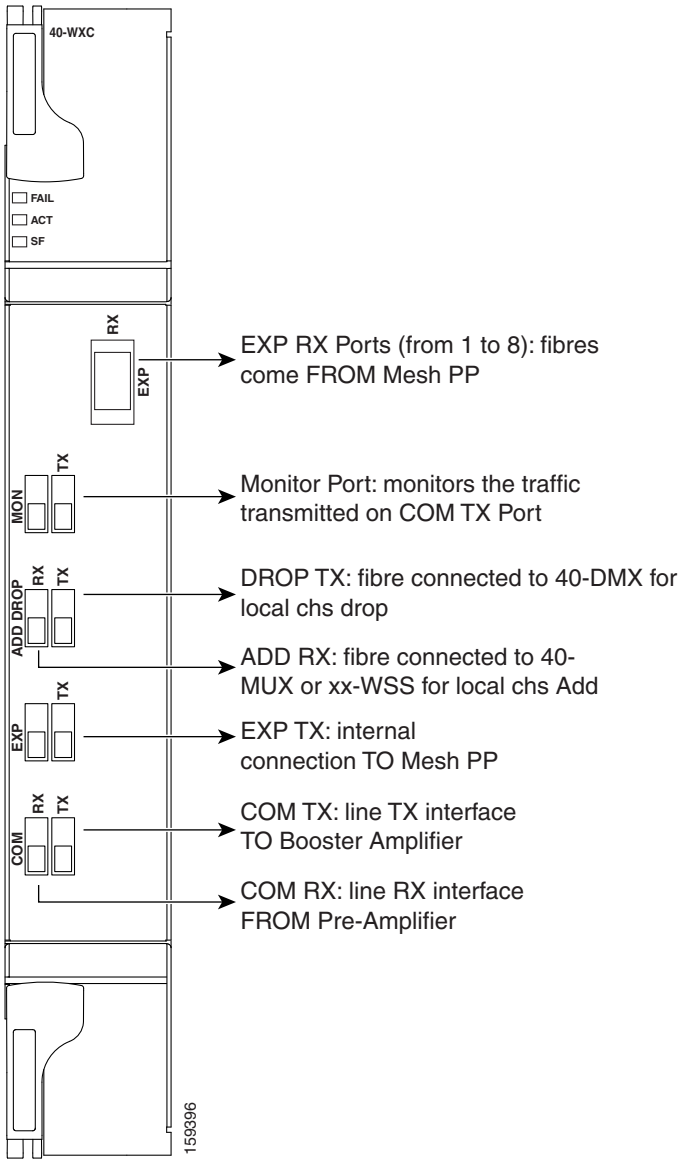
The 40-WXC-C card has six types of ports:

- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- EXP TX: The EXP TX port sends an optical signal to the other 40-WXC-C card within the NE.
- MON TX: The optical service channel (OSC) monitor.
- ADD/DROP RX: The 40-WXC-C card provides 40 input optical channels. For the wavelength range, see Table 7-39 on page 7-67.
- ADD/DROP TX: The DROP TX port sends the split off optical signal that contains drop channels to the 40-WXC-C card, where the channels are further processed and dropped.

Note The PP-MESH interconnects 40-WXC-C cards according to following rule: The EXP-TX port of 40-WXC-C in side “i” is connected to the 40-WXC-C EXP-j-RX port of all the other equipped or provisioned 40-WXC-C cards. The side "i" goes from A to H and side "j" goes from ports 1 to 8 (Side “j” has the same cardinality of the side letter (A<->1, B<->2, ...H<->8). These connections are relevant for routing pourposes or to list the ports that are involved in an OCH-NC network. However, they are not reported in CTC under node view -> Maintenance -> DWDM -> -> Mesh Patch Panel Internal Patchcords.

Figure 7-33 shows the 40-WXC-C card faceplate.

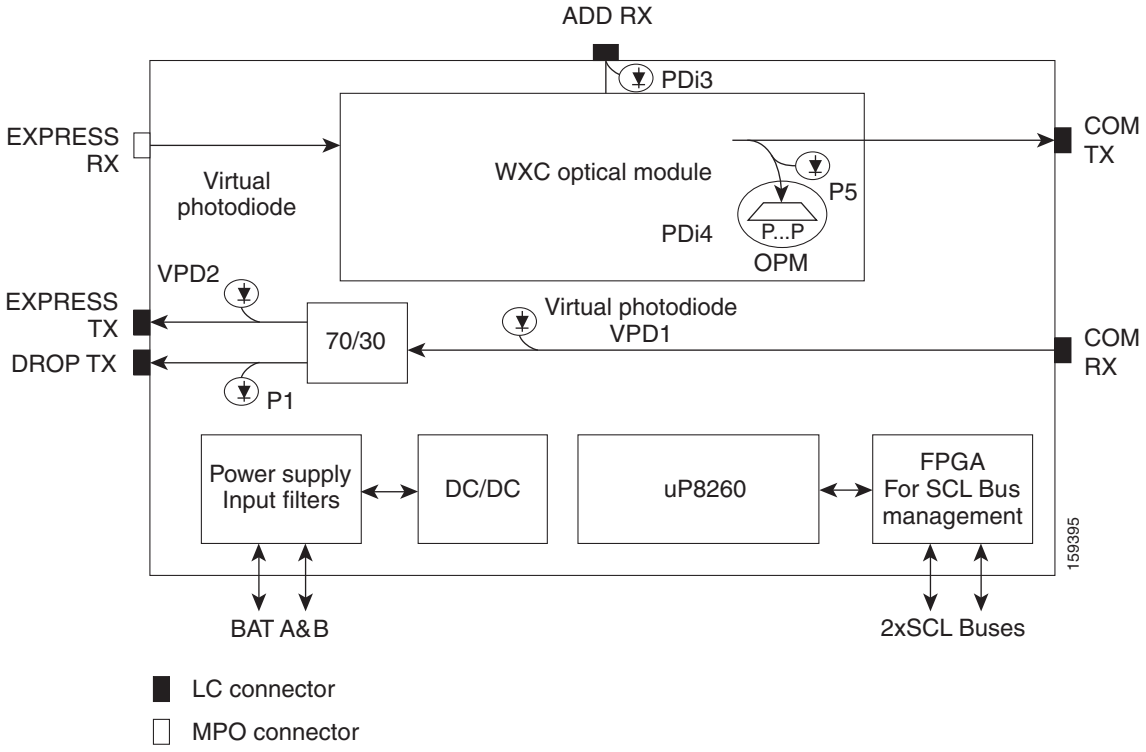
Figure 7-33 40-WXC-C Faceplate



7.12.2 40-WXC-C Block Diagram

Figure 7-34 shows the 40-WXC-C optical module functional block diagram.

Figure 7-34 40-WXC-C Optical Module Functional Block Diagram



Note The Optical Power Monitoring (OPM) device works at per channel level and reports ADD or EXP per channel power according to the switch position.

7.12.3 40-WXC-C Power Monitoring

The 40-WXC-C has 83 physical diodes (P1 through P40) that monitor power at the outputs of the card. Table 7-37 describes the physical diodes.

Table 7-37 40-WXC-C Physical Photodiode Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
P1	DROP	DROP TX
P2	EXP	EXP RX
PD*i*3[1]	RX	Add *i* RX ports (that is, channel input Add *i* RX power), up to 40 ports and therefore 40 PDs[1]

Table 7-37 40-WXC-C Physical Photodiode Port Calibration (continued)

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD*i*4[1]	TX	COM TX port (that is, per-channel output COM TX power) up to 40 channels and therefore 40 PDs
PD5	COM	COM TX port (that is, total output COM TX power)

1. *i* indicates any channel from 01 through 40.

Additionally, the 40-WXC-C has two virtual diodes. Virtual diodes are monitor points for each physical photodiode; they are identified with a physical diode relative to the way that the physical diode is identified with one of the two interlink (ILK) ports. Table 7-38 lists the virtual diodes.

Table 7-38 40-WXC-C Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD1	COM	COM RX port (total input COM RX power)
VPD2	EXP	EXP TX port (total output EXP TX power)

7.12.4 40-WXC-C Channel Plan

Table 7-39 shows the 40 ITU-T 100-GHz-spaced, C band channels (wavelengths) that are cross connected by the 40-WXC-C card.

Table 7-39 40-WXC-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
Ch. 0[1]	29.5	196	1529.55
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40

Table 7-39 40-WXC-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

1. This channel is unused by the 40-WXC-C

7.12.5 40-WXC-C Card-Level Indicators

The 40-WXC-C card has three card-level LED indicators described in Table 7-40.

Table 7-40 40-WXC-C 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 an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-WXC-C 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.12.6 40-WXC-C Port-Level Indicators

You can find the alarm status of the 40-WXC-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

7.13 MMU Card

The single-slot Mesh Multi-Ring Upgrade Module (MMU) card supports multiring and mesh upgrades for ROADM nodes in both the C band and the L band. Mesh/multiring upgrade is the capability to optically bypass a given wavelength from one section of the network or ring to another one without requiring 3R regeneration. In each node, you need to install one east MMU and one west MMU. The card can be installed in Slots 1 through 6 and 12 through 17.

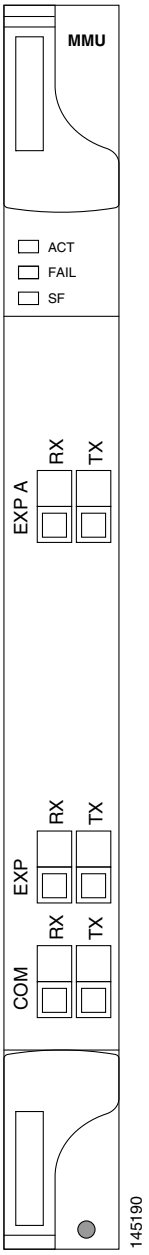
7.13.1 MMU Faceplate Ports

The MMU has six types of ports:

- EXP RX port: The EXP RX port receives the optical signal from the ROADM section available on the NE.
- EXP TX port: The EXP TX port sends the optical signal to the ROADM section available on the NE.
- EXP-A RX port: The EXP-A RX port receives the optical signal from the ROADM section available on other NEs or rings.
- EXP-A TX port: The EXP-A TX port sends the optical signal to the ROADM section available on other NEs or rings.
- COM TX port: The COM TX port sends the optical signal to the fiber stage section.
- COM RX port: The COM RX port receives the optical signal from the fiber stage section.

Figure 7-35 shows the MMU card faceplate.

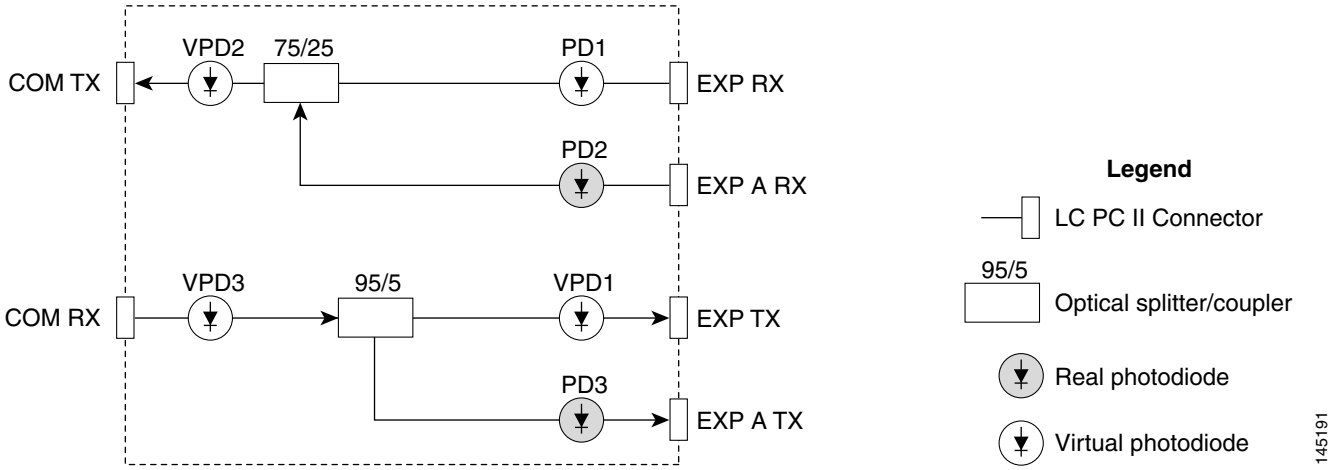
Figure 7-35 MMU Faceplate and Ports



7.13.2 MMU Block Diagram

Figure 7-36 provides a high-level functional block diagram of the MMU card.

Figure 7-36 MMU Block Diagram



7.13.3 MMU Power Monitoring

Physical photodiodes P1 through P3 monitor the power for the MMU card. The returned power level values are calibrated to the ports as shown in Table 7-41. VP1 to VP3 are virtual photodiodes that have been created by adding (by software computation) the relevant path insertion losses of the optical splitters (stored in the module) to the real photodiode (P1 to P3) measurement.

Table 7-41 MMU Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	1 (EXP-RX)	EXP RX
P2	5 (EXP A-RX)	EXP A RX
P3	6 (EXP A-TX)	EXP A TX
VP1	2 (EXP-TX)	EXP TX
VP2	4 (COM-TX)	COM TX
VP3	3 (COM-RX)	COM RX

7.13.4 MMU Card-Level Indicators

Table 7-42 describes the three card-level LED indicators on the MMU card.

Table 7-42 MMU 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 n internal hardware failure occurred. Replace the card if the red FAIL LED persists.

Table 7-42 MMU Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the MMU 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 turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.13.5 MMU Port-Level Indicators

You can find the alarm status of the MMU card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

CHAPTER 8

Transponder and Muxponder Cards

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.

This chapter describes Cisco ONS 15454 transponder (TXP), muxponder (MXP), GE_XP, 10GE_XP, ADM-10G cards, as well as their associated plug-in modules (Small Form-factor Pluggables [SFPs or XFPs]). For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 8.1 Card Overview, page 8-2
- 8.2 Safety Labels, page 8-4
- 8.3 TXP_MR_10G Card, page 8-8
- 8.4 TXP_MR_10E Card, page 8-11
- 8.5 TXP_MR_10E_C and TXP_MR_10E_L Cards, page 8-16
- 8.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards, page 8-20
- 8.7 MXP_2.5G_10G Card, page 8-24
- 8.8 MXP_2.5G_10E_C and MXP_2.5G_10E_L Cards, page 8-35
- 8.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards, page 8-44
- 8.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards, page 8-51
- 8.11 GE_XP and 10GE_XP Cards, page 8-59
- 8.12 ADM-10G Card, page 8-68
- 8.13 Y-Cable and Splitter Protection, page 8-75
- 8.14 Far-End Laser Control, page 8-78
- 8.15 Jitter Considerations, page 8-78

- 8.16 Termination Modes, page 8-78
- 8.17 SFP and XFP Modules, page 8-79

8.1 Card Overview

The card overview section lists the cards described in this chapter and provides compatibility information.

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 "1.16.1 Card Slot Requirements" section on page 1-61 for a list of slots and symbols.

The purpose of a TXP, MXP, GE_XP, 10GE_XP, or ADM-10G card is to convert the "gray" optical client interface signals into trunk signals that operate in the "colored" dense wavelength division multiplexing (DWDM) wavelength range. Client-facing gray optical signals generally operate at shorter wavelengths, whereas DWDM colored optical signals are in the longer wavelength range (for example, 1490 nm = violet; 1510 nm = blue; 1530 nm = green; 1550 nm = yellow; 1570 nm = orange; 1590 nm = red; 1610 nm = brown). Some of the newer client-facing SFPs, however, operate in the colored region. Transponding or muxponding is the process of converting the signals between the client and trunk wavelengths.

An MXP generally handles several client signals. It aggregates, or multiplexes, lower rate client signals together and sends them out over a higher rate trunk port. Likewise, it demultiplexes optical signals coming in on a trunk and sends them out to individual client ports. A TXP converts a single client signal to a single trunk signal and converts a single incoming trunk signal to a single client signal. GE_XP and 10GE_XP cards can be provisioned as TXPs, as MXPs, or as Layer 2 switches.

All of the TXP and MXP cards perform optical to electrical to optical (OEO) conversion. As a result, they are not optically transparent cards. The reason for this is that the cards must operate on the signals passing through them, so it is necessary to do an OEO conversion.

On the other hand, the termination mode for all of the TXPs and MXPs, which is done at the electrical level, can be configured to be transparent. In this case, neither the Line nor the Section overhead is terminated. The cards can also be configured so that either Line or Section overhead can be terminated, or both can be terminated.

Note The MXP_2.5G_10G card, by design, when configured in the transparent termination mode, actually does terminate some of the bytes. See Table 8-39 on page 8-79 for details.

8.1.1 Card Summary

Table 8-1 lists and summarizes the functions of each TXP, TXPP, MXP, and MXPP card.

Table 8-1 Cisco ONS 15454 Transponder and Muxponder Cards

Card	Port Description	For Additional Information
TXP_MR_10G	The TXP_MR_10G card has two sets of ports located on the faceplate.	See the "8.3 TXP_MR_10G Card" section on page 8-8
TXP_MR_10E	The TXP_MR_10E card has two sets of ports located on the faceplate.	See the "8.4 TXP_MR_10E Card" section on page 8-11
TXP_MR_10E_C and TXP_MR_10E_L	The TXP_MR_10E_C and TXP_MR_10E_L cards have two sets of ports located on the faceplate.	See the "8.5 TXP_MR_10E_C and TXP_MR_10E_L Cards" section on page 8-16
TXP_MR_2.5G	The TXP_MR_2.5G card has two sets of ports located on the faceplate.	See the "8.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards" section on page 8-20
TXPP_MR_2.5G	The TXPP_MR_2.5G card has three sets of ports located on the faceplate.	See the "8.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards" section on page 8-20
MXP_2.5G_10G	The MXP_2.5G_10G card has nine sets of ports located on the faceplate.	See the "8.7 MXP_2.5G_10G Card" section on page 8-24.
MXP_2.5G_10E	The MXP_2.5G_10E card has nine sets of ports located on the faceplate.	See the "8.7.4 MXP_2.5G_10E Card" section on page 8-28
MXP_2.5G_10E_C and MXP_2.5G_10E_L	The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards have nine sets of ports located on the faceplate.	See the "8.8 MXP_2.5G_10E_C and MXP_2.5G_10E_L Cards" section on page 8-35
MXP_MR_2.5G	The MXP_MR_2.5G card has nine sets of ports located on the faceplate.	See the "8.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards" section on page 8-44
MXPP_MR_2.5G	The MXPP_MR_2.5G card has ten sets of ports located on the faceplate.	See the "8.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards" section on page 8-44
MXP_MR_10DME_C and MXP_MR_10DME_L	The MXP_MR_10DME_C and MXP_MR_10DME_L cards have eight sets of ports located on the faceplate.	See the "8.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards" section on page 8-51
GE_XP	The GE_XP has 20 GE client ports and two 10GE trunk ports.	See the "8.11 GE_XP and 10GE_XP Cards" section on page 8-59
10GE_XP	The 10GE_XP has two 10 Gigabit Ethernet (GE) client ports and two 10GE trunk ports.	See the "8.11 GE_XP and 10GE_XP Cards" section on page 8-59
ADM-10G	The ADM-10G has 18 sets of ports located on the faceplate.	See the "8.12 ADM-10G Card" section on page 8-68

8.1.2 Card Compatibility

Table 8-2 lists the Cisco Transport Controller (CTC) software compatibility for each TXP, TXPP, MXP, MXPP, 10GE_XP, GE_XP and ADM-10G card.

Table 8-2 Software Release Compatibility for Transponder and Muxponder Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5
TXP_MR_10G	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TXP_MR_10E	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TXP_MR_10E_C	No	No	No	No	No	Yes	Yes	Yes	Yes
TXP_MR_10E_L	No	No	No	No	No	Yes	Yes	Yes	Yes
TXP_MR_2.5G	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TXPP_MR_2.5G	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MXP_2.5G_10G	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MXP_2.5G_10E	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MXP_2.5G_10E_C	No	No	No	No	No	Yes	Yes	Yes	Yes
MXP_2.5G_10E_L	No	No	No	No	No	Yes	Yes	Yes	Yes
MXP_MR_2.5G	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MXPP_MR_2.5G	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MXP_MR_10DME_C	No	No	No	No	No	Yes	Yes	Yes	Yes
MXP_MR_10DME_L	No	No	No	No	No	Yes	Yes	Yes	Yes
GE_XP	No	No	No	No	No	No	No	Yes	Yes
10GE_XP	No	No	No	No	No	No	No	Yes	Yes
ADM-10G	No	No	No	No	No	No	No	Yes	Yes

8.2 Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

8.2.1 Class 1 Laser Product Cards

The MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, ADM-10G, GE_XP, and 10GE_XP cards have Class 1 lasers. The labels that appear on these cards are described in the following sections.

8.2.1.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in Figure 8-1.

Figure 8-1 Class 1 Laser Product Label

Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and can therefore be considered safe. However, some Class 1 laser products might contain laser systems of a higher Class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

8.2.1.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 8-2.

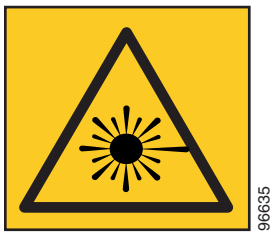
Figure 8-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

8.2.1.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 8-3.

Figure 8-3 Laser Source Connector Label

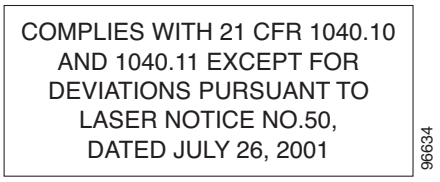


This label indicates that a laser source is present at the optical connector where the label has been placed.

8.2.1.4 FDA Statement Label

The FDA Statement label is shown in Figure 8-4.

Figure 8-4 FDA Statement Label

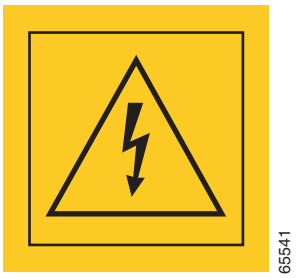


This label shows compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

8.2.1.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 8-5.

Figure 8-5 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

8.2.2 Class 1M Laser Product Cards

The TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, MXPP_MR_2.5G, MXP_MR_10DME_C, and MXP_MR_10DME_L cards have Class 1M lasers.

The labels that appear on these cards are described in the following subsections.

8.2.2.1 Class 1M Laser Product Label

The Class 1M Laser Product label is shown in Figure 8-6.

Figure 8-6 Class 1M Laser Product Label

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

8.2.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 8-7.

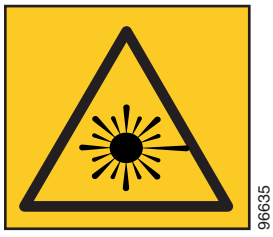
Figure 8-7 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

8.2.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 8-8.

Figure 8-8 Laser Source Connector Label

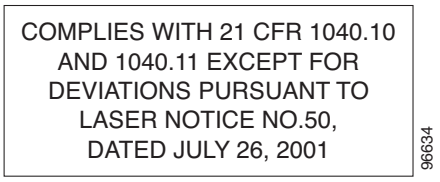


This label indicates that a laser source is present at the optical connector where the label has been placed.

8.2.2.4 FDA Statement Label

The FDA Statement label is shown in Figure 8-9.

Figure 8-9 FDA Statement Label

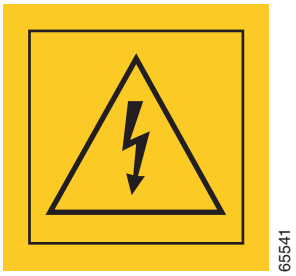


This label shows compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

8.2.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 8-10.

Figure 8-10 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

8.3 TXP_MR_10G Card

The TXP_MR_10G processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). It provides one 10-Gbps port per card that can be provisioned for an STM-64/OC-192 short reach (1310-nm) signal, compliant with ITU-T G.707, ITU-T G.709, ITU-T G.691, and Telcordia GR-253-CORE, or a 10GBASE-LR signal compliant with 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, each of which covers two wavelengths, for a total coverage of 32 different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of forward error correction (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 80 km (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.

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.

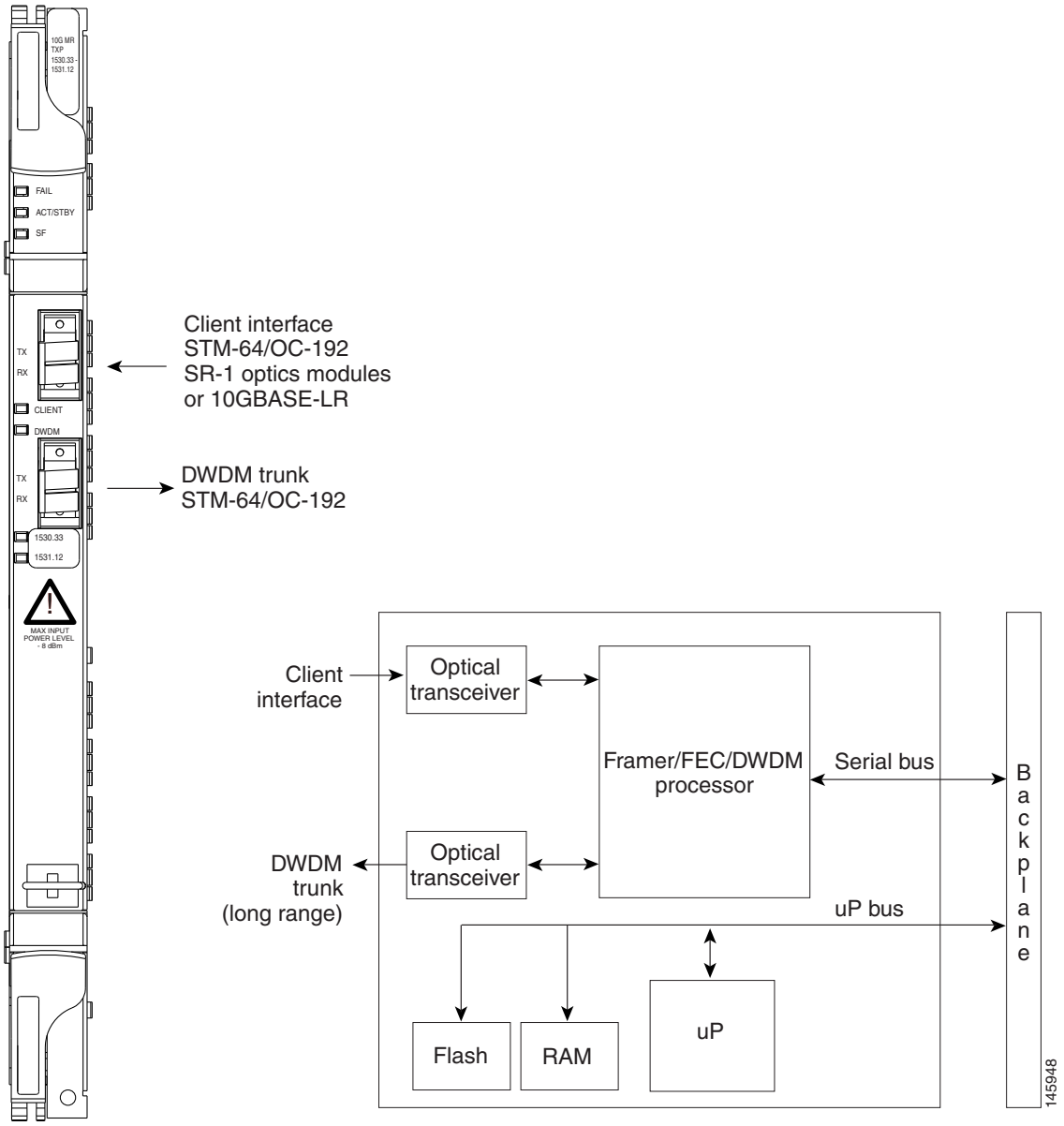
You can install TXP_MR_10G cards in Slots 1 to 6 and 12 to 17 and provision this card in a linear configuration. TXP_MR_10G cards cannot be provisioned as a bidirectional line switched ring (BLSR)/Multiplex Section - Shared Protection Ring (MS-SPRing), a path protection/single node control point (SNCP), or a regenerator. They can only be used in the middle of BLSR/MS-SPRing 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 for the client port and contains two transmit and receive connector pairs (labeled) on the card faceplate.

The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

Figure 8-11 shows the TXP_MR_10G faceplate and block diagram.

Figure 8-11 TXP_MR_10G Faceplate and Block Diagram



For information on safety labels for the card, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

8.3.1 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds and is user-configurable. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

8.3.2 TXP_MR_10G Card-Level Indicators

Table 8-3 lists the three card-level LEDs on the TXP_MR_10G card.

Table 8-3 TXP_MR_10G Card-Level Indicators

Card-Level LED	Description
FAIL LED (Red)	Red 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)	Green indicates that the card is operational (one or both ports active) and ready to carry traffic. Amber indicates that the card is operational and in standby (protect) mode.
SF LED (Amber)	Amber indicates a signal failure or condition such as loss of signal (LOS), loss of frame (LOF), or high bit error rates (BERs) on one or more of the card's ports. The amber SF LED is also illuminated if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the LED turns off.

8.3.3 TXP_MR_10G Port-Level Indicators

Table 8-4 lists the four port-level LEDs in the TXP_MR_10G card.

Table 8-4 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 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 card 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 card is configured for Wavelength 2.

8.4 TXP_MR_10E Card

The TXP_MR_10E card is a multirate transponder for the ONS 15454 platform. The card is fully backward compatible with the TXP_MR_10G card. It processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side) that is tunable over four wavelength channels (spaced at 100 GHz on the ITU grid) in the C band and tunable over eight wavelength channels (spaced at 50 GHz on the ITU grid) in the L band. There are eight versions of the C-band card, with each version covering four wavelengths, for a total coverage of 32 wavelengths. There are five versions of the L-band card, with each version covering eight wavelengths, for a total coverage of 40 wavelengths.

You can install TXP_MR_10E cards in Slots 1 to 6 and 12 to 17 and provision the cards in a linear configuration, BLSR/MS-SPRing, path protection/SNCP, or a regenerator. The card can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the card is configured for transparent termination mode.

The TXP_MR_10E card features a 1550-nm tunable laser (C band) or a 1580-nm tunable laser (L band) for the trunk port and a separately orderable ONS-XC-10G-S1 1310-nm or ONS-XC-10G-L2 1550-nm laser XFP module for the client port.

Note When the ONS-XC-10G-L2 XFP is installed, the TXP_MR_10E card must be installed in Slots 5, 6, 12 or 13.

On its faceplate, the TXP_MR_10E card contains two transmit and receive connector pairs, one for the trunk port and one for the client port. Each connector pair is labeled.

8.4.1 Key Features

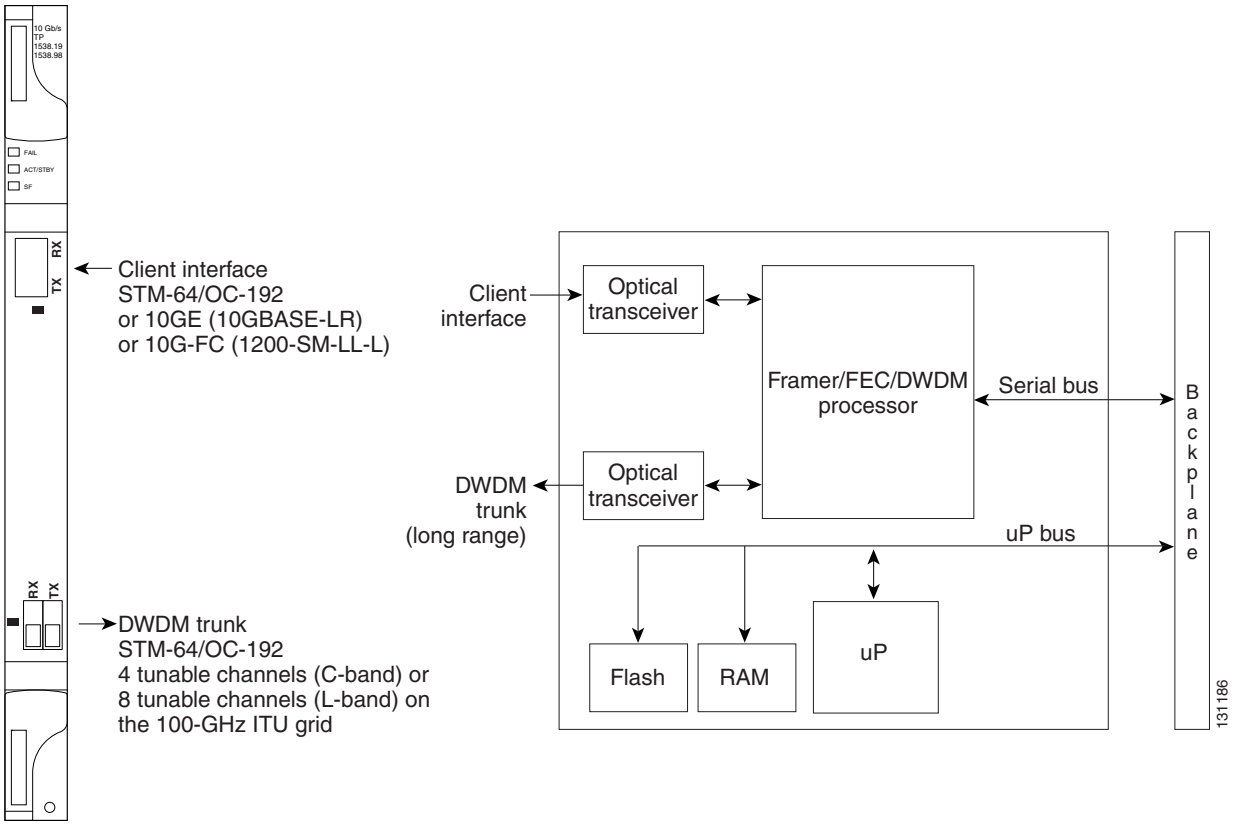
The key features of the TXP_MR_10E card are:

- A tri-rate client interface (available through the ONS-XC-10G-S1 XFP, ordered separately)
  - OC-192 (SR1)
  - 10GE (10GBASE-LR)
  - 10G-FC (1200-SM-LL-L)
- OC-192 to ITU-T G.709 OTU2 provisionable synchronous and asynchronous mapping
- The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

8.4.2 Faceplate and Block Diagram

Figure 8-12 shows the TXP_MR_10E faceplate and block diagram.

Figure 8-12 TXP_MR_10E Faceplate and Block Diagram



For information on safety labels for the card, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E card.

8.4.3 Client Interface

The client interface is implemented with a separately orderable XFP module. The module is a tri-rate transceiver, providing a single port that can be configured in the field to support an OC-192 SR-1 (Telcordia GR-253-CORE) or STM-64 I-64.1 (ITU-T G.691) optical interface, as well as 10GE LAN PHY (10GBASE-LR), 10GE WAN PHY (10GBASE-LW), or 10G FC signals.

The client side XFP pluggable module supports LC connectors and is equipped with a 1310-nm laser.

8.4.4 DWDM Trunk Interface

On the trunk side, the TXP_MR_10E card provides a 10-Gbps STM-64/OC-192 interface. There are four tunable channels available in the 1550-nm band or eight tunable channels available in the 1580-nm band on the 50-GHz ITU grid for the DWDM interface. The TXP_MR_10E card provides 3R (retime, reshape,

and regenerate) transponder functionality for this 10-Gbps trunk interface. Therefore, the card is suited for use in long-range amplified systems. The DWDM interface is complaint with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards.

The DWDM trunk port operates at a rate that is dependent on the input signal and the presence or absence of the ITU-T G.709 Digital Wrapper/FEC. The possible trunk rates are:

- OC192 (9.95328 Gbps)
- OTU2 (10.70923 Gbps)
- 10GE (10.3125 Gbps) or 10GE into OTU2 (ITU G.sup43 11.0957 Gbps)
- 10G FC (10.51875 Gbps) or 10G FC into OTU2 (nonstandard 11.31764 Gbps)

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

8.4.5 Enhanced FEC (E-FEC) Feature

A key feature of the TXP_MR_10E is the availability to configure the forward error correction in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No forward error correction
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7 algorithm, which is a super FEC code

Note The E-FEC of the ONS 15454 and Cisco ASR 9000 are not compatible.

8.4.6 FEC and E-FEC Modes

As client side traffic passes through the TXP_MR_10E card, it can be digitally wrapped using FEC mode, E-FEC mode, or no error correction at all. The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower optical signal-to-noise ratio [OSNR]) with a lower bit error rate than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

Caution Because the transponder has no visibility into the data payload and detect circuits, the TXP_MR_10E card does not display circuits under the card view.

8.4.7 Client-to-Trunk Mapping

The TXP_MR_10E card can perform ODU2-to-OCh mapping, which allows operators to provision data payloads in a standard way across 10-Gbps optical links.

Digital wrappers that define client side interfaces are called Optical Data Channel Unit 2 (ODU2) entities in ITU-T G.709. Digital wrappers that define trunk side interfaces are called Optical Channels (OCh) in ITU-T G.709. ODU2 digital wrappers can include Generalized Multiprotocol Label Switching (G-MPLS) signaling extensions to ITU-T G.709 (such as Least Significant Part [LSP] and Generalized Payload Identifier [G-PID] values) to define client interfaces and payload protocols.

8.4.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide.*

8.4.9 TXP_MR_10E Card-Level Indicators

Table 8-5 lists the three card-level LEDs on the TXP_MR_10E card.

Table 8-5 TXP_MR_10E 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.

8.4.10 TXP_MR_10E Port-Level Indicators

Table 8-6 lists the two port-level LEDs in the TXP_MR_10E card.

Table 8-6 TXP_MR_10E 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.

8.5 TXP_MR_10E_C and TXP_MR_10E_L Cards

The TXP_MR_10E_C and TXP_MR_10E_L cards are multirate transponders for the ONS 15454 platform. The cards are fully backward compatible with the TXP_MR_10G and TXP_MR_10E cards. They processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). The TXP_MR_10E_C is tunable over the entire set of C-band wavelength channels (82 channels spaced at 50 GHz on the ITU grid). The TXP_MR_10E_L is tunable over the entire set of L-band wavelength channels (80 channels spaced at 50 GHz on the ITU grid) and is particularly well suited for use in networks that employ DS fiber or SMF-28 single-mode fiber.

The advantage of these cards over previous versions (TXP_MR_10G and TXP_MR_10E) is that there is only one version of each card (one C-band version and one L-band version) instead of several versions needed to cover each band.

You can install TXP_MR_10E_C and TXP_MR_10E_L cards in Slots 1 to 6 and 12 to 17 and provision the cards in a linear configuration, BLSR/MS-SPRing, path protection/SNCP, or a regenerator. The cards can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the cards are configured for transparent termination mode.

The TXP_MR_10E_C and TXP_MR_10E_L cards feature a universal transponder 2 (UT2) 1550-nm tunable laser (C band) or a UT2 1580-nm tunable laser (L band) for the trunk port and a separately orderable ONS-XC-10G-S1 1310-nm or ONS-XC-10G-L2 1550-nm laser XFP module for the client port.

Note When the ONS-XC-10G-L2 XFP is installed, the TXP_MR_10E_C or TXP_MR_10E-L card is required to be installed in a high-speed slot (slot 6, 7, 12, or 13)

On its faceplate, the TXP_MR_10E_C and TXP_MR_10E_L cards contain two transmit and receive connector pairs, one for the trunk port and one for the client port. Each connector pair is labeled.

8.5.1 Key Features

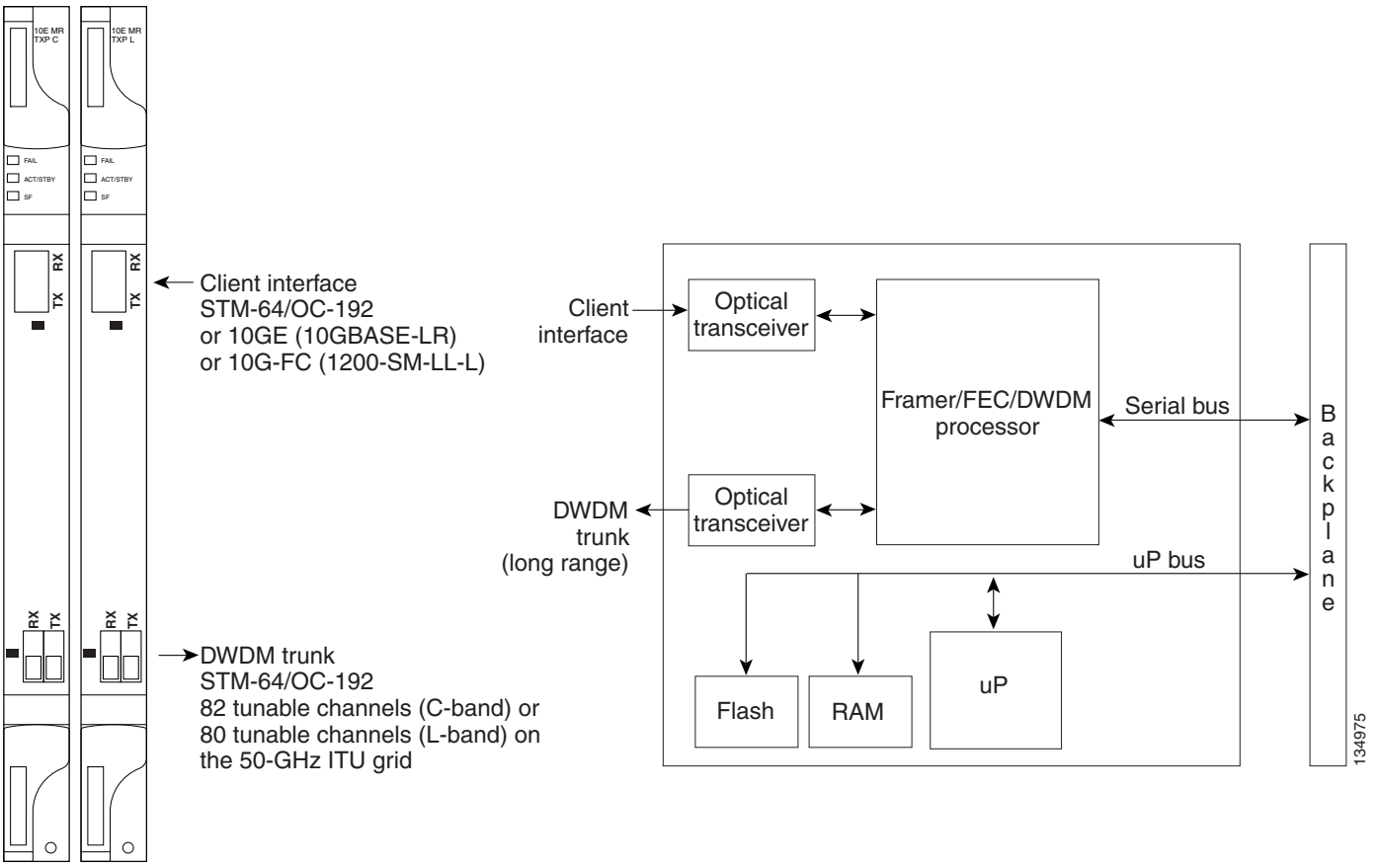
The key features of the TXP_MR_10E_C and TXP_MR_10E_L cards are:

- A tri-rate client interface (available through the ONS-XC-10G-S1 XFP, ordered separately):
  - OC-192 (SR1)
  - 10GE (10GBASE-LR)
  - 10G-FC (1200-SM-LL-L)
- A UT2 module tunable through the entire C band (TXP_MR_10E_C card) or L band (TXP_MR_10E_L card). The channels are spaced at 50 GHz on the ITU grid.
- OC-192 to ITU-T G.709 OTU2 provisionable synchronous and asynchronous mapping.
- The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

8.5.2 Faceplates and Block Diagram

Figure 8-13 shows the TXP_MR_10E_C and TXP_MR_10E_L faceplates and block diagram.

Figure 8-13 TXP_MR_10E_C and TXP_MR_10E_L Faceplates and Block Diagram



For information on safety labels for the cards, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E_C or TXP_MR_10E_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the cards.

8.5.3 Client Interface

The client interface is implemented with a separately orderable XFP module. The module is a tri-rate transceiver, providing a single port that can be configured in the field to support an OC-192 SR-1 (Telcordia GR-253-CORE) or STM-64 I-64.1 (ITU-T G.691) optical interface, as well as 10GE LAN PHY (10GBASE-LR), 10GE WAN PHY (10GBASE-LW), or 10G-FC signals.

The client side XFP pluggable module supports LC connectors and is equipped with a 1310-nm laser.

8.5.4 DWDM Trunk Interface

On the trunk side, the TXP_MR_10E_C and TXP_MR_10E_L cards provide a 10-Gbps STM-64/OC-192 interface. There are 80 tunable channels available in the 1550-nm C band or 82 tunable channels available in the 1580-nm L band on the 50-GHz ITU grid for the DWDM interface. The TXP_MR_10E_C and TXP_MR_10E_C cards provide 3R transponder functionality for this 10-Gbps trunk interface. Therefore, the card is suited for use in long-range amplified systems. The DWDM interface is compliant with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards.

The DWDM trunk port operates at a rate that is dependent on the input signal and the presence or absence of the ITU-T G.709 Digital Wrapper/FEC. The possible trunk rates are:

- OC192 (9.95328 Gbps)
- OTU2 (10.70923 Gbps)
- 10GE (10.3125 Gbps) or 10GE into OTU2 (ITU G.sup43 11.0957 Gbps)
- 10G-FC (10.51875 Gbps) or 10G-FC into OTU2 (nonstandard 11.31764 Gbps)

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

8.5.5 Enhanced FEC (E-FEC) Feature

A key feature of the TXP_MR_10E_C and TXP_MR_10E_L cards is the availability to configure the forward error correction in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No forward error correction
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7 algorithm, which is a super FEC code

8.5.6 FEC and E-FEC Modes

As client side traffic passes through the TXP_MR_10E_C and TXP_MR_10E_L cards, it can be digitally wrapped using FEC mode, E-FEC mode, or no error correction at all. The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower bit error rate than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

Caution Because the transponder has no visibility into the data payload and detect circuits, the TXP_MR_10E_C and TXP_MR_10E_L cards do not display circuits under the card view.

8.5.7 Client-to-Trunk Mapping

The TXP_MR_10E_C and TXP_MR_10E_L cards can perform ODU2-to-OCh mapping, which allows operators to provision data payloads in a standard way across 10-Gbps optical links.

Digital wrappers that define client side interfaces are called ODU2 entities in ITU-T G.709. Digital wrappers that define trunk side interfaces are called OCh in ITU-T G.709. ODU2 digital wrappers can include G-MPLS signaling extensions to ITU-T G.709 (such as LSP and G-PID values) to define client interfaces and payload protocols.

8.5.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the TXP_MR_10E_C and TXP_MR_10E_L cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

8.5.9 TXP_MR_10E_C and TXP_MR_10E_L Card-Level Indicators

Table 8-7 lists the three card-level LEDs on the TXP_MR_10E_C and TXP_MR_10E_L cards.

Table 8-7 TXP_MR_10E _C and TXP_MR_10E_L 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.

8.5.10 TXP_MR_10E_C and TXP_MR_10E_L Port-Level Indicators

Table 8-8 lists the two port-level LEDs in the TXP_MR_10E_C and TXP_MR_10E_L cards.

Table 8-8 TXP_MR_10E_C and TXP_MR_10E_L 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.

8.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards

The TXP_MR_2.5G card 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 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, each of which covers four wavelengths, for a total coverage of 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.

The TXP_MR_2.5G and TXPP_MR_2.5G cards support 2R (retime, regenerate) and 3R (retime, reshape, and regenerate) 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 8-9 shows the possible combinations of client interfaces, input bit rates, 2R and 3R modes, and ITU-T G.709 monitoring.

Table 8-9 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 Fibre Channel (2G-FC)/fiber connectivity (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 Fibre 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
Enterprise System Connection (ESCON)	200 Mbps	2R	—
SDI/D1 video	270 Mbps	2R	—

Table 8-9 2R and 3R Mode and ITU-T G.709 Compliance by Client Interface (continued)

Client Interface	Input Bit Rate	3R vs. 2R	ITU-T G.709
ISC-1 Compat	1.06 Gbps	3R	Off
ISC-3	1.06 or 2.125 Gbps	2R	—
ETR_CLO	16 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 8-10 lists the calculated trunk bit rates for the client interfaces with ITU-T G.709 enabled.

Table 8-10 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 PM or digital wrapping of received signals is available in this pass-through mode.

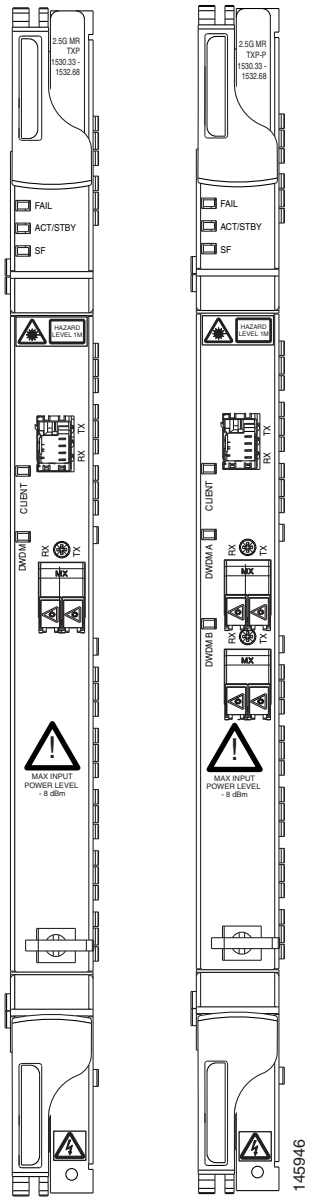
For 3R operation mode, the TXP_MR_2.5G and TXPP_MR_2.5G cards apply a digital wrapper to the incoming client interface signals (OC-N/STM-N, 1G-FC, 2G-FC, GE). PM is available on all of these signals except for 2G-FC, and varies depending upon the type of signal. For client inputs other than OC-48/STM-16, 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 cards have 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. PM of the ITU-T G.709 OH and SONET/SDH OH is implemented.

8.6.1 Faceplate

Figure 8-14 shows the TXP_MR_2.5G and TXPP_MR_2.5G faceplates.

Figure 8-14 TXP_MR_2.5G and TXPP_MR_2.5G Faceplates

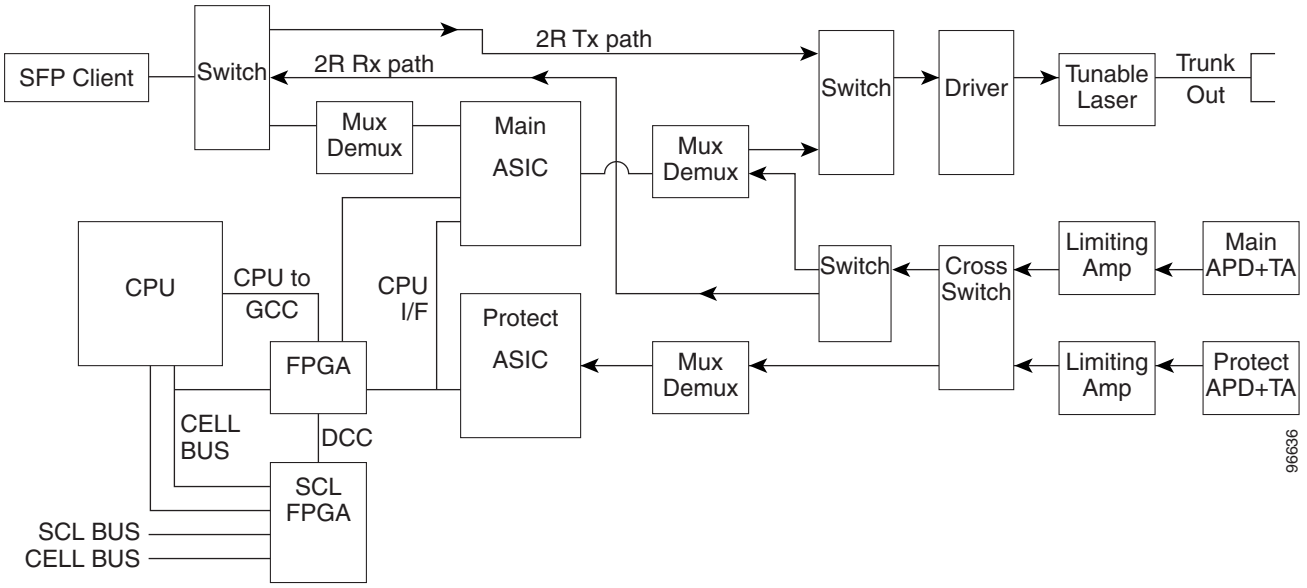


For information on safety labels for the cards, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

8.6.2 Block Diagram

Figure 8-15 shows a block diagram of the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Figure 8-15 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/MS-SPRing, a path protection/SNCP, or a regenerator. They can be used in the middle of BLSR/MS-SPRing or 1+1 spans only 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. It 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.

8.6.3 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the TXP_MR_2.5G and TXPP_MR_2.5G cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

8.6.4 TXP_MR_2.5G and TXPP_MR_2.5G Card-Level Indicators

Table 8-11 lists the three card-level LEDs on the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Table 8-11 TXP_MR_2.5G 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.

8.6.5 TXP_MR_2.5G and TXPP_MR_2.5G Port-Level Indicators

Table 8-12 lists the four port-level LEDs on the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Table 8-12 TXP_MR_2.5G and TXPP_MR_2.5G 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 (TXP_MR_2.5G only)	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green DWDM A LED (TXPP_MR_2.5G only)	The green DWDM A LED indicates that the DWDM A port is in service and that it is receiving a recognized signal.
Green DWDM B LED (TXPP_MR_2.5G only)	The green DWDM B LED indicates that the DWDM B port is in service and that it is receiving a recognized signal.

8.7 MXP_2.5G_10G Card

The MXP_2.5G_10G card 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, ITU-T 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 SONET OC-1 (STS-1) fiber optic signals defined in Telcordia GR-253-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 SONET 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 16 different versions, each of which covers two wavelengths, for a total coverage of 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 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.

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.

Caution Do not install an MXP_2.5G_10G card in Slot 3 if you have installed a DS3/EC1-48 card in Slots 1or 2. Likewise, do not install an MXP_2.5G_10G card in Slot 17 if you have installed a DS3/EC1-48 card in Slots 15 or 16. If you do, the cards will interact and cause DS-3 bit errors.

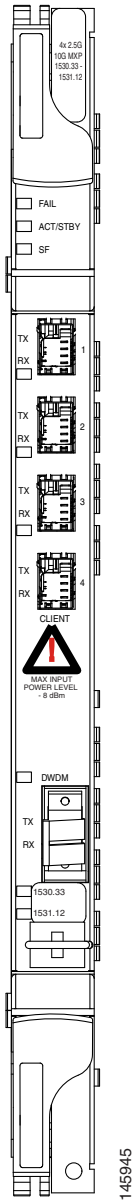
You can provision this card in a linear configuration. MXP_2.5G_10G cards cannot be provisioned as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. They can be used in the middle of BLSR/MS-SPRing or 1+1 spans only when the card is configured for transparent termination mode.

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 SFP connectors on the client side for optical cable termination.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode. This is necessary to provision a 4xOC-48 OCHCC circuit.

Figure 8-16 shows the MXP_2.5G_10G faceplate.

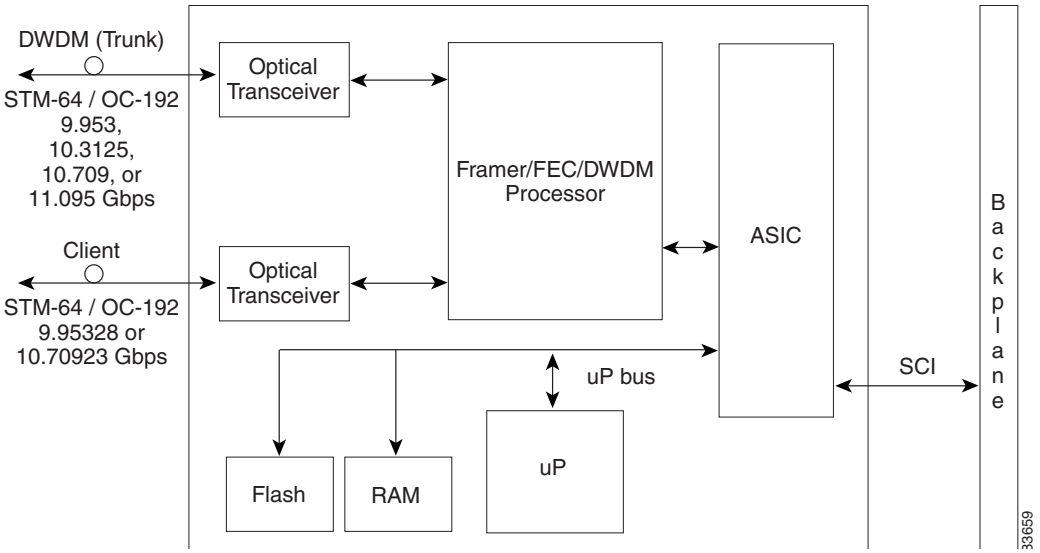
Figure 8-16 MXP_2.5G_10G Faceplate



For information on safety labels for the card, see the "8.2.1 Class 1 Laser Product Cards" section on page 8-4.

Figure 8-17 shows a block diagram of the MXP_2.5G_10G card.

Figure 8-17 MXP_2.5G_10G Card Block Diagram



8.7.1 Timing Synchronization

The MXP_2.5G_10G card is synchronized to the TCC2/TCC2P clock during normal conditions and transmits the ITU-T G.709 frame using this clock. The TCC2/TCC2P card can operate from an external building integrated timing supply (BITS) clock, an internal Stratum 3 clock, or from clock recovered from one of the four valid client clocks. If clocks from both TCC2/TCC2P 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.

8.7.2 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10G card, refer to the *Cisco ONS 15454 DWDM Procedure Guide.*

8.7.3 MXP_2.5G_10G Card-Level Indicators

Table 8-13 describes the three card-level LEDs on the MXP_2.5G_10G card.

Table 8-13 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.

8.7.3.1 MXP_2.5G_10G Port-Level Indicators

Table 8-14 describes the four port-level LEDs on the MXP_2.5G_10G card.

Table 8-14 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 card 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 card is configured for Wavelength 2.

8.7.4 MXP_2.5G_10E Card

The faceplate designation of the card is "4x2.5G 10E MXP." The MXP_2.5G_10E card is a DWDM muxponder for the ONS 15454 platform that supports full transparent termination the client side. The card multiplexes four 2.5 Gbps client signals (4 x OC48/STM-16 SFP) into a single 10-Gbps DWDM optical signal on the trunk side. The MXP_2.5G_10E provides wavelength transmission service for the four incoming 2.5 Gbps client interfaces. The MXP_2.5G_10E muxponder passes all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up generic communications channels (GCCs) for data communications, enable FEC, or facilitate performance monitoring.

The MXP_2.5G_10E works with optical transport network (OTN) devices defined in ITU-T G.709. The card supports ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "8.7.7 Multiplexing Function" section on page 8-31.

The MXP_2.5G_10E card is not compatible with the MXP_2.5G_10G card, which does not support full transparent termination. You can install MXP_2.5G_10E cards in Slots 1 to 6 and 12 to 17. You can provision this card in a linear configuration, as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. The card can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the card is configured for transparent termination mode.

The MXP_2.5G_10E 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 uses SFP modules on the client side for optical cable termination. The SFP pluggable modules are short reach (SR) or intermediate reach (IR) and support an LC fiber connector.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode. This is necessary to provision a 4xOC-48 OCHCC circuit.

8.7.4.1 Key Features

The MXP_2.5G_10E card has the following high level features:

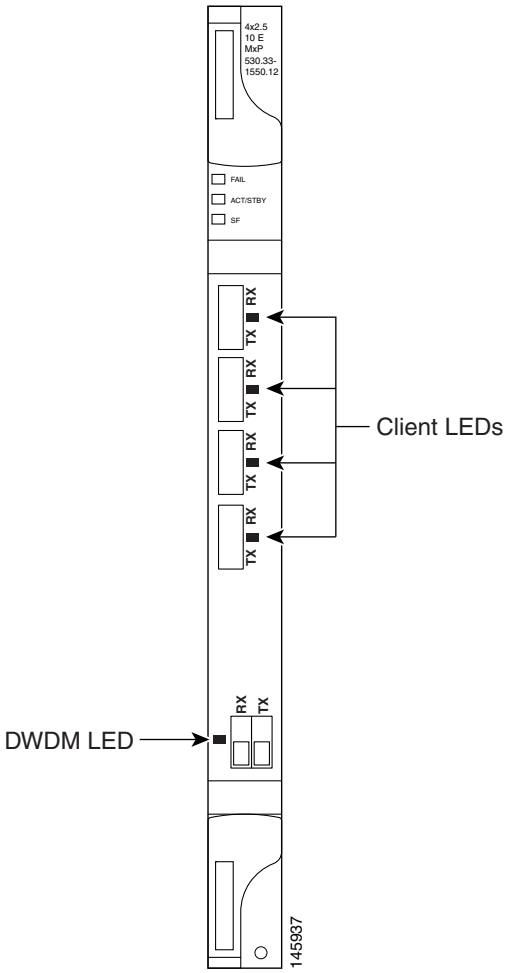
- Four 2.5 Gbps client interfaces (OC-48/STM-16) and one 10 Gbps trunk. The four OC-48 signals are mapped into a ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- Onboard E-FEC processor: The processor supports both standard Reed-Solomon (RS, specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm. A new block code (BCH) algorithm implemented in E-FEC allows recovery of an input BER up to 1E-3.
- Pluggable client interface optic modules: The MXP_2.5G_10E card has modular interfaces. Two types of optics modules can be plugged into the card. These include an OC-48/STM 16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- High level provisioning support: The MXP_2.5G_10E card is initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- Link monitoring and management: The MXP_2.5G_10E card uses standard OC-48 OH (overhead) bytes to monitor and manage incoming interfaces. The card passes the incoming SDH/SONET data stream and its overhead bytes transparently.
- Control of layered SONET/SDH transport overhead: The card is provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

- Automatic timing source synchronization: The MXP_2.5G_10E normally synchronizes from the TCC2/TCC2P card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P is not available, the MXP_2.5G_10E automatically synchronizes to one of the input client interface clocks.
- Configurable squelching policy: The card can be configured to squelch the client interface output if there is LOS at the DWDM receiver or if there is a remote fault. In the event of a remote fault, the card manages multiplex section alarm indication signal (MS-AIS) insertion.

8.7.5 Faceplate

Figure 8-18 shows the MXP_2.5G_10E faceplate.

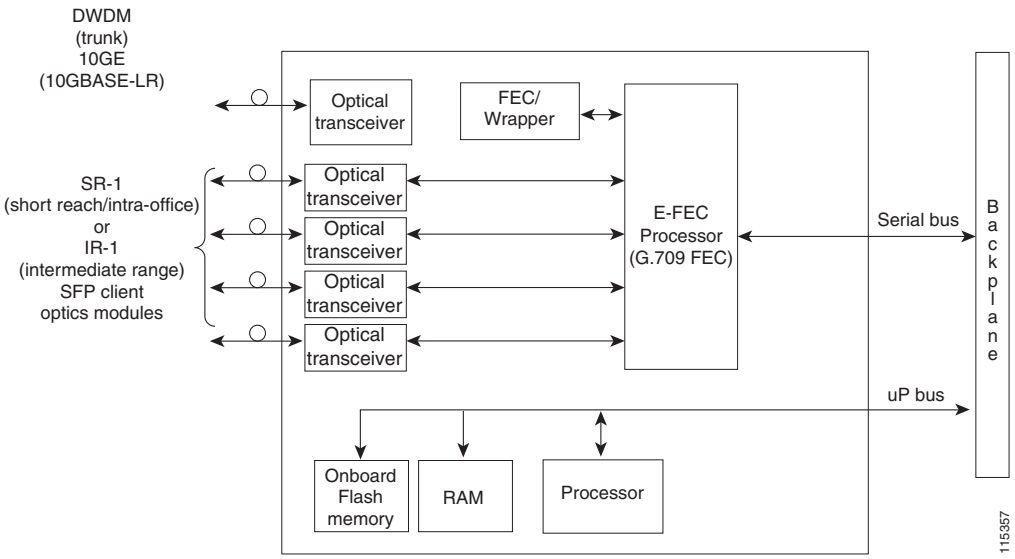
Figure 8-18 MXP_2.5G_10E Faceplate



For information on safety labels for the card, see the "8.2.1 Class 1 Laser Product Cards" section on page 8-4.

Figure 8-19 shows a block diagram of the MXP_2.5G_10E card.

Figure 8-19 MXP_2.5G_10E Block Diagram



8.7.6 Client Interfaces

The MXP_2.5G_10E provides four intermediate- or short-range OC-48/STM-16 ports per card on the client side. Both SR-1 or IR-1 optics can be supported and the ports use SFP connectors. The client interfaces use four wavelengths in the 1310-nm, ITU 100-MHz-spaced, channel grid.

8.7.6.1 DWDM Interface

The MXP_2.5G_10E serves as an OTN multiplexer, transparently mapping four OC-48 channels asynchronously to ODU1 into one 10-Gbps trunk. The DWDM trunk is tunable for transmission over four wavelengths in the 1550-nm, ITU 100-GHz spaced channel grid.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10E card.

8.7.7 Multiplexing Function

The muxponder is an integral part of the reconfigurable optical add/drop multiplexer (ROADM) network. The key function of MXP_2.5G_10E is to multiplex 4 OC-48/STM16 signals onto one ITU-T G.709 OTU2 optical signal (DWDM transmission). The multiplexing mechanism allows the signal to be terminated at a far-end node by another MXP_2.5G_10E card.

Termination mode transparency on the muxponder is configured using OTUx and ODUx OH bytes. The ITU-T G.709 specification defines OH byte formats that are used to configure, set, and monitor frame alignment, FEC mode, section monitoring, tandem connection monitoring, and termination mode transparency.

The MXP_2.5G_10E card performs ODU to OTU multiplexing as defined in ITU-T G.709. The ODU is the framing structure and byte definition (ITU-T G.709 digital wrapper) used to define the data payload coming into one of the SONET/SDH client interfaces on MXP_2.5G_10E. The term ODU1 refers to an ODU that operates at 2.5-Gbps line rate. On the MXP_2.5G_10E, there are four client interfaces that can be defined using ODU1 framing structure and format by asserting a ITU-T G.709 digital wrapper.

The output of the muxponder is a single 10-Gbps DWDM trunk interface defined using OTU2. It is within the OTU2 framing structure that FEC or E-FEC information is appended to enable error checking and correction.

8.7.8 Timing Synchronization

The MXP_2.5G_10E card is synchronized to the TCC2/TCC2P clock during normal conditions and transmits the ITU-T G.709 frame using this clock. No holdover function is implemented. If neither TCC2/TCC2P clock is available, the MXP_2.5G_10E switches automatically (hitless) to the first of the four valid client clocks with no time restriction as to how long it can run on this clock. The MXP_2.5G_10E continues to monitor the TCC2/TCC2P card. If a TCC2/TCC2P card is restored to working order, the MXP_2.5G_10E reverts to the normal working mode of running from the TCC2/TCC2P clock. If there is no valid TCC2/TCC2P clock and all of the client channels become invalid, the card waits (no valid frames processed) until one of the TCC2/TCC2P cards supplies a valid clock. In addition, the card is allowed to select the recovered clock from one active and valid client channel and supply that clock to the TCC2/TCC2P card.

8.7.9 Enhanced FEC (E-FEC) Capability

The MXP_2.5G_10E can configure the FEC in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No FEC
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7, two orthogonally concatenated BCH super FEC code. This FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved BCH. The constructed code is decoded iteratively to achieve the expected performance.

8.7.10 FEC and E-FEC Modes

As client side traffic passes through the MXP_2.5G_10E card, it can be digitally wrapped using FEC mode error correction or E-FEC mode error correction (or no error correction at all). The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower BER than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

8.7.11 SONET/SDH Overhead Byte Processing

The card passes the incoming SONET/SDH data stream and its overhead bytes for the client signal transparently. The card can be provisioned to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

8.7.12 Client Interface Monitoring

The following parameters are monitored on the MXP_2.5G_10E card:

- Laser bias current is measured as a PM parameter
- LOS is detected and signaled
- Transmit (TX) and receive (RX) power are monitored

The following parameters are monitored in real time mode (one second):

- Optical power transmitted (client)
- Optical power received (client)

In case of loss of communication (LOC) at the DWDM receiver or far-end LOS, the client interface behavior is configurable. AIS can be invoked or the client signal can be squelched.

8.7.13 Wavelength Identification

The card uses trunk lasers that are wave-locked, which allows the trunk transmitter to operate on the ITU grid effectively. Table 8-15 describes the required trunk transmit laser wavelengths. The laser is tunable over eight wavelengths at 50-GHz spacing or four at 100-GHz spacing.

Table 8-15 MXP_2.5G_10E Trunk Wavelengths

Band	Wavelength (nm)
30.3	1530.33
30.3	1531.12
30.3	1531.90
30.3	1532.68
34.2	1534.25
34.2	1535.04
34.2	1535.82
34.2	1536.61
38.1	1538.19
38.1	1538.98
38.1	1539.77
38.1	1540.56
42.1	1542.14
42.1	1542.94

Table 8-15 MXP_2.5G_10E Trunk Wavelengths (continued)

Band	Wavelength (nm)
42.1	1543.73
42.1	1544.53
46.1	1546.12
46.1	1546.92
46.1	1547.72
46.1	1548.51
50.1	1550.12
50.1	1550.92
50.1	1551.72
50.1	1552.52
54.1	1554.13
54.1	1554.94
54.1	1555.75
54.1	1556.55
58.1	1558.17
58.1	1558.98
58.1	1559.79
58.1	1560.61

8.7.14 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10E card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

8.7.15 Jitter

For SONET and SDH signals, the MXP_2.5G_10E card complies with Telcordia GR-253-CORE, ITU-T G.825, and ITU-T G.873 for jitter generation, jitter tolerance, and jitter transfer. See the "8.15 Jitter Considerations" section on page 8-78 for more information.

8.7.16 Lamp Test

The MXP_2.5G_10E card supports a lamp test function that is activated from the ONS 15454 front panel or through CTC to ensure that all LEDs are functional.

8.7.17 Onboard Traffic Generation

The MXP_2.5G_10E card provides internal traffic generation for testing purposes according to pseudo-random bit sequence (PRBS), SONET/SDH, or ITU-T G.709.

8.7.18 MXP_2.5G_10E Card-Level Indicators

Table 8-16 describes the three card-level LEDs on the MXP_2.5G_10E card.

Table 8-16 MXP_2.5G_10E 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.

8.7.19 MXP_2.5G_10E Port-Level Indicators

Table 8-17 describes the port-level LEDs on the MXP_2.5G_10E card.

Table 8-17 MXP_2.5G_10E Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	A 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.

8.8 MXP_2.5G_10E_C and MXP_2.5G_10E_L Cards

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards are DWDM muxponders for the ONS 15454 platform that support transparent termination mode on the client side. The faceplate designation of the cards is "4x2.5G 10E MXP C" for the MXP_2.5G_10E_C card and "4x2.5G 10E MXP L" for the MXP_2.5G_10E_L card. The cards multiplex four 2.5-Gbps client signals (4 x OC48/STM-16 SFP) into a single 10-Gbps DWDM optical signal on the trunk side. The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards provide wavelength transmission service for the four incoming 2.5 Gbps client interfaces. The MXP_2.5G_10E_C and MXP_2.5G_10E_L muxponders pass all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate PM.

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards work with OTN devices defined in ITU-T G.709. The cards support ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "8.8.5 Multiplexing Function" section on page 8-39.

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards are not compatible with the MXP_2.5G_10G card, which does not support transparent termination mode.

You can install MXP_2.5G_10E_C and MXP_2.5G_10E_L cards in Slots 1 to 6 and 12 to 17. You can provision a card in a linear configuration, as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. The cards can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the cards are configured for transparent termination mode.

The MXP_2.5G_10E_C card features a tunable 1550-nm C-band laser on the trunk port. The laser is tunable across 82 wavelengths on the ITU grid with 50-GHz spacing between wavelengths. The MXP_2.5G_10E_L features a tunable 1580-nm L-band laser on the trunk port. The laser is tunable across 80 wavelengths on the ITU grid, also with 50-GHz spacing. Each card features four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The cards uses dual LC connectors on the trunk side and use SFP modules on the client side for optical cable termination. The SFP pluggable modules are SR or IR and support an LC fiber connector.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode. This is necessary to provision a 4xOC-48 OCHCC circuit.

8.8.1 Key Features

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards have the following high level features:

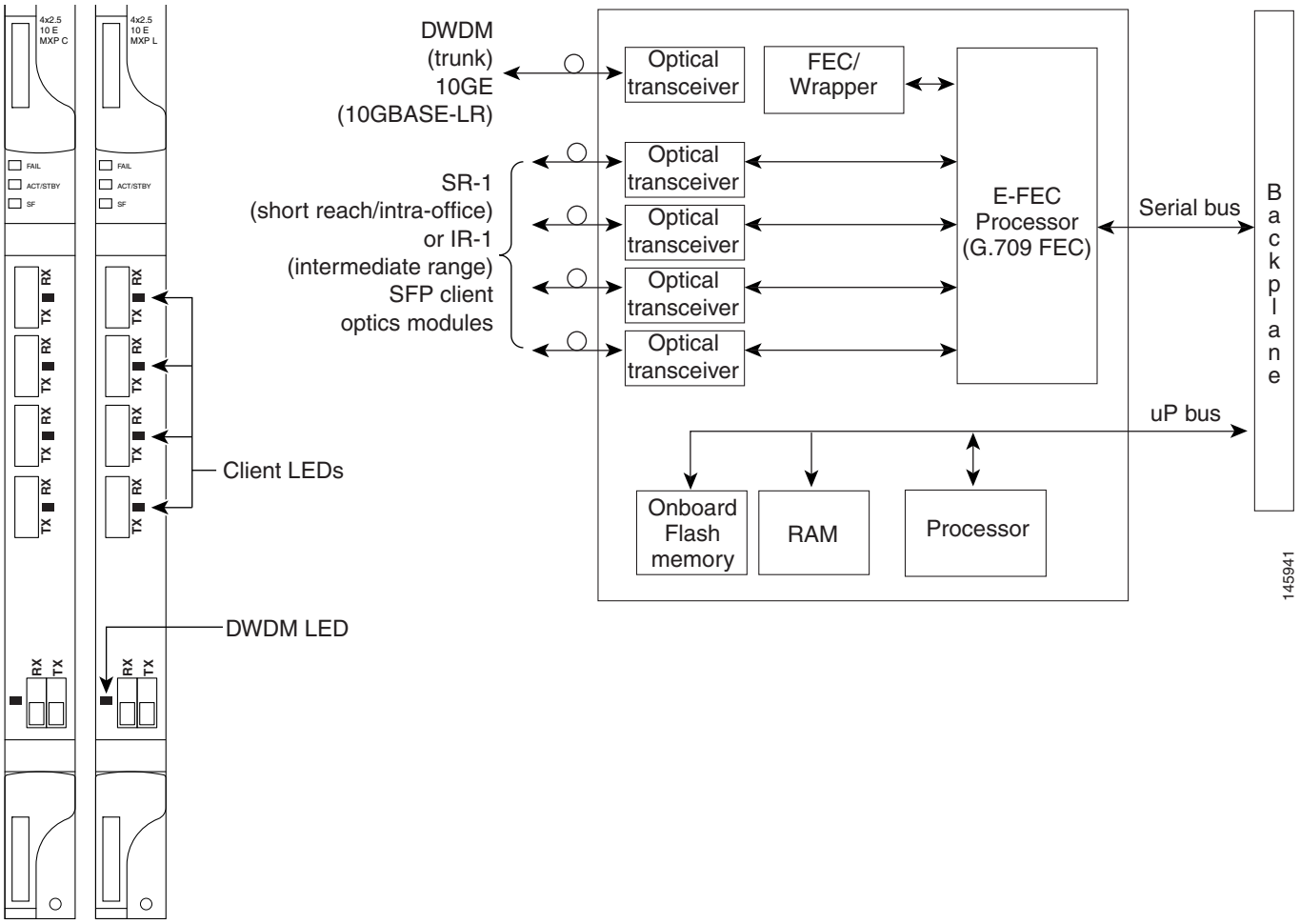
- Four 2.5 Gbps client interfaces (OC-48/STM-16) and one 10 Gbps trunk. The four OC-48 signals are mapped into a ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- Onboard E-FEC processor: The processor supports both standard RS (specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm. A new BCH algorithm implemented in E-FEC allows recovery of an input BER up to 1E-3.
- Pluggable client interface optic modules: The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards have modular interfaces. Two types of optics modules can be plugged into the card. These include an OC-48/STM 16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- High level provisioning support: The cards are initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- Link monitoring and management: The cards use standard OC-48 OH (overhead) bytes to monitor and manage incoming interfaces. The cards pass the incoming SDH/SONET data stream and its overhead bytes transparently.

- Control of layered SONET/SDH transport overhead: The cards are provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards normally synchronize from the TCC2/TCC2P card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P is not available, the cards automatically synchronize to one of the input client interface clocks.
- Configurable squelching policy: The cards can be configured to squelch the client interface output if there is LOS at the DWDM receiver or if there is a remote fault. In the event of a remote fault, the card manages MS-AIS insertion.
- The cards are tunable across the full C band (MXP_2.5G_10E_C) or full L band (MXP_2.5G_10E_L), thus eliminating the need to use different versions of each card to provide tunability across specific wavelengths in a band.

8.8.2 Faceplate

Figure 8-20 shows the MXP_2.5G_10E_C and MXP_2.5G_10E_L faceplates and block diagram.

Figure 8-20 MXP_2.5G_10E _C and MXP_2.5G_10E_L Faceplates and Block Diagram



For information on safety labels for the cards, see the "8.2.1 Class 1 Laser Product Cards" section on page 8-4.

8.8.3 Client Interfaces

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards provide four intermediate- or short-range OC-48/STM-16 ports per card on the client side. Both SR-1 and IR-1 optics can be supported and the ports use SFP connectors. The client interfaces use four wavelengths in the 1310-nm, ITU 100-GHz-spaced, channel grid.

8.8.4 DWDM Interface

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards serve as OTN multiplexers, transparently mapping four OC-48 channels asynchronously to ODU1 into one 10-Gbps trunk. For the MXP_2.5G_10E_C card, the DWDM trunk is tunable for transmission over the entire C band and for the MXP_2.5G_10E_L card, the DWDM trunk is tunable for transmission over the entire L band. Channels are spaced at 50-GHz on the ITU grid.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards.

8.8.5 Multiplexing Function

The muxponder is an integral part of the ROADM network. The key function of the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards is to multiplex four OC-48/STM16 signals onto one ITU-T G.709 OTU2 optical signal (DWDM transmission). The multiplexing mechanism allows the signal to be terminated at a far-end node by another similar card.

Transparent termination on the muxponder is configured using OTUx and ODUx OH bytes. The ITU-T G.709 specification defines OH byte formats that are used to configure, set, and monitor frame alignment, FEC mode, section monitoring, tandem connection monitoring, and transparent termination mode.

The MXP_2.5G_10E and MXP_2.5G_10E_L cards perform ODU to OTU multiplexing as defined in ITU-T G.709. The ODU is the framing structure and byte definition (ITU-T G.709 digital wrapper) used to define the data payload coming into one of the SONET/SDH client interfaces on the cards. The term ODU1 refers to an ODU that operates at 2.5-Gbps line rate. On the cards, there are four client interfaces that can be defined using ODU1 framing structure and format by asserting a ITU-T G.709 digital wrapper.

The output of the muxponder is a single 10-Gbps DWDM trunk interface defined using OTU2. It is within the OTU2 framing structure that FEC or E-FEC information is appended to enable error checking and correction.

8.8.6 Timing Synchronization

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards are synchronized to the TCC2/TCC2P clock during normal conditions and transmit the ITU-T G.709 frame using this clock. No holdover function is implemented. If neither TCC2/TCC2P clock is available, the card switches automatically (hitless) to the first of the four valid client clocks with no time restriction as to how long it can run on this clock. The card continues to monitor the TCC2/TCC2P card. If a TCC2/TCC2P card is restored to working order, the card reverts to the normal working mode of running from the TCC2/TCC2P clock. If there is no valid TCC2/TCC2P clock and all of the client channels become invalid, the card waits (no valid frames processed) until one of the TCC2/TCC2P cards supplies a valid clock. In addition, the card is allowed to select the recovered clock from one active and valid client channel and supply that clock to the TCC2/TCC2P card.

8.8.7 Enhanced FEC (E-FEC) Capability

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards can configure the FEC in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No FEC
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm

- E-FEC—Standard ITU-T G.975.1 I.7, two orthogonally concatenated BCH super FEC code. This FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved block codes (BCH). The constructed code is decoded iteratively to achieve the expected performance.

8.8.8 FEC and E-FEC Modes

As client side traffic passes through the card, it can be digitally wrapped using FEC mode error correction or E-FEC mode error correction (or no error correction at all). The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower BER than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

8.8.9 SONET/SDH Overhead Byte Processing

The card passes the incoming SONET/SDH data stream and its overhead bytes for the client signal transparently. The card can be provisioned to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

8.8.10 Client Interface Monitoring

The following parameters are monitored on the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards:

- Laser bias current is measured as a PM parameter.
- LOS is detected and signaled.
- Rx and Tx power are monitored.

The following parameters are monitored in real time mode (one second):

- Optical power transmitted (client)
- Optical power received (client)

In case of LOC at the DWDM receiver or far-end LOS, the client interface behavior is configurable. AIS can be invoked or the client signal can be squelched.

8.8.11 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. Both the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards implement the UT2 module. The MXP_2.5G_10E_C card uses a C-band version of the UT2 and the MXP_2.5G_10E_L card uses an L-band version.

Table 8-18 describes the required trunk transmit laser wavelengths for the MXP_2.5G_10E_C card. The laser is tunable over 82 wavelengths in the C band at 50-GHz spacing on the ITU grid.

Table 8-18 MXP_2.5G_10E_C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389

Table 8-18 MXP_2.5G_10E_C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

Table 8-19 describes the required trunk transmit laser wavelengths for the MXP_2.5G_10E_L card. The laser is fully tunable over 80 wavelengths in the L band at 50-GHz spacing on the ITU grid.

Table 8-19 MXP_2.5G_10E_L Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76

Table 8-19 MXP_2.5G_10E_L Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

8.8.12 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards, see the *Cisco ONS 15454 DWDM Procedure Guide*.

8.8.13 Jitter

For SONET and SDH signals, the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards comply with Telcordia GR-253-CORE, ITU-T G.825, and ITU-T G.873 for jitter generation, jitter tolerance, and jitter transfer. See the "8.15 Jitter Considerations" section on page 8-78 for more information.

8.8.14 Lamp Test

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards support a lamp test function that is activated from the ONS 15454 front panel or through CTC to ensure that all LEDs are functional.

8.8.15 Onboard Traffic Generation

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards provide internal traffic generation for testing purposes according to PRBS, SONET/SDH, or ITU-T G.709.

8.8.16 MXP_2.5G_10E_C and MXP_2.5G_10E_L Card-Level Indicators

Table 8-20 describes the three card-level LEDs on the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards.

Table 8-20 MXP_2.5G_10E_C and MXP_2.5G_10E_L 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.

8.8.17 MXP_2.5G_10E and MXP_2.5G_10E_L Port-Level Indicators

Table 8-21 describes the port-level LEDs on the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards.

Table 8-21 MXP_2.5G_10E_C and MXP_2.5G_10E_L Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	A 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.

8.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards

The MXP_MR_2.5G card aggregates a mix and match of client Storage Area Network (SAN) service client inputs (GE, FICON, Fibre Channel, and ESCON) into one 2.5 Gbps STM-16/OC-48 DWDM signal on the trunk side. It provides one long-reach STM-16/OC-48 port per card and is compliant with Telcordia GR-253-CORE.

Note In Software Release 7.0 and later, two additional operating modes have been made available to the user: pure ESCON (all 8 ports running ESCON), and mixed mode (Port 1 running FC/GE/FICON, and Ports 5 through 8 running ESCON). When the card is part of a system running Software Release 6.0 or below, only one operating mode, (FC/GE) is available for use.

The 2.5-Gbps Multirate Muxponder–Protected–100 GHz–Tunable 15xx.xx-15yy.yy (MXPP_MR_2.5G) card aggregates various client SAN service client inputs (GE, FICON, Fibre Channel, and ESCON) into one 2.5 Gbps STM-16/OC-48 DWDM signal on the trunk side. It provides two long-reach STM-16/OC-48 ports per card and is compliant with ITU-T G.957 and Telcordia GR-253-CORE.

Because the cards are tunable to one of four adjacent grid channels on a 100-GHz spacing, each card is available in eight versions, with 15xx.xx representing the first wavelength and 15yy.yy representing the last wavelength of the four available on the card. In total, 32 DWDM wavelengths are covered in accordance with the ITU-T 100-GHz grid standard, G.692, and Telcordia GR-2918-CORE, Issue 2. The card versions along with their corresponding wavelengths are shown in Table 8-22.

Table 8-22 Card Versions

Card Version	Frequency Channels at 100 GHz (0.8 nm) Spacing			
1530.33–1532.68	1530.33 nm	1531.12 nm	1531.90 nm	1532.68 nm
1534.25–1536.61	1534.25 nm	1535.04 nm	1535.82 nm	1536.61 nm
1538.19–1540.56	1538.19 nm	1538.98 nm	1539.77 nm	1540.56 nm
1542.14–1544.53	1542.14 nm	1542.94 nm	1543.73 nm	1544.53 nm
1546.12–1548.51	1546.12 nm	1546.92 nm	1547.72 nm	1548.51 nm
1550.12–1552.52	1550.12 nm	1550.92 nm	1551.72 nm	1552.52 nm
1554.13–1556.55	1554.13 nm	1554.94 nm	1555.75 nm	1556.55 nm
1558.17–1560.61	1558.17 nm	1558.98 nm	1559.79 nm	1560.61 nm

The muxponders are intended to be used in applications with long DWDM metro or regional unregenerated spans. Long transmission distances are achieved through the use of flat gain optical amplifiers.

The client interface supports the following payload types:

- 2G FC
- 1G FC
- 2G FICON
- 1G FICON
- GE
- ESCON

Note Because the client payload cannot oversubscribe the trunk, a mix of client signals can be accepted, up to a maximum limit of 2.5 Gbps.

Table 8-23 shows the input data rate for each client interface, and the encapsulation method. The current version of the ITU-T Transparent Generic Framing Procedure (GFP-T) G.7041 supports transparent mapping of 8B/10B block-coded protocols, including Gigabit Ethernet, Fibre Channel, and FICON.

In addition to the GFP mapping, 1-Gbps traffic on Port 1 or 2 of the high-speed serializer/deserializer (SERDES) is mapped to an STS-24c channel. If two 1-Gbps client signals are present at Port 1 and Port 2 of the SERDES, the Port 1 signal is mapped into the first STS-24c channel and the Port 2 signal into the second STS-24c channel. The two channels are then mapped into an OC-48 trunk channel.

Table 8-23 MXP_MR_2.5G and MXPP_MR_2.5G Client Interface Data Rates and Encapsulation

Client Interface	Input Data Rate	ITU-T GFP-T G.7041 Encapsulation
2G FC	2.125 Gbps	Yes
1G FC	1.06 Gbps	Yes
2G FICON	2.125 Gbps	Yes
1G FICON	1.06 Gbps	Yes
GE	1.25 Gbps	Yes
ESCON	0.2 Gbps	Yes

Table 8-24 shows some of the mix and match possibilities on the various client ports. The table is intended to show the full client payload configurations for the card.

Table 8-24 Client Data Rates and Ports

Mode	Port(s)	Aggregate Data Rate
2G FC	1	2.125 Gbps
1G FC	1, 2	2.125 Gbps
2G FICON	1	2.125 Gbps
1G FICON	1, 2	2.125 Gbps
GE	1, 2	2.5 Gbps
1G FC ESCON (mixed mode)	1 5, 6, 7, 8	1.06 Gbps 0.8 Gbps 1.86 Gbps total
1G FICON ESCON (mixed mode)	1 5, 6, 7, 8	1.06 Gbps 0.8 Gbps 1.86 Gbps total
GE ESCON (mixed mode)	1 5, 6, 7, 8	1.25 Gbps 0.8 Gbps Total 2.05 Gbps
ESCON	1, 2, 3, 4, 5, 6, 7, 8	1.6 Gbps

8.9.1 Performance Monitoring

GFP-T performance monitoring (GFP-T PM) is available via remote monitoring (RMON), and trunk PM is managed according to Telcordia GR-253-CORE and ITU G.783/826. Client PM is achieved through RMON for FC and GE.

8.9.2 Distance Extension

A buffer-to-buffer credit management scheme provides FC flow control. With this feature enabled, a port indicates the number of frames that can be sent to it (its buffer credit), before the sender is required to stop transmitting and wait for the receipt of a "ready" indication The MXP_MR_2.5G and MXPP_MR_2.5 cards support FC credit-based flow control with a buffer-to-buffer credit extension of up to 1600 km (994.2 miles) for 1G FC and up to 800 km (497.1 miles) for 2G FC. The feature can be enabled or disabled.

8.9.3 Slot Compatibility

You can install MXP_MR_2.5G and MXPP_MR_2.5G cards in Slots 1 to 6 and 12 to 17. The TCC2/TCC2P card is the only other card required to be used with these muxponder cards. Cross-connect cards do not affect the operation of the muxponder cards.

8.9.4 Interoperability with Cisco MDS Switches

You can provision a string (port name) for each fiber channel/FICON interface on the MXP_MR_2.5G and MXPP_MR_2.5G cards, which allows the MDS Fabric Manager to create a link association between that SAN port and a SAN port on a Cisco MDS 9000 switch.

8.9.5 Client and Trunk Ports

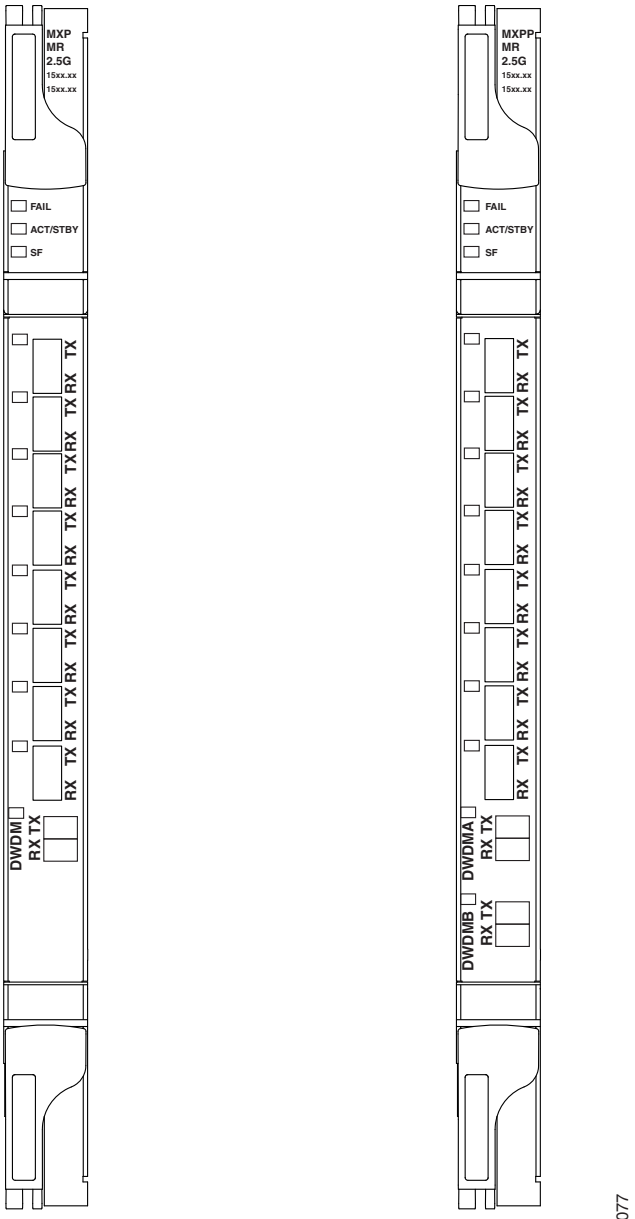
The MXP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client ports. The card contains eight 12.5 degree downward tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. The trunk port is a dual-LC connector with a 45 degree downward angle.

The MXPP_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. The card contains eight 12.5 degree downward tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. There are two trunk port connectors (one for working and one for protect). Each is a dual-LC connector with a 45-degree downward angle.

8.9.6 Faceplates

Figure 8-21 shows the MXP_MR_2.5G and MXPP_MR_2.5G faceplates.

Figure 8-21 MXP_MR_2.5G and MXPP_MR_2.5G Faceplates



MXP_MR_2.5G MXPP_MR_2.5G

For information on safety labels for the cards, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

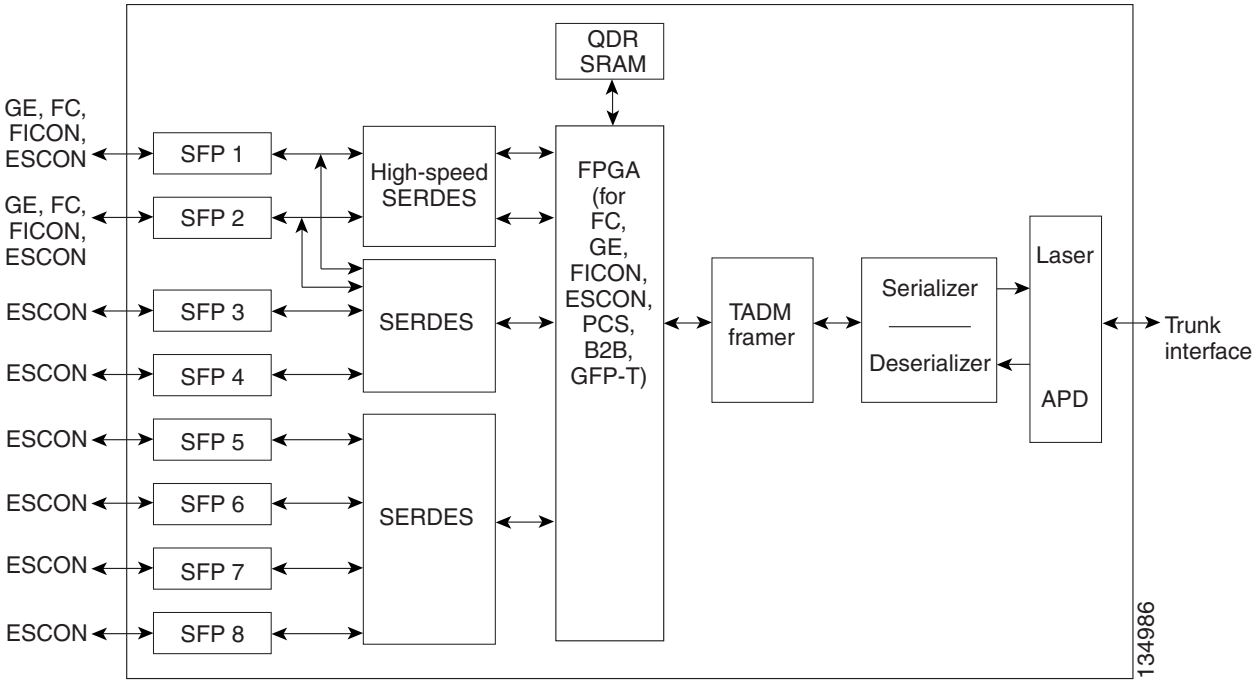
8.9.7 Block Diagram

Figure 8-22 shows a block diagram of the MXP_MR_2.5G card. The card has eight SFP client interfaces. Ports 1 and 2 can be used for GE, FC, FICON, or ESCON. Ports 3 through 8 are used for ESCON client interfaces. There are two SERDES blocks dedicated to the high-speed interfaces (GE, FC, FICON, and ESCON) and two SERDES blocks for the ESCON interfaces. A FPGA is provided to support different configurations for different modes of operation. This FPGA has a Universal Test and Operations

Physical Interface for ATM (UTOPIA) interface. A transceiver add/drop multiplexer (TADM) chip supports framing. Finally, the output signal is serialized and connected to the trunk front end with a direct modulation laser. The trunk receive signal is converted into an electrical signal with an avalanche photodiode (APD), is deserialized, and is then sent to the TADM framer and FPGA.

The MXPP_MR_2.5G is the same, except a 50/50 splitter divides the power at the trunk interface. In the receive direction, there are two APDs, two SERDES blocks, and two TADM framers. This is necessary to monitor both the working and protect paths. A switch selects one of the two paths to connect to the client interface.

Figure 8-22 MXP_MR_2.5G and MXPP_MR_2.5G Block Diagram



Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_2.5G and MXPP_MR_2.5G cards in a loopback configuration on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_2.5G and MXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_2.5G and MXPP_MR_2.5G cards.

8.9.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_MR_2.5G and MXPP_MR_2.5G cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

8.9.9 MXP_MR_2.5G and MXPP_MR_2.5G Card-Level Indicators

Table 8-25 lists the card-level LEDs on the MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 8-25 MXP_MR_2.5G and MXPP_MR_2.5G Card-Level Indicators

Card-Level LED	Description
FAIL LED (Red)	Red 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)	Green indicates that the card is operational (one or both ports active) and ready to carry traffic. Amber indicates that the card is operational and in standby (protect) mode.
SF LED (Amber)	Amber 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 illuminated if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the LED turns off.

8.9.10 MXP_MR_2.5G and MXPP_MR_2.5G Port-Level Indicators

Table 8-26 lists the port-level LEDs on the MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 8-26 MXP_MR_2.5G and MXPP_MR_2.5G Port-Level Indicators

Port-Level LED	Description
Client LEDs (eight LEDs)	Green indicates that the port is carrying traffic (active) on the interface. Amber indicates that the port is carrying protect traffic (MXPP_MR_2.5G). Red indicates that the port has detected a loss of signal.
DWDM LED (MXP_MR_2.5G)	
Green (Active)	Green indicates that the card is carrying traffic (active) on the interface.
Red (LOS)	A red LED indicates that the interface has detected an LOS or LOC.
DWDMA and DWDMB LEDs (MXPP_MR_2.5G)	
Green (Active)	Green indicates that the card is carrying traffic (active) on the interface.
Amber (Protect Traffic)	When the LED is amber, it indicates that the interface is carrying protect traffic in a splitter protection card (MXPP_MR_2.5G).
Red (LOS)	A red LED indicates that the interface has detected an LOS or LOC.

8.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards

The MXP_MR_10DME_C and MXP_MR_10DME_L cards aggregate a mix of client SAN service client inputs (GE, FICON, and Fibre Channel) into one 10.0 Gbps STM-64/OC-192 DWDM signal on the trunk side. It provides one long-reach STM-64/OC-192 port per card and is compliant with Telcordia GR-253-CORE and ITU-T G.957.

The cards support aggregation of the following signal types:

- 1-Gigabit Fibre Channel
- 2-Gigabit Fibre Channel
- 4-Gigabit Fibre Channel
- 1-Gigabit Ethernet
- 1-Gigabit ISC-Compatible (ISC-1)
- 2-Gigabit ISC-Peer (ISC-3)

Note On the card faceplates, the MXP_MR_10DME_C and MXP_MR_10DME_L cards are displayed as 10DME_C and 10DME_L, respectively.

Caution The card can be damaged by dropping it. Handle it safely.

The MXP_MR_10DME_C and MXP_MR_10DME_L muxponders pass all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate PM. The MXP_MR_10DME_C and MXP_MR_10DME_L cards work with the OTN devices defined in ITU-T G.709. The cards support ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "8.7.7 Multiplexing Function" section on page 8-31.

Note Because the client payload cannot oversubscribe the trunk, a mix of client signals can be accepted, up to a maximum limit of 10 Gbps.

You can install MXP_MR_10DME_C and MXP_MR_10DME_L cards in Slots 1 to 6 and 12 to 17.

Note The MXP_MR_10DME_C and MXP_MR_10DME_L cards are not compatible with the MXP_2.5G_10G card, which does not support transparent termination mode.

The MXP_MR_10DME_C card features a tunable 1550-nm C-band laser on the trunk port. The laser is tunable across 82 wavelengths on the ITU grid with 50-GHz spacing between wavelengths. The MXP_MR_10DME_L features a tunable 1580-nm L-band laser on the trunk port. The laser is tunable across 80 wavelengths on the ITU grid, also with 50-GHz spacing. Each card features four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The cards uses dual LC connectors on the trunk side and use SFP modules on the client side for optical cable termination. The SFP pluggable modules are SR or IR and support an LC fiber connector.

Table 8-27 shows the input data rate for each client interface, and the encapsulation method. The current version of the GFP-T G.7041 supports transparent mapping of 8B/10B block-coded protocols, including Gigabit Ethernet, Fibre Channel, ISC, and FICON.

In addition to the GFP mapping, 1-Gbps traffic on Port 1 or 2 of the high-speed SERDES is mapped to an STS-24c channel. If two 1-Gbps client signals are present at Port 1 and Port 2 of the high-speed SERDES, the Port 1 signal is mapped into the first STS-24c channel and the Port 2 signal into the second STS-24c channel. The two channels are then mapped into an OC-48 trunk channel.

Table 8-27 MXP_MR_10DME_C and MXP_MR_10DME_L Client Interface Data Rates and Encapsulation

Client Interface	Input Data Rate	GFP-T G.7041 Encapsulation
2G FC	2.125 Gbps	Yes
1G FC	1.06 Gbps	Yes
2G FICON/2G ISC-Compatible (ISC-1)/ 2G ISC-Peer (ISC-3)	2.125 Gbps	Yes
1G FICON/1G ISC-Compatible (ISC-1)/ 1G ISC-Peer (ISC-3)	1.06 Gbps	Yes
Gigabit Ethernet	1.25 Gbps	Yes

There are two FPGAs on each MXP_MR_10DME_C and MXP_MR_10DME_L, and a group of four ports is mapped to each FPGA. Group 1 consists of Ports 1 through 4, and Group 2 consists of Ports 5 through 8. Table 8-28 shows some of the mix and match possibilities on the various client data rates for Ports 1 through 4, and Ports 5 through 8. An X indicates that the data rate is supported in that port.

Table 8-28 Supported Client Data Rates for Ports 1 through 4 and Ports 5 through 8

Port (Group 1)	Port (Group 2)	Gigabit Ethernet	1G FC	2G FC	4G FC
1	5	X	X	X	X
2	6	X	X	—	—
3	7	X	X	X	—
4	8	X	X	—	—

GFP-T PM is available through RMON and trunk PM is managed according to Telcordia GR-253-CORE and ITU G.783/826. Client PM is achieved through RMON for FC and GE.

A buffer-to-buffer credit management scheme provides FC flow control. With this feature enabled, a port indicates the number of frames that can be sent to it (its buffer credit), before the sender is required to stop transmitting and wait for the receipt of a “ready” indication The MXP_MR_10DME_C and MXP_MR_10DME_L cards support FC credit-based flow control with a buffer-to-buffer credit extension of up to 1600 km (994.1 miles) for 1G FC, up to 800 km (497.1 miles) for 2G FC, or up to 400 km (248.5 miles) for 4G FC. The feature can be enabled or disabled.

The MXP_MR_10DME_C and MXP_MR_10DME_L cards feature a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client ports. The cards contains eight 12.5 degree downward tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. The trunk port is a dual-LC connector with a 45 degree downward angle.

The throughput of the MXP_MR_10DME_C and MXP_MR_10DME_L cards is affected by the following parameters:

- Distance extension—If distance extension is enabled on the card, it provides more throughput but more latency. If distance extension is disabled on the card, the buffer to buffer credits on the storage switch affects the throughput; higher the buffer to buffer credits higher is the throughput.

Note For each link to operate at the maximum throughput, it requires a minimum number of buffer credits to be available on the devices which the link connects to. The number of buffer credits required is a function of the distance between the storage switch extension ports and the link bandwidth, that is, 1G, 2G, or 4G. These buffer credits are provided by either the storage switch (if distance extension is disabled) or by both the storage switch and the card (if distance extension is enabled).

- Forward Error Correction (FEC)—If Enhanced FEC (E-FEC) is enabled on the trunk port of the card, the throughout is significantly reduced in comparison to standard FEC being set on the trunk port.

Note If distance extension is enabled on the card, the FEC status does not usually affect the throughput of the card.

- Payload size—The throughput of the card decreases with decrease in payload size.

The resultant throughput of the card is usually the combined effect of the above parameters.

8.10.1 Key Features

The MXP_MR_10DME_C and MXP_MR_10DME_L cards have the following high-level features:

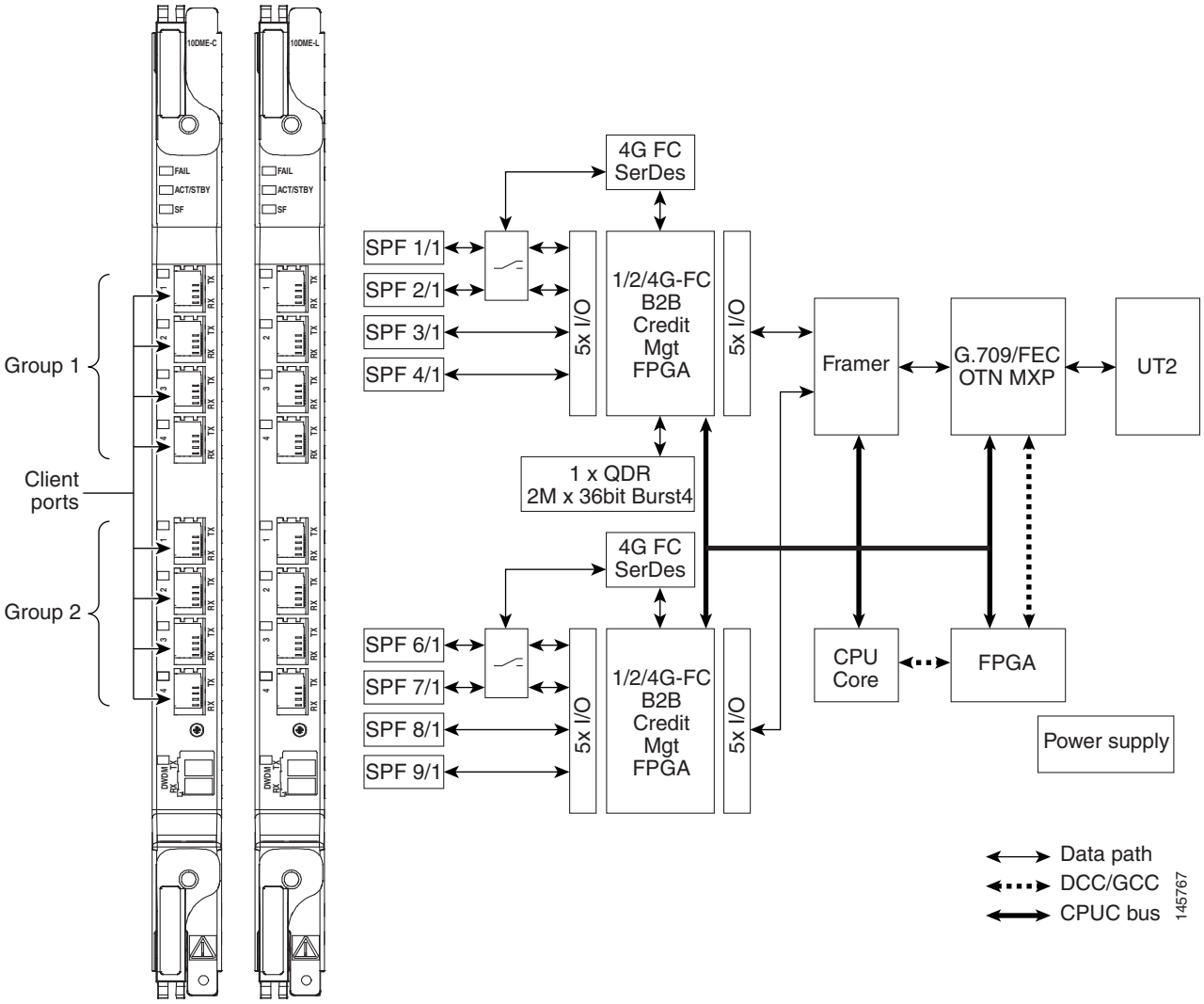
- Onboard E-FEC processor: The processor supports both standard RS (specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm. A new BCH algorithm implemented in E-FEC allows recovery of an input BER up to 1E-3.
- Pluggable client interface optic modules: The MXP_MR_10DME_C and MXP_MR_10DME_L cards have modular interfaces. Two types of optics modules can be plugged into the card. These include an OC-48/STM 16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- Y-cable protection: Supports Y-cable protection between the same card type only, on ports with the same port number and signal rate. See the "8.13.1 Y-Cable Protection" section on page 8-75 for more detailed information.
- High level provisioning support: The cards are initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- ALS: A safety mechanism used in the event of a fiber cut. For details regarding ALS provisioning for the MXP_MR_10DME_C and MXP_MR_10DME_L cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

- Link monitoring and management: The cards use standard OC-48 OH bytes to monitor and manage incoming interfaces. The cards pass the incoming SDH/SONET data stream and its OH bytes transparently.
- Control of layered SONET/SDH transport overhead: The cards are provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The MXP_MR_10DME_C and MXP_MR_10DME_L cards normally synchronize from the TCC2/TCC2P card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P is not available, the cards automatically synchronize to one of the input client interface clocks.
- Configurable squelching policy: The cards can be configured to squelch the client interface output if there is LOS at the DWDM receiver or if there is a remote fault. In the event of a remote fault, the card manages MS-AIS insertion.
- The cards are tunable across the full C band (MXP_MR_10DME_C) or full L band (MXP_MR_10DME_L), thus eliminating the need to use different versions of each card to provide tunability across specific wavelengths in a band.
- You can provision a string (port name) for each fiber channel/FICON interface on the MXP_MR_10DME_C and MXP_MR_10DME_L cards, which allows the MDS Fabric Manager to create a link association between that SAN port and a SAN port on a Cisco MDS 9000 switch.

8.10.2 Faceplate

Figure 8-23 shows the MXP_MR_10DME_C and MXP_MR_10DME_L faceplates and block diagram.

Figure 8-23 MXP_MR_10DME_C and MXP_MR_10DME_L Faceplates and Block Diagram



For information on safety labels for the cards, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DME_C and MXP_MR_10DME_L cards.

8.10.3 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. Both the MXP_MR_10DME_C and MXP_MR_10DME_L cards implement the UT2 module. The MXP_MR_10DME_C card uses a C-band version of the UT2 and the MXP_MR_10DME_L card uses an L-band version.

Table 8-29 describes the required trunk transmit laser wavelengths for the MXP_MR_10DME_C card. The laser is tunable over 82 wavelengths in the C band at 50-GHz spacing on the ITU grid.

Table 8-29 MXP_MR_10DME_C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578

Table 8-29 MXP_MR_10DME_C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

Table 8-30 describes the required trunk transmit laser wavelengths for the MXP_MR_10DME_L card. The laser is fully tunable over 80 wavelengths in the L band at 50-GHz spacing on the ITU grid.

Table 8-30 MXP_MR_10DME_L Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91

Table 8-30 MXP_MR_10DME_L Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

8.10.4 MXP_MR_10DME_C and MXP_MR_10DME_L Card-Level Indicators

Table 8-31 describes the three card-level LEDs on the MXP_MR_10DME_C and MXP_MR_10DME_L cards.

Table 8-31 MXP_MR_10DME_C and MXP_MR_10DME_L 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.

8.10.5 MXP_MR_10DME_C and MXP_MR_10DME_L Port-Level Indicators

Table 8-32 describes the port-level LEDs on the MXP_MR_10DME_C and MXP_MR_10DME_L cards.

Table 8-32 MXP_MR_10DME_C and MXP_MR_10DME_L Port-Level Indicators

Port-Level LED	Description
Port LED (eight LEDs, four for each group, one for each SFP)	When green, the port LED indicates that the client port is either in service and receiving a recognized signal (that is, no signal fail), or Out of Service and Maintenance (OOS,MT or locked, maintenance) and the signal fail and alarms are being ignored.
Green/Red/Amber/Off	When red, the port LED indicates that the client port is in service but is receiving a signal fail (LOS). When amber, the port LED indicates that the port is provisioned and in a standby state. When off, the port LED indicates that the SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware has failed.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

8.11 GE_XP and 10GE_XP Cards

The GE_XP and 10GE_XP cards are Gigabit Ethernet (GE) transponders for the ONS 15454 ANSI and ETSI platforms. The cards aggregate Ethernet packets received on the client ports for transport on C-band trunk ports that operate on a 100-GHz-grid. The ports operate with ITU-T G.709 framing and either FEC or E-FEC. The cards are designed for bulk GE point-to-point transport over 10GE LAN PHY wavelengths for Video-on-Demand (VOD), or broadcast video across protected 10GE LAN PHY wavelengths.

The GE_XP and 10GE_XP cards can be installed in Slots 1 through 6 or 12 through 17. The GE_XP is a double-slot card with twenty GE client ports and two 10GE trunk ports. The 10GE_XP is a single-slot card with two 10GE client ports and two 10GE trunk ports. The client ports support SX, LX, and ZX SFPs and SR and 10GBASE LR XFPs. (LR2 XFPs are not supported.) The trunk ports support a DWDM XFP.

Caution A fan-tray assembly (15454E-CC-FTA for the ETSI shelf, or 15454-CC-FTA for the ANSI shelf) must be installed in a shelf where a GE_XP or 10GE_XP card is installed.

GE_XP and 10GE_XP cards can be provisioned to perform different GE transport roles. Both cards can perform as Layer 2 Ethernet switches. However, the 10GE_XP can also perform as a 10GE TXP, and the GE_XP can perform as a 10GE or 20GE MXP. Table 8-33 shows the card modes supported by each card.

Note Changing the GE_XP and 10GE_XP card mode requires the ports to be in a OOS-DSBL (ANSI) or Locked, disabled (ETSI) service state. In addition, no circuits can be provisioned on the cards when the mode is being changed.

Table 8-33 GE_XP and 10GE_XP Card Modes

Card Mode	Card	Description
Layer 2 Ethernet switch	GE_XP 10GE_XP	Provides capability to switch between any client port traffic and any trunk port. Supported Ethernet protocols and services include QoS (Quality of Service), CoS (Class of Service), QinQ, MAC learning, service provider VLANs (SVLANs), and other Ethernet switch services.
10GE TXP	10GE_XP	Provides a point-to-point application in which each 10 Gigabit Ethernet client port is mapped to a 10 Gigabit Ethernet trunk port.
10GE MXP 20GE MXP	GE_XP	Provides the ability to multiplex any combination of the card's twenty GE client ports to one or both of its 10GE trunk ports. The card can be provisioned as a single MXP with twenty GE client ports or as two MXPs with ten GE client ports and one trunk port.

GE_XP card uses ethernet statistical multiplexing to aggregate GE traffic over the 10GE interface. In order to demultiplex the stream an additional VLAN tag is added for each client port. This results in reduction in traffic due to 10 ports in full line rate for the 10GE MXP mode. Additional tag is added on client port on the GE to 10GE direction and is removed on the reverse direction. This tag consists of four byte.

For 20GE MXP mode, full traffic cannot be sustained with all 20 ports connected to the trunk.

8.11.1 Key Features

The GE_XP and 10GE_XP cards have the following high-level features:

- GE MXP, TXP, and Layer 2 switch capability over the ONS 15454 DWDM platform.
- Interoperable with TXP_MR_10E and TXP_MR_10E_C cards. Also interoperable with Cisco Catalyst 6500 and Cisco 7600 series GE and 10GE interfaces.
- Compatible with the ONS 15454 ANSI high-density shelf assembly, the ETSI ONS 15454 shelf assembly, and the ETSI ONS 15454 high-density shelf assembly. Compatible with TCC2 and TCC2P cards.
- Ports: The GE_XP has twenty GE client ports and two 10GE trunk ports. The 10GE_XP has two 10GE client ports and two 10GE trunk ports. The client GE signals are mapped into an ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- FEC and E-FEC: ITU-T G.709 framing with standard Reed-Soloman (RS) (255,237) FEC. Performance monitoring and ITU-T G.709 Optical Data Unit (ODU) synchronous and asynchronous mapping. E-FEC with ITU-T G.709 ODU and 2.7 Gbps with greater than 8 dB coding gain.
- Broadcast drop-and-continue capability for VOD and broadcast video applications.
- Layer 2 switch mode provides VLAN translation, QinQ, ingress CoS egress QoS, Fast Ethernet protection switching, and other Layer 2 Ethernet services.
- IEEE 802.3 frame format supported for 10GE interfaces. The minimum frame size is 64 bytes. The maximum frame size is user-provisionable.
- MAC learning capability in Layer 2 switch mode.
- Configurable service provider VLANs (SVLANs) and customer VLANs (CVLANs).
- In Layer 2 switch mode, ports can be provisioned as network-to-network interfaces (NNIs) or user-network interfaces (UNIs) to facilitate service provider to customer traffic management.

- When a port is in UNI mode, tagging can be configured as transparent or selective. In transparent mode, only SVLANs in the node's VLAN database can be configured. In selective mode, a CVLAN-to-SVLAN relationship can be defined.
- Layer 2 VLAN port mapping allows the cards to be configured as multiple GE TXPs and MXPs.
- Protection through Y-cable protection schemes.
- Pluggable client interface optic modules (SFPs and XFPs): Client ports support tri-rate SX, LX, and ZX SFPs, and 10-Gbps SR1 XFPs.
- Pluggable trunk interface optic modules; trunk ports support the DWDM XFP.

8.11.2 Faceplate and Block Diagram

Figure 8-24 shows the GE_XP faceplate and block diagram.

Figure 8-24 GE_XP Faceplates and Block Diagram

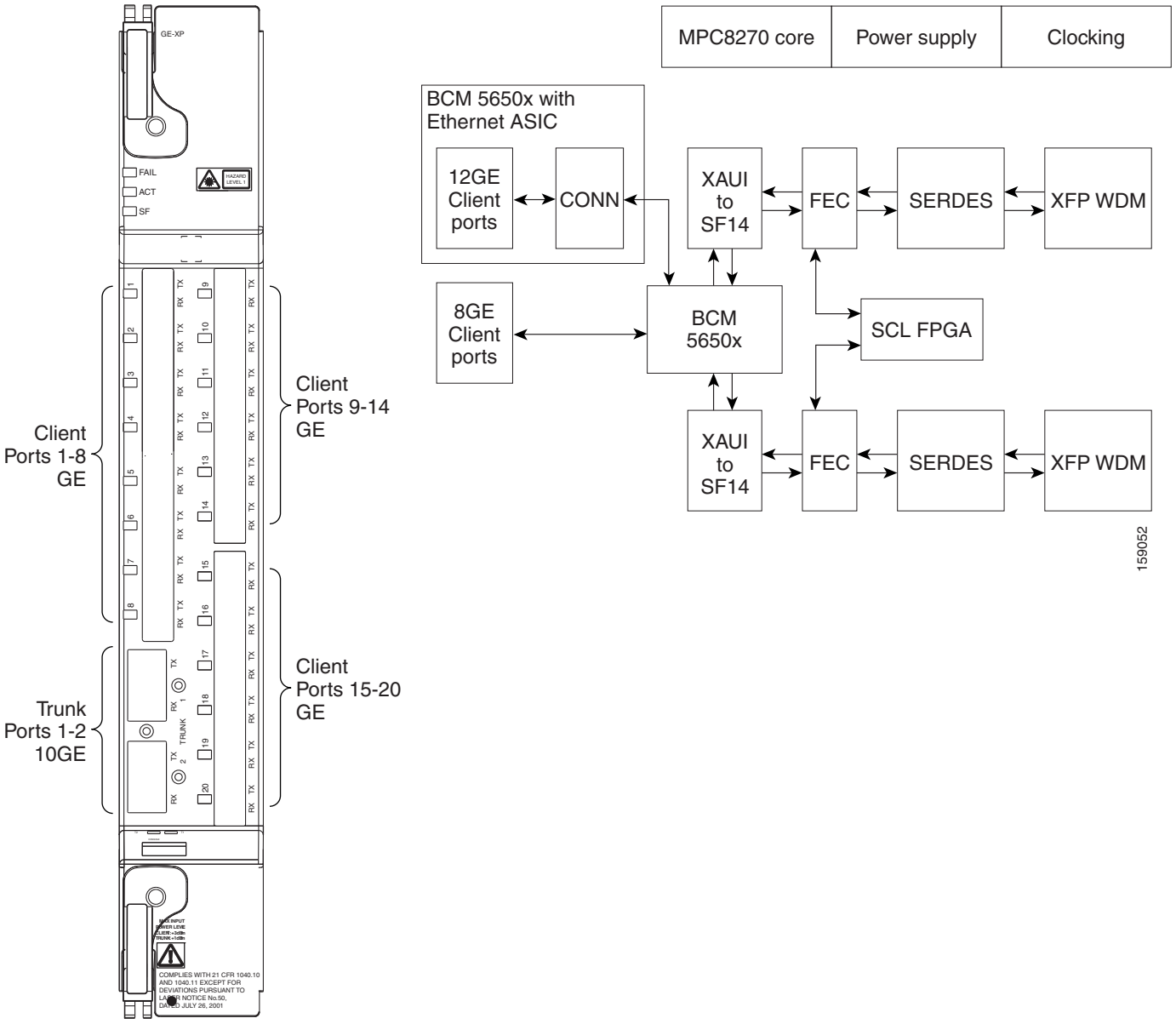
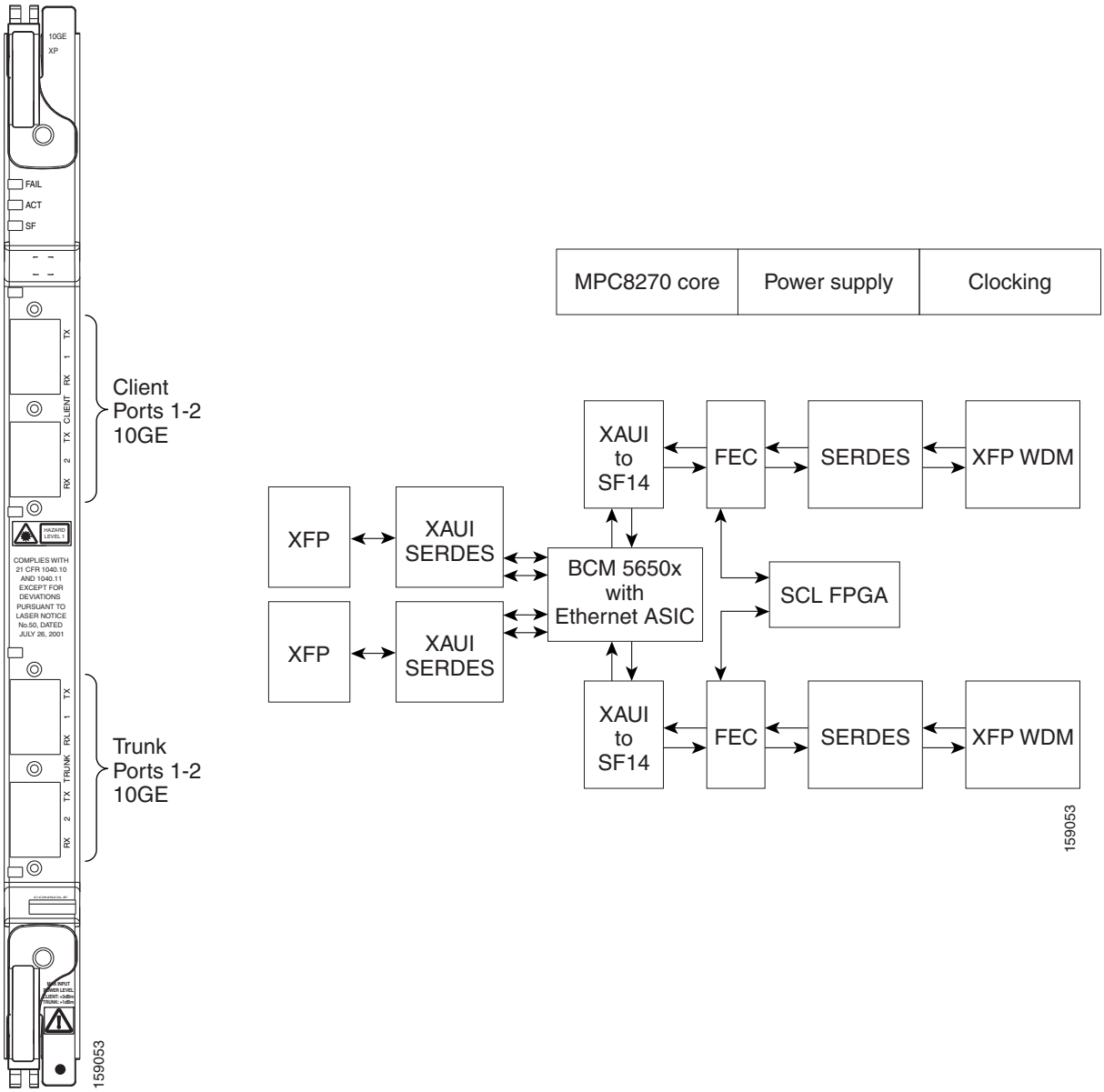


Figure 8-25 shows the 10GE_XP faceplate and block diagram.

Figure 8-25 10GE_XP Faceplates and Block Diagram



For information on safety labels for the cards, see the "8.2.2 Class 1M Laser Product Cards" section on page 8-6.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the GE_XP and 10GE_XP cards.

8.11.3 Client Interface

The client interface is implemented with separately orderable SFP or XFP modules. The client interfaces support the following tri-rate SFPs and XFPs using dual LC connectors and multi-mode fiber:

- SFP- GE/1G-FC/2G-FC - 850 nm - MM - LC (PID ONS-SE-G2F-SX)
- SFP - GE/1G-FC/2G-FC 1300 nm - SM - LC (PID ONS-SE-G2F-LX)
- SFP - GE/1G-FC/2G-FC 1300 nm - SM - LC (PID ONS-SE-G2F-ZX)
- SFP - 10/100/1000Base-T - Copper (PID ONS-SE-ZE-EL) Intra office up to 100; Cable: RJ45 STP CAT5, CAT5E, and CAT6

Note When using the ONS-SE-ZE-EL pluggable port module in the GE_XP card, the maximum throughput is 98.5%.

The client interfaces support the following dual-rate XFP using dual LC connectors and single-mode fiber:

- XFP - OC-192/STM-64/10GE/10-FC/OTU2 - 1310 SR - SM LC (PID: ONS-XC-10G-S1)

Note On GE_XP card, the copper Pluggable Port Module (PPM) interface can auto-negotiate and carry traffic even when the peer interface operates at rates other than 1000 Mbps.

8.11.4 DWDM Trunk Interface

The GE_XP and 10GE_XP cards have two 10GE trunk ports operating at 10GE (10.3125 Gbps) or 10GE into OTU2 (nonstandard 10.0957 Gbps). The ports are compliant with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards. The ports are capable of carrying C band and L band wavelengths through insertion of DWDM XFPs. Forty channels are available in the 1550-nm C band 100-GHz ITU grid, and forty channels are available in the L band.

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

8.11.5 Configuration Management

The GE_XP and 10GE_XP cards support the following configuration management parameters:

- Port name—User-assigned text string.
- Admin State/Service State—Administrative and service states to manage and view port status.
- MTU—Provisionable maximum transfer unit (MTU) to set the maximum number of bytes per frames accepted on the port.
- Mode—Provisional port mode, either Autonegotiation or the port speed.
- Flow Control—Flow control according to IEEE 802.1x pause frame specification can be enabled or disabled for TX and RX ports.
- Bandwidth—Provisionable maximum bandwidth allowed for the port.

- Ingress CoS—Assigns a CoS value to the port from 0 (highest) to 7 (lowest) and accepts CoS of incoming frames.
- Egress QoS—Defines the QoS capabilities at the egress port.
- NIM—Defines the port network interface management type based on Metro Ethernet Forum specifications. Ports can be defined as UNI (user-to-network interface) or NNI (network-to-network interface).
- MAC Learning—MAC Address learning to facilitate switch processing.
- VLAN tagging provided according to the IEEE 802.1Q standard.

Note When the GE_XP and 10GE_XP cards are provisioned in a MXP or TXP mode, only the following parameters are available: Port Name, State, MTU, Mode, Flow control, and Bandwidth.

8.11.6 Security

GE_XP and 10GE_XP card ports can be provisioned to block traffic from a user-defined set of MAC addresses. The remaining traffic is normally switched. You can manually specify the set of blocked MAC addresses for each port. Each port of the card can receive traffic from a limited predefined set of MAC addresses. The remaining traffic will be dropped. This capability is a subset of the Cisco IOS "Port Security" feature.

8.11.7 Y-Cable Protection

The GE_XP card supports Y-cable protection when it is provisioned in 10GE or 20GE MXP card mode. The 10GE_XP supports Y-cable protection when it is provisioned in 10GE TXP card mode. Two cards can be joined in a Y-cable protection group with one card assigned as the working card and the other defined as the protection card. This protection mechanism provides redundant bidirectional paths. See the "8.13.1 Y-Cable Protection" section on page 8-75 for more detailed information. The Y-protection mechanism is provisionable and can be set ON or OFF (OFF is the default mode). When a signal fault is detected (LOS, LOF, SD, or SF on the DWDM receiver port in the case of ITU-T G.709 mode) the protection mechanism software automatically switches between paths.

8.11.8 Layer 2 Over DWDM Protection

When the GE_XP and 10GE_XP are in Layer 2 (L2) over DWDM card mode, protection is handled by the hardware at the Layer 1 and Layer 2 levels. Fault detection and failure propagation is communicated through the ITU-T G.709 frame overhead bytes. For protected VLANs, traffic is flooded around the 10GE DWDM ring. To set up the Layer 2 protection, you identify a node and the GE_XP or 10GE_XP port that is to serve as the master node and port for the VLAN ring on the card view Provisioning > Protection tab (Figure 8-26). If a failure occurs, the node and port are responsible for opening and closing VLAN loops.

Note The Forced option in the Protection drop-down list converts all the SVLANs to protected SVLANs irrespective of the SVLAN protection configuration in the SVLAN database. This is applicable to a point-to-point linear topology. The SVLAN protection must be forced to move all SVLANs, including protected and unprotected SVLANs, to the protect path irrespective of provisioned SVLAN attributes.

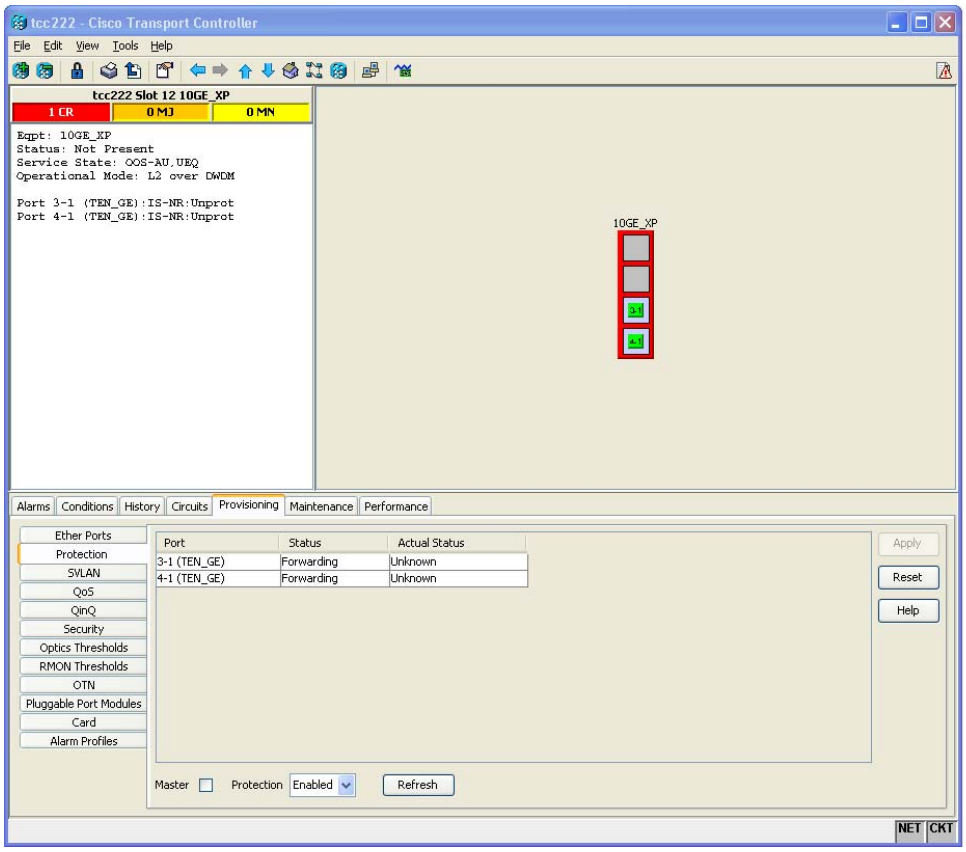
A FAPS switchover happens in the following failure scenarios:

- DWDM line failures caused by a fiber cut
- Unidirectional failure in the DWDM network caused by a fiber cut
- Fiber pull on the master card trunk port followed by a hard reset on the master card
- Hard reset on the master card
- Hard reset on the slave card
- An OTN failure is detected (LOS, OTUK-LOF, OTUK-LOM, or OTUK-LOM on the DWDM receiver port in the case of ITU-T G.709 mode)
- Trunk ports are moved to OOS,DSBLD (Locked,disabled) state
- Improper removal of XFPs

A FAPS switchover does not happen in the following scenarios:

- Slave card trunk port in OOS,DSBLD (Locked,disabled) state followed by a hard reset of the slave card
- OTN alarms raised on the slave card trunk port followed by a hard reset of the slave card
- Dual failure in the VLAN ring caused by fiber pull on the master and slave cards and restoration of a single failure
- Dual failure in the VLAN ring caused by the trunk port of master and slave cards in OOS,DSBLD (Locked,disabled) state and restoration of a single failure by placing one trunk port in IS state
- Dual failure in the VLAN ring due to the trunk port of master and slave cards in OOS,DSBLD (Locked,disabled) state followed by a hard or soft reset of the master card

Figure 8-26 GE_XP and 10GE_XP Layer 2 Over DWDM Provisioning > Protection Tab



8.11.9 GE_XP and 10GE_XP Card-Level Indicators

Table 8-34 describes the three card-level LEDs on the GE_XP and 10GE_XP cards.

Table 8-34 GE_XP and 10GE_XP 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 LED Green (Active)	If the ACT LED is green, the card is operational (one or more ports active) and ready to carry traffic.
Amber SF LED	The amber SF LED indicates that a signal failure or condition such as LOS, LOF, or high BERs is present 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.

8.11.10 GE_XP and 10GE_XP Port-Level Indicators

Table 8-35 describes the port-level LEDs on the GE_XP and 10GE_XP cards.

Table 8-35 GE_XP and XP_10G Port-Level Indicators

Port-Level LED	Description
Port LEDs Green/Red/Amber/Off	Green—The client port is either in service and receiving a recognized signal (that is, no signal fail), or Out of Service and Maintenance (OOS,MT or locked, maintenance) and the signal fail and alarms are being ignored. Red—The client port is in service but is receiving a signal fail (LOS). Amber—The port is provisioned and in a standby state. Off—The SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware has failed.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and receiving a recognized signal.

8.12 ADM-10G Card

The ADM-10G card operates on ONS 15454 SONET, ONS 15454 SDH, and DWDM networks to carry optical signals and Gigabit Ethernet signals over DWDM wavelengths for transport. The card aggregates lower bit-rate client SONET or SDH signals (OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, or Gigabit Ethernet) onto a C-band tunable DWDM trunk operating at a higher OC-192/STM-64 rate. In a DWDM network, the ADM-10G card transports traffic over DWDM by mapping Gigabit Ethernet and SONET or SDH circuits onto the same wavelength with multiple protection options.

The ADM-10G card is a double-slot card that can be installed in Slots 1 through 5 or 12 through 16 in standard and high-density SONET shelves (15454-SA-ANSI or 15454-SA-HD), the ETSI ONS 15454 standard shelf assembly, or the ETSI ONS 15454 high-density shelf assembly. Installation is supported in any of these slots.

Note The recommended slots are 1-2, 3-4, 5-6 and 12-13, 14-15, 16-17.

Caution Fan-tray assembly 15454E-CC-FTA (ETSI shelf)/15454-CC-FTA (ANSI shelf) must be installed in a shelf where the ADM-10G card is installed.

The card is compliant with ITU-T G.825 and ITU-T G.783 for SDH signals. It supports concatenated and nonconcatenated AU-4 mapped STM-1, STM-4, and STM-16 signals as specified in ITU-T G.707. The card also complies with Section 5.6 of Telcordia GR-253-CORE and supports synchronous transport signal (STS) mapped OC-3, OC-12, and OC-48 signals as specified in the standard.

The client SFP and trunk XFP are compliant with interface requirements in Telcordia GR-253-CORE, ITU-T G.957 and/or ITU-T G.959.1, and IEEE 802.3.

8.12.1 Key Features

The ADM-10G card has the following high-level features:

- Two-slot width
- Operates with the TCC2 or TCC2P
- Has built-in OC-192/STM-64 ADM function including client, trunk, and STS cross-connect
- Provides dual-card redundancy in path protection and 1+1 client protection schemes
- Allows creation of ADM peer groups
- Supports SONET, SDH, and Gigabit Ethernet protocols on client SFPs
- Supports XFP DWDM trunk interface single wavelengths
- Supports only double-card configuration.
- Returns zero bit errors when a TCC2 or TCC2P card switches from active to standby or when manual or forced protection switches occur
- 16 SFP-based client interfaces (gray, colored, and CWDM optics available)
- Client support for STM1/STM4/STM16/GE client signals (8 Gigabit Ethernet maximum)
- 1 XFP-based trunk interface supporting E-FEC/FEC and ITU-T G.709
- 2 SR XFP Interlink interfaces supporting redundancy connection with protection board and pass-through traffic
- Frame-mapped generic framing procedure (GFP-F) mapping for Ethernet over SONET or SDH
- Can be installed or pulled from operation, in any slot, without impacting other service cards in the shelf

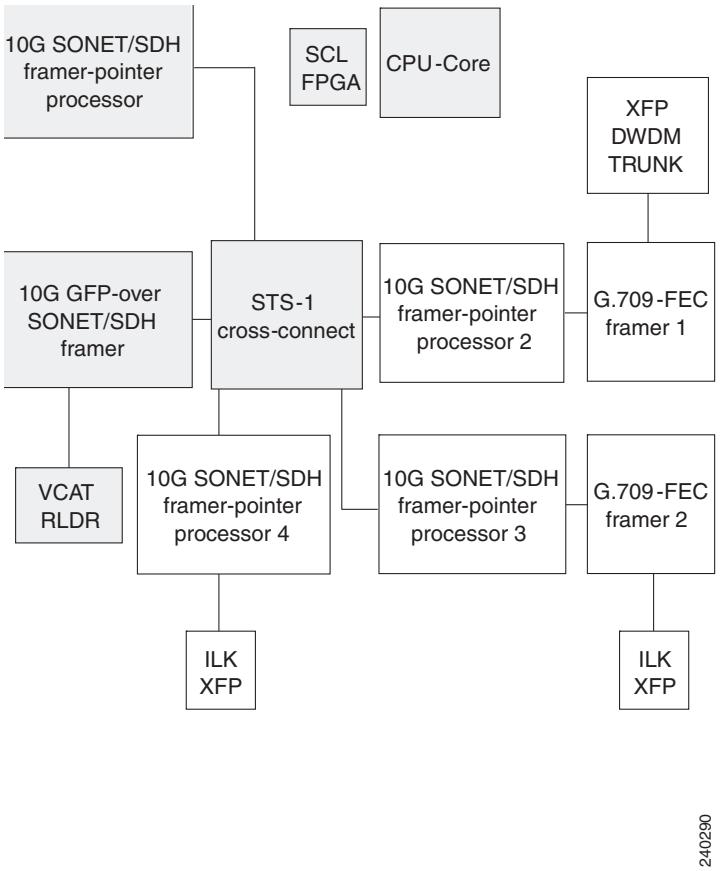
8.12.2 GFP Interoperability

The ADM-10G card defaults to GFP-F encapsulation that is compliant with ITU-T G.7041. This mode allows the card to operate with ONS 15310-CL, ONS 15310-MA, or ONS 15454 data cards (for example, ONS 15454 CE100T-8 or ML1000-2 cards). GFP encapsulation also allows the ADM-10G card to interoperate with other vendors' Gigabit Ethernet interfaces that adhere to the ITU-T G.7041 standard.

8.12.3 Faceplate

Figure 8-27 shows the ADM-10G card faceplate.

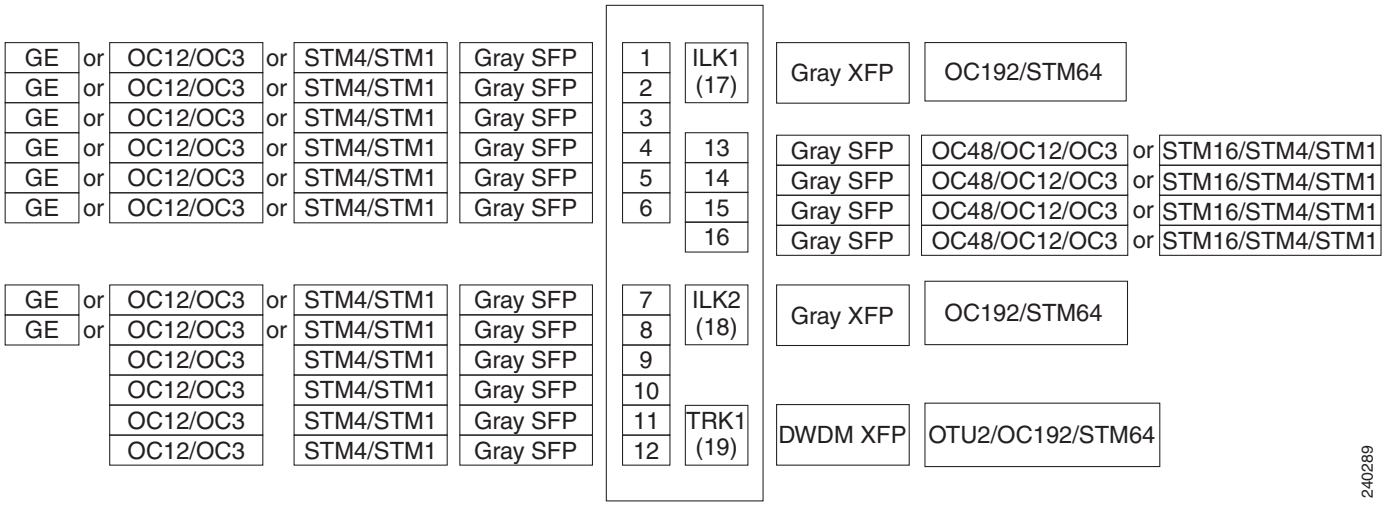
Figure 8-27 ADM-10G Card Faceplate and Block Diagram



8.12.4 Port Configuration Rules

ADM-10G card client and trunk port capacities are shown in Figure 8-28.

Figure 8-28 ADM-10G Card Port Capacities



8.12.5 Client Interfaces

The ADM-10G card uses LC optical port connectors and, as shown in Figure 8-28, supports up to 16 SFPs that can be utilized for OC-N/STM-N traffic. Eight of the SFPs can be used for Gigabit Ethernet. The interfaces can support any mix of OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, or Gigabit Ethernet of any reach, such as SX, LX, ZX, SR, IR, or LR. The interfaces support a capacity of:

- 4 x OC-48/STM-16
- 16 x OC-12/STM-4
- 16 x OC-3/STM-1
- 8 x GE

The supported client SFPs are:

- Gray SFPs
  - 1000Base-SX SFP 850 nm (ONS-SE-G2F-SX=)
  - 1000Base-LX SFP 1310 nm (ONS-SE-G2F-LX=)
  - OC48/STM16 IR1, OC12/STM4 SR1, OC3/STM1 SR1, GE-LX multirate SFP 1310 nm (ONS-SE-Z1=)
  - OC3/STM1 IR1, OC12/STM4 IR1 multirate SFP 1310 nm (ONS-SI-622-I1=)
  - OC48/STM16 SR1 SFP 1310 nm (ONS-SI-2G-S1=)
  - OC48/STM16 IR1 SFP 1310 nm (ONS-SI-2G-I1=)
- Colored DWDM SFPs
  - 1000Base-ZX SFP 1550 nm (ONS-SI-GE-ZX=)
  - OC3/STM1 LR2 SFP 1550 nm (ONS-SI-155-L2=)
  - OC48/STM16 LR2 SFP 1550 nm (ONS-SI-2G-L2=)
  - OC48/STM16 SFP (ONS-SC-2G-xx.x)

Note xx.x = 28.7 to 60.6. ONS-SC-2G-28.7, ONS-SC-2G-33.4, ONS-SC-2G-41.3, ONS-SC-2G-49.3, and ONS-SC-2G-57.3 are supported from Release 8.5 and later.

- CWDM SFPs
  - OC48/STM16/GE CWDM SFP (ONS-SC-Z3-xxxx)

8.12.6 Interlink Interfaces

Two 2R interlink interfaces, called ILK1 and ILK2, are automatically created on each ADM-10G card and placed in the IS/Unlocked service state. Physically cabling these ports between two ADM-10G cards, located on the same shelf, allows you to configure them as an ADM Peer Group.The ILK ports carry 10G of traffic each.

The interlink interfaces support the following STM64 SR1 (ONS-XC-10G-S1=) XFP:

8.12.7 DWDM Trunk Interface

The ADM-10G card supports OC-192/STM-64 signal transport and ITU-T G.709 digital wrapper according to the ITU-T G.709 standard. It supports one DWDM trunk XFP at a time in a double-slot configuration.

The supported DWDM trunk XFPs are:

- 10G DWDM (ONS-XC-10G-xx.x=) (colored XFP)
- STM64 SR1 (ONS-XC-10G-S1=) (gray XFP)

8.12.8 Configuration Management

When using OC-48/STM-16 traffic, some contiguous port configurations, listed in Table 8-36, are unavailable due to hardware limitations. This limitation does not impact the Gigabit Ethernet payload.

Note The ADM-10G card cannot be used in the same shelf with SONET or SDH cross-connect cards.

Table 8-36 OC-48/STM-16 Configuration Limitations

OC-48/STM-16 Port Number	Ports Restricted from Optical Traffic
OC-48/STM-16 on Port 13	No OC-N/STM-N on Port 1 through Port 3
OC-48/STM-16 on Port 14	No OC-N/STM-N on Port 4 through Port 6
OC-48/STM-16 on Port 15	No OC-N/STM-N on Port 7 through Port 9
OC-48/STM-16 on Port 16	No OC-N/STM-N on Port 10 through Port 12

Note The total traffic rate for each trunk cannot exceed OC-192/STM-64 on each ADM-10G card, or for each ADM peer group.

Note Gigabit Ethernet is not supported on Port 9 and Port 10. Port 11 and Port 12 support only OC-3/STM-1 or OC-12/STM-4.

Additionally, the following guidelines apply to the ADM-10G card:

- The trunk port supports OC-192/STM-64 and OTU2.
- The Interlink port supports OC-192/STM-64.
- Up to six ADM-10G cards can be installed in one shelf.
- The card can be used in all 15454-SA-ANSI and 15454-SA-HD shelves as well as ETSI ONS 15454 standard and high-density shelves.
- A lamp test function can be activated from CTC to ensure that all LEDs are functional.
- The card can operate as a working protected or working nonprotected card.
- In a redundant configuration, an active card hardware or software failure triggers a switch to the standby card. This switch is detected within 10 ms and is completed within 50 ms.
- ADM-10G cards support jumbo frames with MTU sizes of 64 to 10,000 bytes; the maximum is 9,216.
- After receiving a link or path failure, the ADM-10G card can shut down only the downstream Gigabit Ethernet port.

Note In ADM-10G cards, the Gigabit Ethernet port does not support flow control.

8.12.9 Security

The ADM-10G card that an SFP or XFP is plugged into implements the Cisco Standard Security Code Check Algorithm that keys on vendor ID and serial number.

If a PPM is plugged into a port on the card but fails the security code check because it is not a Cisco PPM, a minor NON-CISCO-PPM alarm is raised.

If a PPM with a nonqualified product ID is plugged into a port on this card—that is, the PPM passes the security code as a Cisco PPM but it has not been qualified for use on the ADM-10G card, a minor UNQUAL-PPM alarm is raised.

8.12.10 Protection

The ADM-10G card supports 1+1 and SONET path protection and SDH SNCP protection architectures in compliance with Telcordia GR-253-CORE, Telcordia GR-1400-CORE, and ITU-T G.841 specifications.

8.12.10.1 Circuit Protection Schemes

The ADM-10G card supports path protection/SNCP circuits at the STS/VC4 (high order) level and can be configured to switch based on signal degrade calculations.

The card allows open-ended path protection/SNCP configurations incorporating other vendor equipment. In an open-ended path protection/SNCP, you can specify one source point and two possible end points (or two possible source points and one endpoint) and the legs can include other vendor equipment. The source and endpoints are part of the network discovered by CTC.

For detailed information about path protection configurations, SNCPs, and PPMNs, refer to the *Cisco ONS 15454 Reference Manual*.

8.12.10.2 Port Protection Schemes

For 1+1 optical client port protection, you can configure the system to use any pair of like facility interfaces that are collocated on the same ADM-10G card or on different cards. The 1+1 protection scheme can also work in a unidirectional (unprotected) way or a bidirectional (protected) way. The client port 1-16 can support 1+1 protection scheme when equipped with an OC-N card. The ADM-10G uses the same protection scheme as the OC-N card. For information on optical card protection, refer to Chap 7, Card Protection of the *Cisco ONS 15454 Reference Manual*.

8.12.11 ADM-10G Card-Level Indicators

Table 8-37 describes the card-level LEDs on the ADM-10G card.

Table 8-37 ADM-10G Card-Level Indicators

Card-Level LED	Description
ACT LED Green (Active) Amber (Standby)	Green indicates that the card is operational (one or both ports active) and ready to carry traffic. Amber indicates that the card is operational and in standby (protect) mode.
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. It the card is inserted in a slot that is preprovisioned for a different card, this LED flashes until a Missing Equipment Attribute (MEA) condition is raised. You might also need to replace the card if the red FAIL LED persists.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BER errors 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.

8.12.12 ADM-10G Card Port-Level Indicators

Table 8-38 describes the port-level LEDs on the ADM-10G card.

Note Client or trunk ports can each be in active or standby mode as defined in the related section for each specific protection type. For example, fiber-switched protection has active or standby trunk ports; 1+1 APS protection has active or standby client ports, and client 1+1 protection does not utilize active or standby ports.

Table 8-38 ADM-10G Card Port-Level LED Indications

Port-Level Status	Tri-color LED Description
The port-level LED is active and unprotected.	• If a port is in OOS/locked state for any reason, the LED is turned off. • If a port is in IS/unlocked state and the PPM is preprovisioned or is physically equipped with no alarms, the LED is green. • If a port is in IS state and the PPM is physically equipped but does have alarms, the LED is red.
The port-level LED is in standby.	• If a port is in OOS/locked state for any reason, the LED is turned off. • If a port is in the IS/unlocked state and the PPM is preprovisioned or is physically equipped with no alarms, the LED is amber. • If a port is in IS state and physically equipped but does have alarms, the LED is red.

8.13 Y-Cable and Splitter Protection

Y-cable and splitter protection are two main forms of card protection that are available for TXP and MXP cards, and for the GE_XP and 10GE_XP cards when they provisioned in TXP or MXP mode. Y-cable protection is provided at the client port level. Splitter protection is provided at the trunk port level.

Note GE_XP and 10GE_XP use VLAN protection when they are provisioned in Layer 2 over DWDM mode. For information, see the "8.11.8 Layer 2 Over DWDM Protection" section on page 8-65. The ADM-10G card uses path protection and 1+1 protection. For more information, see the "8.12.10 Protection" section on page 8-73.

8.13.1 Y-Cable Protection

Y-cable protection is available for the following ONS 15454 TXP, MXP, GE_XP, and 10GE_XP cards:

- TXP_MR_10G
- TXP_MR_10E
- TXP_MR_2.5G
- MXP_2.5G_10G
- MXP_2.5G_10E
- MXP_2.5G_10E_C
- MXP_2.5G_10E_L
- MXP_MR_2.5G
- MXP_MR_10DME_C
- MXP_MR_10DME_L
- GE_XP (when in 10GE or 20GE MXP card mode)
- 10GE_XP (when in 10GE TXP card mode)

To create Y-cable protection, you create a Y-cable protection group for two TXP, MXP, GE_XP or 10GE_XP 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, MXP, GE_XP or 10GE_XP cards. The two TX signals from the client side of the TXP, MXP, GE_XP or 10GE_XP 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.

When an MXP_MR_2.5G, MXP_MR_10DME_C, or MXP_MR_10DME_L card provisioned with Y-cable protection is used on a storage ISL link (FC1G, FC2G, FC4G, FICON1G, FICON2G, or FICON4G), a protection switchover resets the standby port to active. This reset reinitializes the end-to-end link to avoid any link degradation caused due to loss of buffer credits during switchover. This results in an end-to-end traffic hit of 15 to 20 seconds.

Use the TXP_MR_2.5G card to avoid the 15 to 20 second traffic hit. When a Y-cable protection switchover occurs, the storage ISL link does not reinitialize and results in an end-to-end traffic hit of less than 50ms.

Note Y cable connectors will not work with copper SFPs as Y cable is made up of optical connectors and their is no way to physically connect this to a copper SFP.

Note There is a traffic hit of upto a couple hundred milliseconds on the MXP_MR_2.5G and MXP_MR_10DME cards in Y-cable configuration when a fiber cut or SFP failure occurs on one of the client ports.

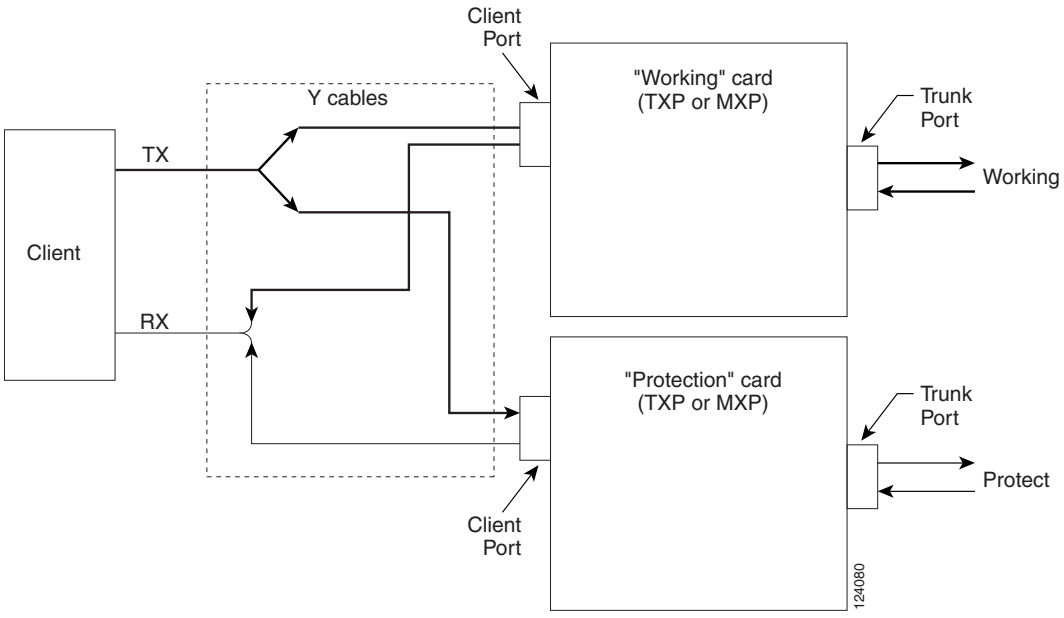
Note If you create a GCC on either card of the protect group, the trunk port stays permanently active, regardless of the switch state. When you provision a GCC, you are provisioning unprotected overhead bytes. The GCC is not protected by the protect group.

Figure 8-29 shows the Y-cable signal flow.

Note Loss of Signal–Payload (LOS-P) alarms, also called Incoming Payload Signal Absent alarms, can occur on a split signal if the ports are not in a Y-cable protection group.

Note Removing an SFP from the client ports of a Y-cable protection group card causes an IMPROPRMVL (PPM) alarm. The working port raises the CR,IMPROPRMVL,SA alarm and the protected port raises the MN,IMPROPRMVL,NSA alarm. The severity on the client ports is changed according to the protection switch state.

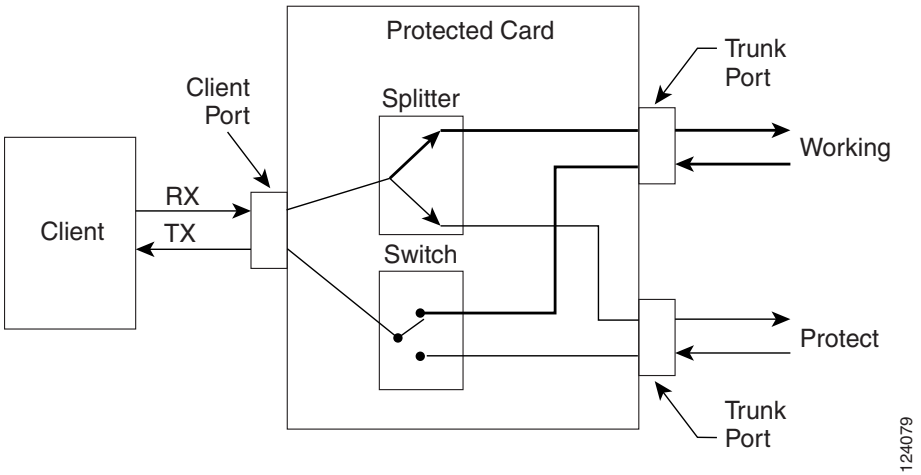
Figure 8-29 Y-Cable Protection



8.13.2 Splitter Protection

Splitter protection, shown in Figure 8-30, is provided with TXPP and MXPP cards. To implement splitter protection, a client injects a single signal into the client RX port. An optical splitter internal to the card then splits the signal into two separate signals and routes them to the two trunk TX ports. The two signals are transmitted over diverse optical paths. The far-end MXPP or TXPP card uses an optical switch to choose one of the two trunk RX port signals and injects it into the TX client port. When using splitter protection with two MXPP or TXPP cards, there are two different optical signals that flow over diverse paths in each direction. In case of failure. the far-end switch must choose the appropriate signal using its built-in optical switch. The triggers for a protection switch are LOS, LOF, SF, or SD.

Figure 8-30 Splitter Protection



8.14 Far-End Laser Control

The 15454 DWDM cards provide a transparent mode that accurately conveys the client input signal to the far-end client output signal. The client signal is normally carried as payload over the DWDM signals. Certain client signals, however, cannot be conveyed as payload. In particular, client LOS or LOF cannot be carried. Far-end laser control (FELC) is the ability to convey an LOS or LOF from the near-end client input to the far-end client output.

If an LOS is detected on the near-end client input, the near-end trunk sets the appropriate bytes in the OTN overhead of the DWDM line. These bytes are received by the far-end trunk, and cause the far-end client laser to be turned off. When the laser is turned off, it is said to be squelched. If the near-end LOS clears, the near-end trunk clears the appropriate bytes in the OTN overhead, the far-end detects the changed bytes, and the far-end client squelch is removed.

FELC also covers the situation in which the trunk port detects that it has an invalid signal; the client is squelched so as not to propagate the invalid signal.

Payload types with the 2R mode preclude the use of OTN overhead bytes. In 2R mode, an LOS on the client port causes the trunk laser to turn off. The far end detects the LOS on its trunk receiver and squelches the client.

FELC is not provisionable. It is always enabled when the DWDM card is in transparent termination mode. However, FELC signaling to the far-end is only possible when ITU-T G.709 is enabled on both ends of the trunk span.

8.15 Jitter Considerations

Jitter introduced by the SFPs used in the transponders and muxponders must be considered when cascading several cards. With TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, MXPP_MR_2.5G, and TXP_MR_10E cards, several transponders can be cascaded before the cumulative jitter violates the jitter specification. The recommended limit is 20 cards. With TXP_MR_10G cards, you can also cascade several cards, although the recommended limit is 12 cards. With MXP_2.5G_10G and MXP_2.5G_10E cards, any number of cards can 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.

The maximum reach between one transponder and the other must be halved if a Y cable is used. For more information on Y-cable operation, see the "8.13.1 Y-Cable Protection" section on page 8-75.

8.16 Termination Modes

Transponder and muxponder cards have various SONET and SDH termination modes that can be configured using CTC (see the "Provision Transponder and Muxponder Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*). The termination modes are summarized in Table 8-39.

Table 8-39 Termination Modes

Cards	Termination Mode	Description
All TXP and MXP cards, with the exception of the MXP_2.5G_10G card (see next section of this table)	Transparent Termination	All the bytes of the payload pass transparently through the cards.
	Section Termination	The SONET transport overhead (TOH) section bytes and the SDH regenerator section overhead (SOH) bytes are terminated. None of these SOH bytes are passed through. They are all regenerated, including the SONET TOH section DCC (SDCC) bytes and the SDH regenerator section DCC (RS-DCC) bytes. In the section termination mode, the SONET TOH line and SDH multiplex section overhead bytes are passed transparently.
	Line Termination	In line termination mode, the section and line overhead bytes for SONET and the overhead bytes for the SDH multiplex and regenerator sections are terminated. None of the overhead bytes are passed through. They are all regenerated, including the SONET SDCC and line DCC (LDCC) bytes and the SDH RS-DCC and multiplexer section DCC (MS-DCC) bytes.
MXP_2.5G_10G[1]	Transparent Termination	All client bytes pass transparently except the following: B1 is rebuilt, S1 is rewritten, A1 to A2 are regenerated, and H1 to H3 are regenerated.
	Section Termination	The SONET TOH section bytes and the SDH regenerator section overhead bytes are terminated. None of these section overhead bytes are passed through. They are all regenerated, including the SONET TOH section DCC bytes and the SDH RS-DCC bytes. In the section termination mode, the SONET TOH line and SDH multiplex section overhead bytes are passed transparently.
	Line Termination	In the line termination mode, the section and line overhead bytes for SONET and the overhead bytes for the SDH multiplex and regenerators sections are terminated. None of the overhead bytes are passed through. They are all regenerated, including the SONET SDCC and LDCC bytes and the SDH RS-DCC and MS-DCC bytes.

1. Clients operating at the OC48/STM16 rate are multiplexed into an OC192/STM64 frame before going to OTN or DWDM.

For TXP and MXP cards, adhere to the following conditions while DCC termination provisioning:

- For SDCC/RS-DCC provisioning, the card should be in the Section/RS-DCC or Line/MS-DCC termination mode.
- For LDCC/MS-DCC provisioning, the card should be in the Line/MS-DCC termination mode.

For more information on enabling termination modes, see the procedures for changing card setting in the "Provision Transponder and Muxponder Cards" chapter of the *Cisco ONS 15454 DWDM Procedure Guide*.

8.17 SFP and XFP Modules

SFPs and 10-Gbps SFPs (XFPs) are integrated fiber optic transceivers that provide high-speed serial links from a port or slot to the network. For more information on SFPs/XFPs and for a list of SFPs/XFPs supported by the transponder and muxponder cards, see the Installing the GBIC, SFP, and XFP Optics Modules in Cisco ONS Platforms.

In CTC, SFPs/XFPs are called pluggable port modules (PPMs). To provision SFPs/XFPs and change the line rate for multirate PPMs, see the *Cisco ONS 15454 DWDM Procedure Guide*.

CHAPTER 9

Node Reference

This chapter explains the ONS 15454 dense wavelength division multiplexing (DWDM) node types that are available for the ONS 15454. The DWDM node type is determined by the type of amplifier and filter cards that are installed in an ONS 15454. The chapter also explains the DWDM automatic power control (APC), reconfigurable optical add/drop multiplexing (ROADM) power equalization, span loss verification, and automatic node setup (ANS) functions.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Note In this chapter, "OPT-BST" refers to the OPT-BST, OPT-BST-E, OPT-BST-L cards, and to the OPT-AMP-L and OPT-AMP-17-C cards when they are provisioned in OPT-LINE (optical booster) mode. "OPT-PRE" refers to the OPT-PRE card and to the OPT-AMP-L and OPT-AMP-17-C cards provisioned in OPT-PRE (pre-amplifier) mode.

Chapter topics include:

- 9.1 DWDM Node Configurations, page 9-1
- 9.2 Multishelf Node, page 9-18
- 9.3 Optical Sides, page 9-21
- 9.4 Configuring Mesh DWDM Networks, page 9-30
- 9.5 DWDM Node Cabling, page 9-41
- 9.6 Automatic Node Setup, page 9-57
- 9.7 DWDM Functional View, page 9-61

9.1 DWDM Node Configurations

The ONS 15454 supports the following DWDM node configurations: hub, terminal, optical add/drop multiplexing (OADM), reconfigurable OADM (ROADM), anti-amplified spontaneous emission (anti-ASE), line amplifier, optical service channel (OSC) regeneration line, multishelf nodes, and node configurations for mesh networks. All node configurations can be provisioned with C-band or L-band cards except the OADM and anti-ASE nodes. These nodes require AD-xB-xx.x or AD-xC-xx.x cards, which are C-band only. All node configurations can be single-shelf or multishelf.

Note The Cisco TransportPlanner tool creates a plan for amplifier placement and proper node equipment.

Note To support multiple optical sides in mesh DWDM networks, east and west are no longer used to reference the left and right sides of the ONS 15454 shelf. If a network running a previous software release is upgraded to this release, west will be mapped to A and east to B. In two-sided nodes, such as a hub or ROADM node, Side A refers to Slots 1 through 6 and Side B refers to Slots 12 through 17. Terminal nodes have one side labeled "A," regardless of which slots have cards installed. For more information about configuring the ONS 15454 in mesh DWDM networks, see the "9.4 Configuring Mesh DWDM Networks" section on page 9-30.

9.1.1 Hub Node

A hub node is a single ONS 15454 node equipped with two TCC2/TCC2P cards and one of the following combinations:

- Two 32MUX-O cards and two 32DMX-O or 32DMX cards
- Two 32WSS cards and two 32DMX or 32DMX-O cards
- Two 32WSS-L cards and two 32DMX-L cards
- Two 40-WSS-C or 40-WSS-CE cards and two 40-DMX-C or 40DMX-CE cards

Note The 32WSS/32WSS-L/40-WSS-C/40-WSS-CE and 32DMX/32DMX-L/40-DMX-C/40-DMX-CE cards are normally installed in ROADM nodes, but they can also be installed in hub and terminal nodes. If the cards are installed in a hub node, the 32WSS/32WSS-L/40-WSS-C/40-WSS-CE express ports (EXP RX and EXP TX) are not cabled.

A dispersion compensation unit (DCU) can also be added, if necessary. Figure 9-1 shows a hub node configuration with 32MUX-O and 32DMX-O cards installed.

Figure 9-1 Hub Node Configuration Example with 32-Channel C-Band Cards

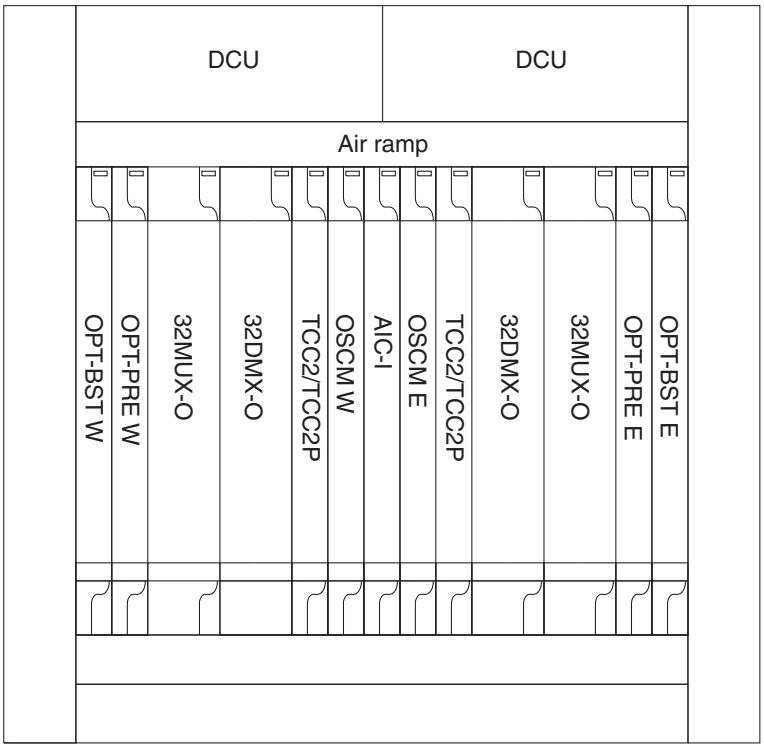


Figure 9-2 shows a 40-channel hub node configuration with 40-WSS-C cards installed.

Figure 9-2 Hub Node Configuration Example with 40-WSS-C Cards

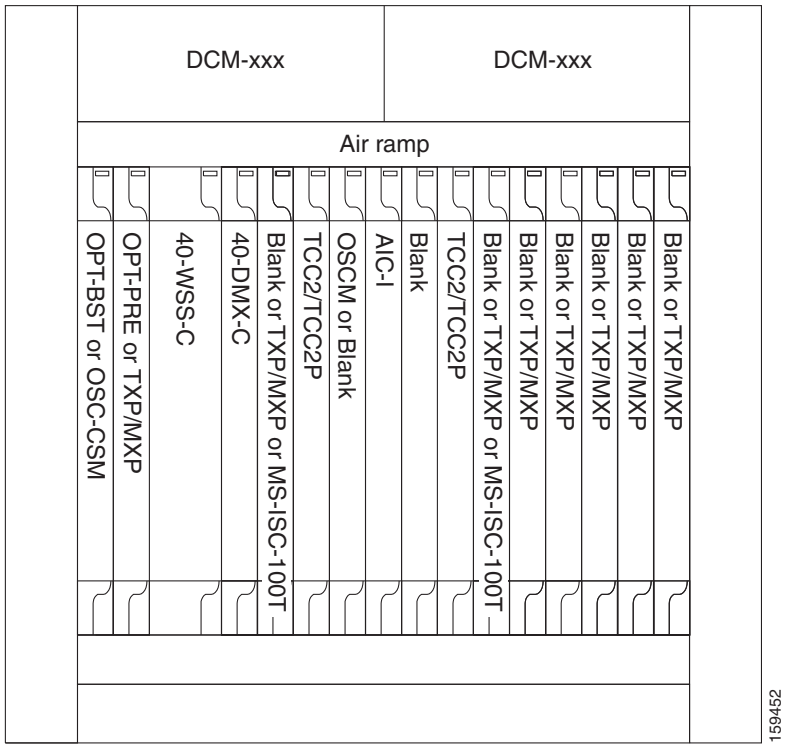
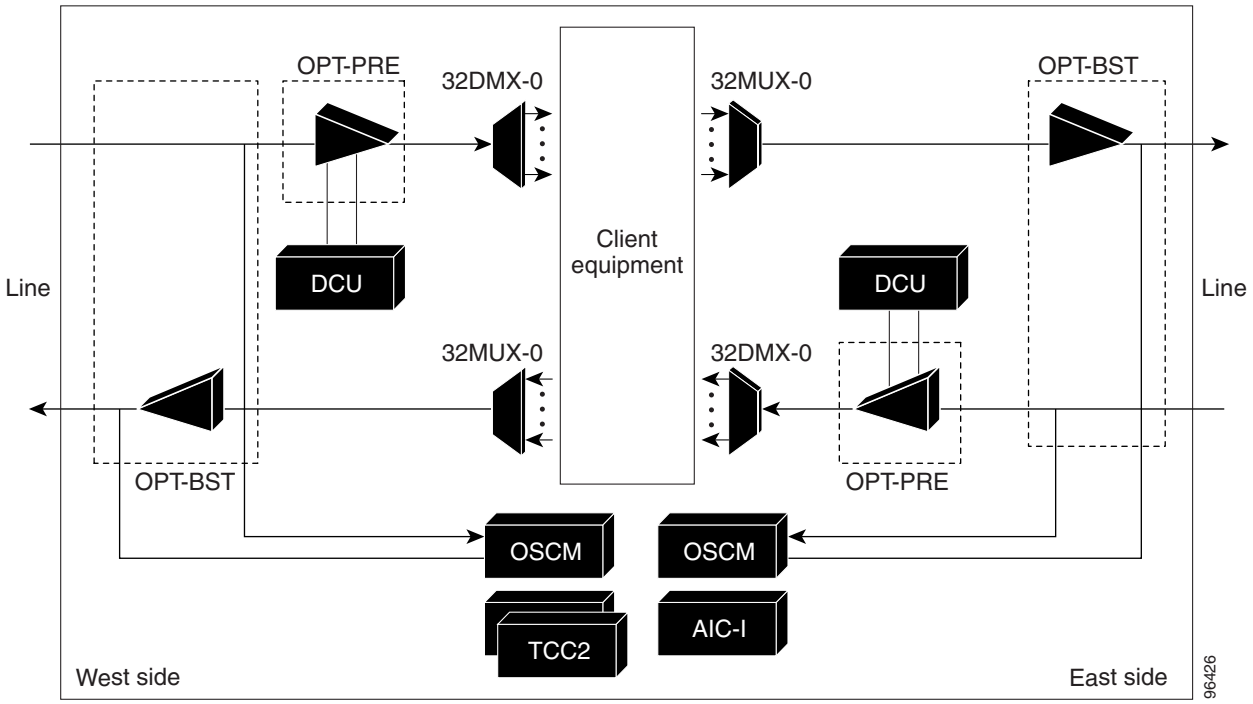


Figure 9-3 shows the channel flow for a hub node. Up to 32 channels from the client ports are multiplexed and equalized onto one fiber. Then, multiplexed channels are transmitted to the OPT-BST amplifier. The OPT-BST output is combined with an output signal from the OSCM card and transmitted to the other side.

Received signals are divided between the OSCM card and an OPT-PRE card. Dispersion compensation is applied to the signal received by the OPT-PRE amplifier, and it is then sent to the 32DMX-O card, which demultiplexes and attenuates the input signal.

Figure 9-3 Hub Node Channel Flow Example



9.1.2 Terminal Node

A terminal node is a single ONS 15454 node equipped with two TCC2/TCC2P cards and one of the following combinations:

- One 32MUX-O card and one 32DMX-O card
- One 32WSS card and either a 32DMX or a 32DMX-O card
- One 32WSS-L card and one 32DMX-L card
- One 40-WSS-C or 40-WSS-CE card and one 40-DMX-C or 40-DMX-CE card
- One 40-MUX-C and one 40-DMX-C or 40-DMX-CE card

Cards in the terminal nodes can be installed in Slots 1 through 6 or Slots 12 through 17. The side where cards are installed is always assigned as Side A. Figure 9-4 shows an example of a terminal configuration with a 2MUX-O card installed. The channel flow for a terminal node is the same as the hub node (Figure 9-3).

Figure 9-4 Terminal Node Configuration With 32MUX-O Cards Installed

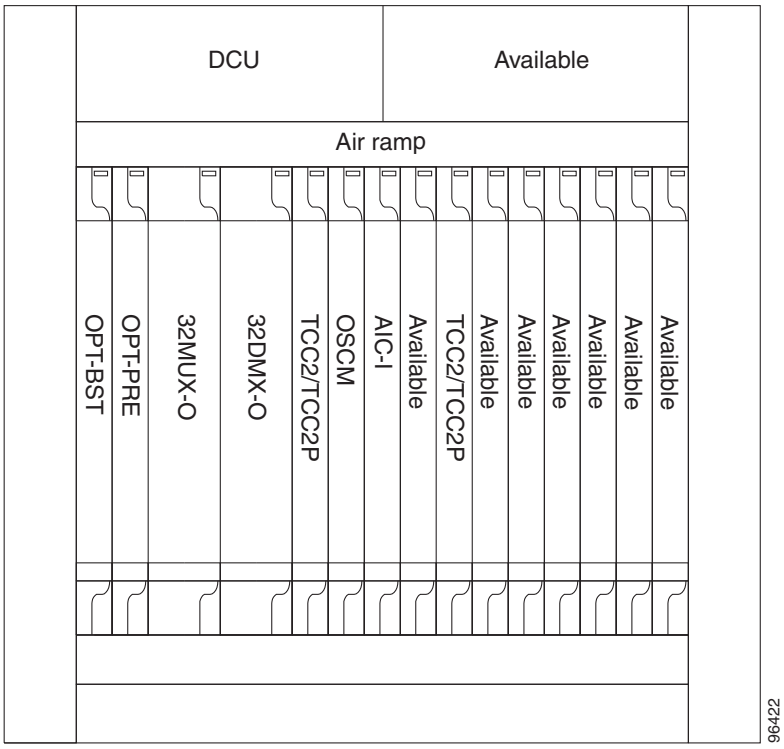


Figure 9-5 shows an example of a terminal configuration with a 40-WSS-C card installed.

Figure 9-5 Terminal Node Configuration with 40-WSS-C Cards Installed

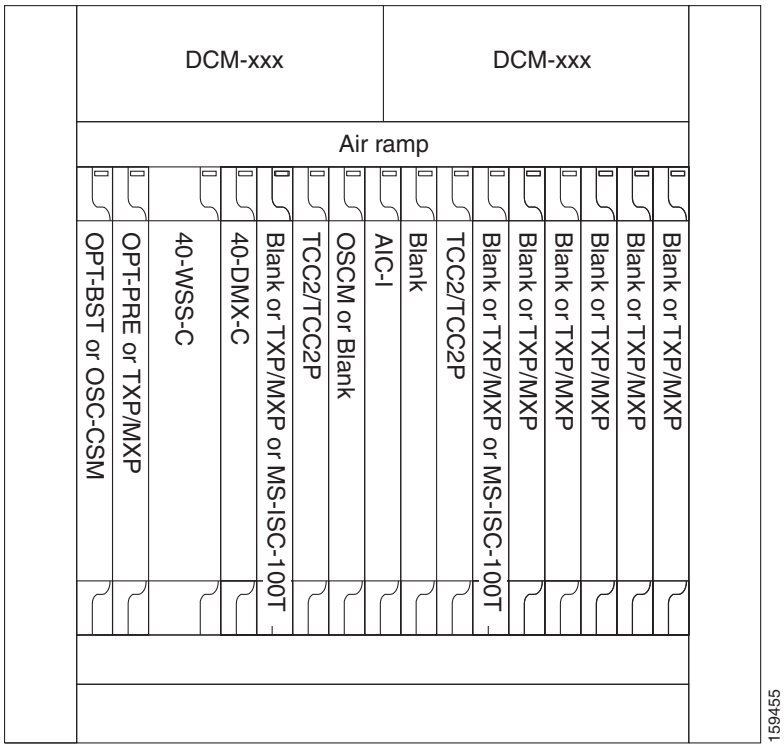
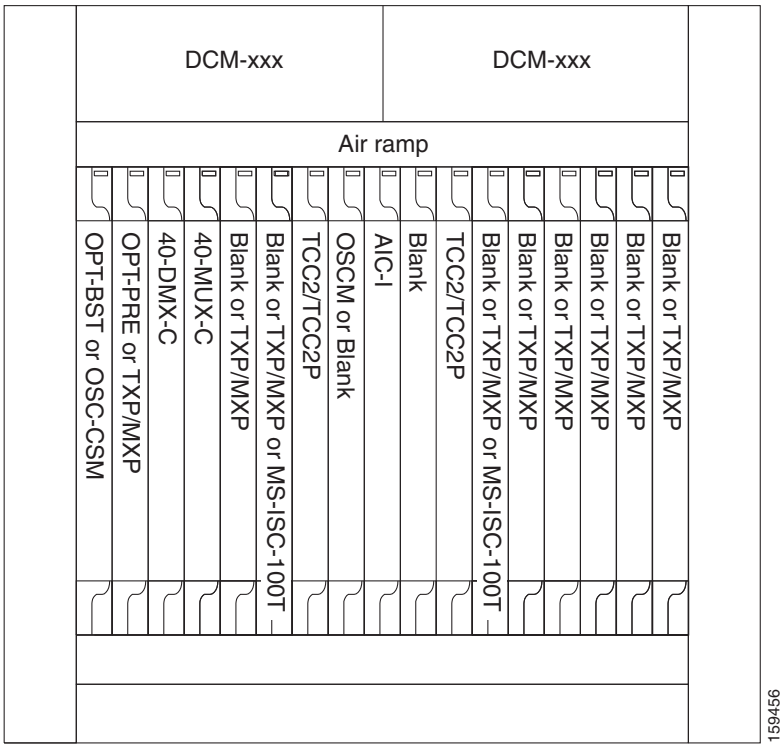


Figure 9-5 shows an example of a terminal configuration with a 40-MUX-C card installed.

Figure 9-6 Terminal Node with 40-MUX-C Cards Installed



9.1.3 OADM Node

An OADM node is a single ONS 15454 node equipped with cards installed on both sides and at least one AD-xC-xx.x card or one AD-xB-xx.x card and two TCC2/TCC2P cards. 32MUX-O/40-MUX-C or 32DMX-O/40-DMX-C/40-DMX-CE cards cannot be installed in an OADM node. In an OADM node, channels can be added or dropped independently from each direction and then passed through the reflected bands of all OADMs in the DWDM node (called express path). They can also be passed through one OADM card to another OADM card without using a TDM ITU-T line card (called optical pass-through) if an external patchcord is installed.

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 Cisco TransportPlanner tool or your site plan.

OADM nodes can be amplified or passive. In amplified OADMs, booster and preamplifier cards are installed on bode sides of the node. Figure 9-7 shows an example of an amplified OADM node configuration. In addition, OADM nodes can be asymmetric. Amplifiers may be installed in one side, but not the other. Or preamplifiers may be installed in one side, and a booster in the other.

Figure 9-7 Amplified OADM Node Configuration Example

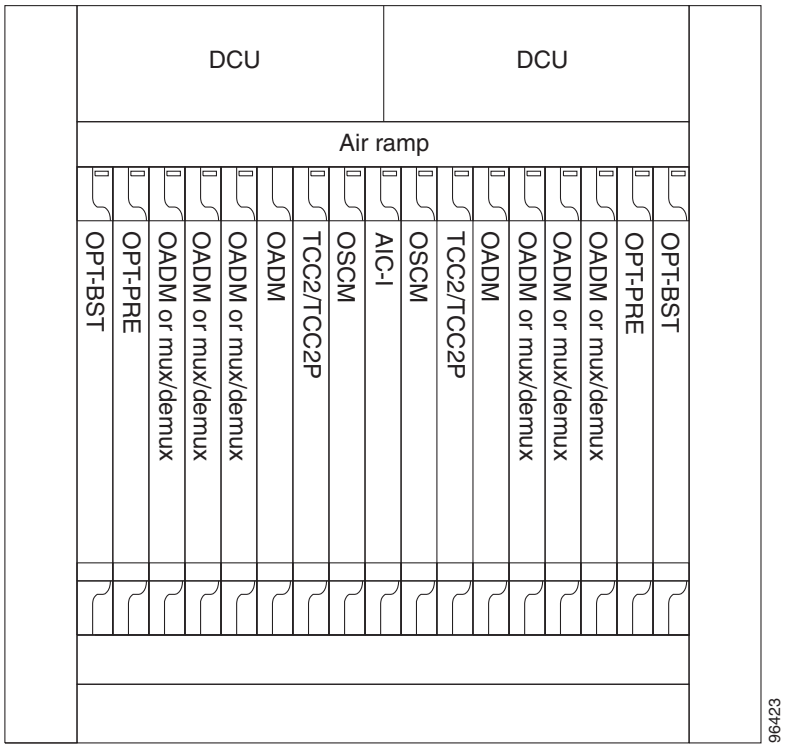


Figure 9-8 shows an example of the channel flow on the amplified OADM node. Since the 32-wavelength plan is based on eight bands (each band contains four channels), optical adding and dropping can be performed at the band level and/or at the channel level (meaning individual channels can be dropped).

Figure 9-8 Amplified OADM Node Channel Flow Example

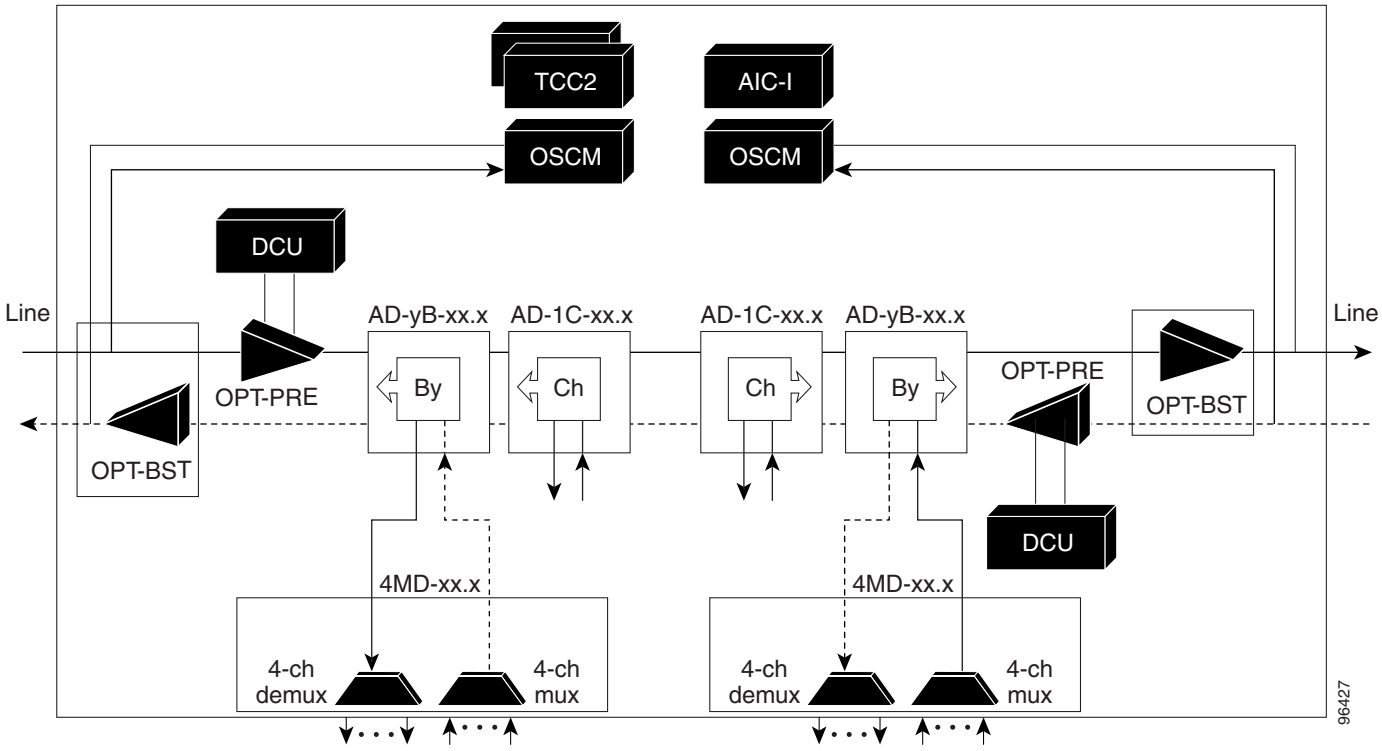


Figure 9-9 shows an example of a passive OADM node configuration. The passive OADM node is equipped with a band filter, one four-channel multiplexer/demultiplexer, and a channel filter on each side of the node.

Figure 9-9 Passive OADM Node Configuration Example

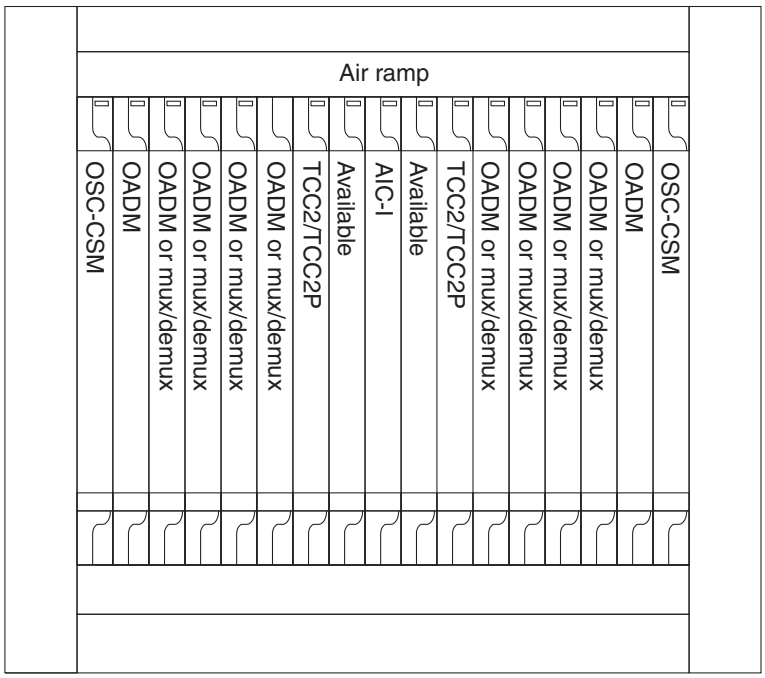
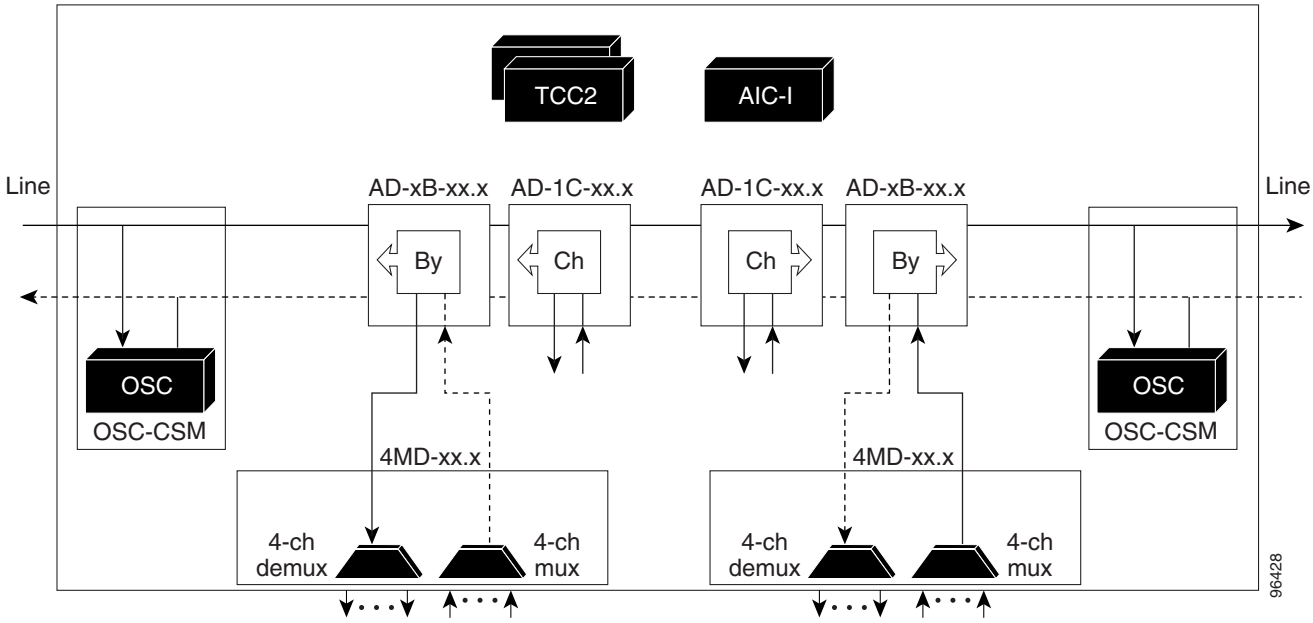


Figure 9-10 shows an example of traffic flow on the passive OADM node. The signal flow of the channels is the same as the amplified OADM, except that the OSC-CSM card is used instead of the OPT-BST and OSCM cards.

Figure 9-10 Passive OADM Node Channel Flow Example



9.1.4 ROADM Node

A ROADM node adds and drops wavelengths without changing the physical fiber connections. A ROADM node is equipped with two TCC2/TCC2P cards and one of the following combinations:

- Two 32WSS cards and, optionally, two 32DMX or 32DMX-O cards
- Two 32WSS-L cards and, optionally, two 32DMX-L cards
- Two 40-WSS-C or 40-WSS-CE cards and, optionally, two 40-DMX-C or 40-DMX-CE cards

Transponders (TXPs) and muxponders (MXPs) can be installed in Slots 6 and 12 and, if amplification is not used, in any open slot.

Note Although not required, 32DMX-O can be used in an ROADM node. Cisco TransportPlanner automatically chooses the demultiplexer card that is best for the ROADM node based on the network requirements.

Figure 9-11 shows an example of an amplified ROADM node configuration with 32DMX cards installed.

Figure 9-11 ROADM Node with 32DMX Cards Installed

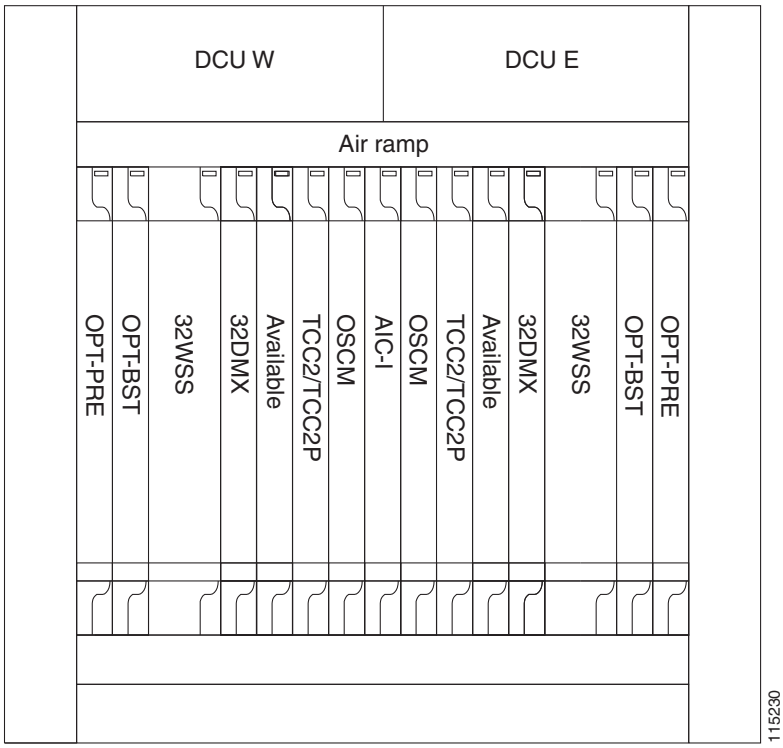


Figure 9-12 shows an example of an amplified ROADM node configuration with 40-WSS-C cards installed.

Figure 9-12 ROADM Node with 40-WSS-C Cards Installed

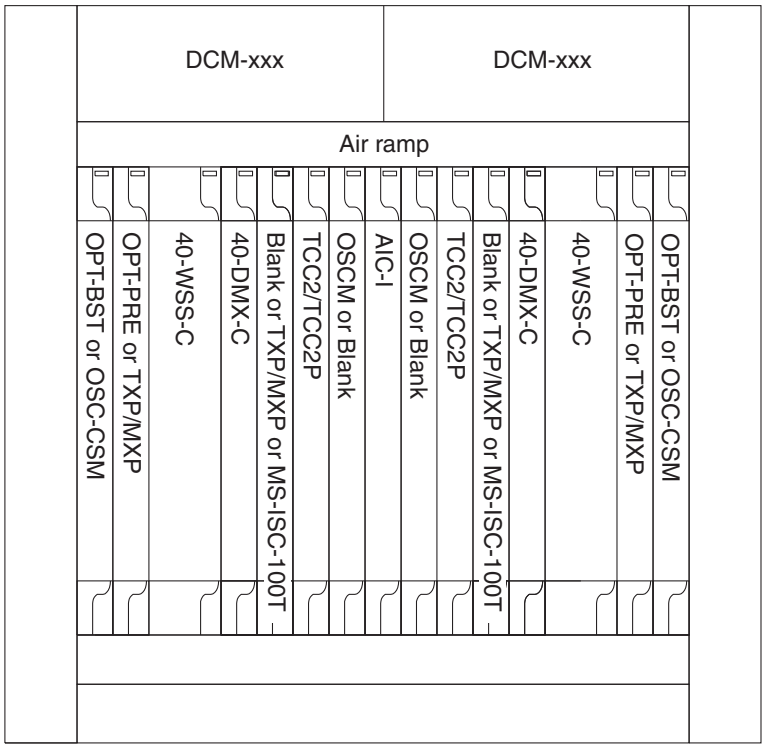


Figure 9-13 shows an example of an ROADM node with 32WSS-L and 32DMX-L cards installed.

Figure 9-13 ROADM Node with 32WSS-L and 32DMX-L Cards Installed

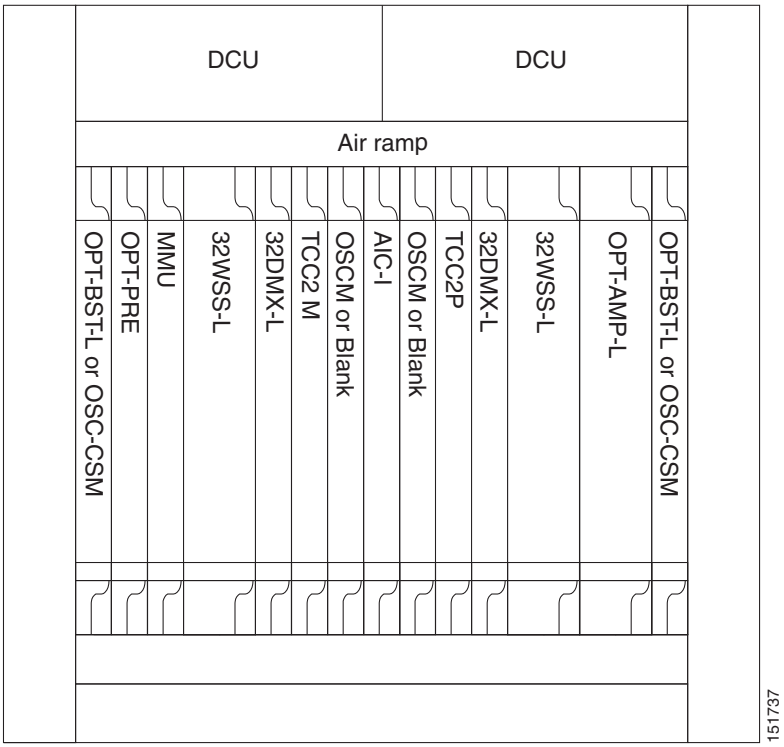
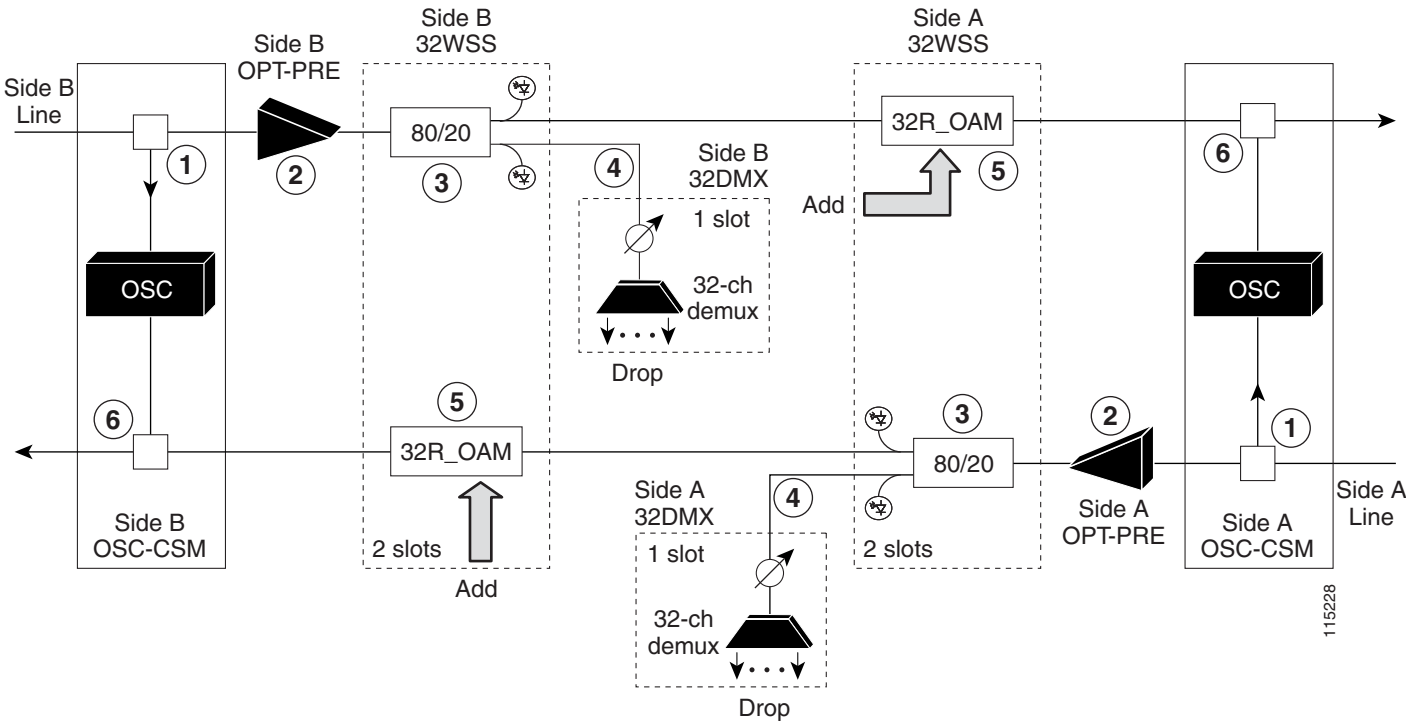


Figure 9-14 shows an example of an ROADM optical signal flow from Side A to Side B. The optical signal flow from Side B to Side A follows an identical path through the Side B OSC-CSM and 32WSS or 40-WSS-C cards. In this example, OSC-CSM cards are installed so OPT-BSTs are not needed.

Figure 9-14 ROADM Optical Signal Flow Example



1	The OSC-CSM receives the optical signal. It separates the optical service channel from the optical payload and sends the payload to the OPT-PRE module.
2	The OPT-PRE compensates for chromatic dispersion, amplifies the optical payload, and sends it to the 32WSS or 40-WSS-C/40-WSS-CE.
3	The 32WSS or 40-WSS-C/40-WSS-CE splits the signal into two components. The 80 percent component is sent to the DROP-TX port and the 20 percent component is sent to the EXP-TX port.
4	The drop component goes to the 32DMX card or 40-DMX-C/40-DMX-CE card where it is demultiplexed and dropped.
5	The express wavelength aggregate signal goes to the 32WSS or 40-WSS-C/40-WSS-CE on the other side where it is demultiplexed. Channels are stopped or forwarded based upon their switch states. Forwarded wavelengths are merged with those coming from the ADD path and sent to the OSC-CSM module.
6	The OSC-CSM combines the multiplexed payload with the OSC and sends the signal out the transmission line.

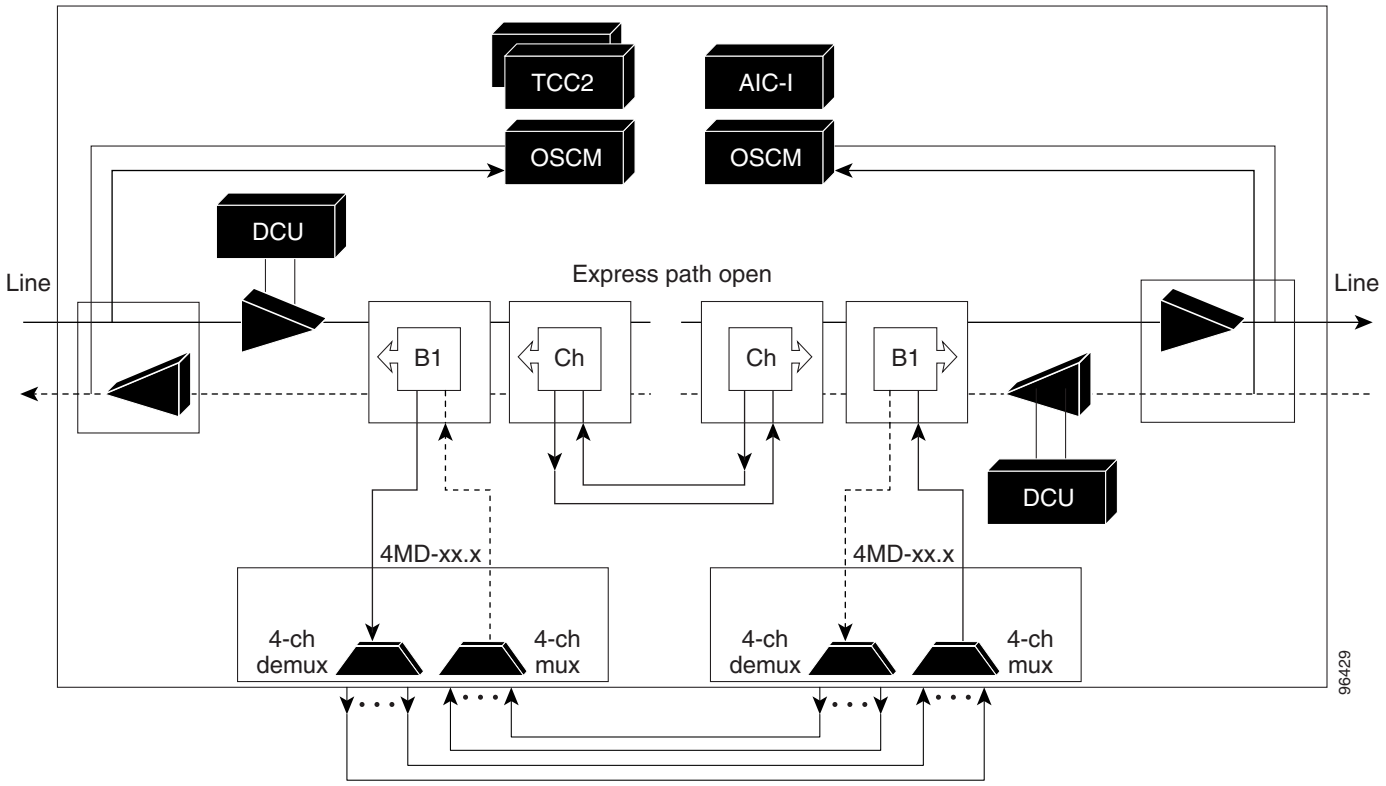
9.1.5 Anti-ASE Node

In a mesh ring network, the ONS 15454 requires a node configuration that prevents 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 9-8 on page 9-10.

Figure 9-15 shows an anti-ASE node that uses all wavelengths in the pass-through mode. Use Cisco TransportPlanner to determine the best configuration for anti-ASE nodes.

Figure 9-15 Anti-ASE Node Channel Flow Example



9.1.6 Line Amplifier Node

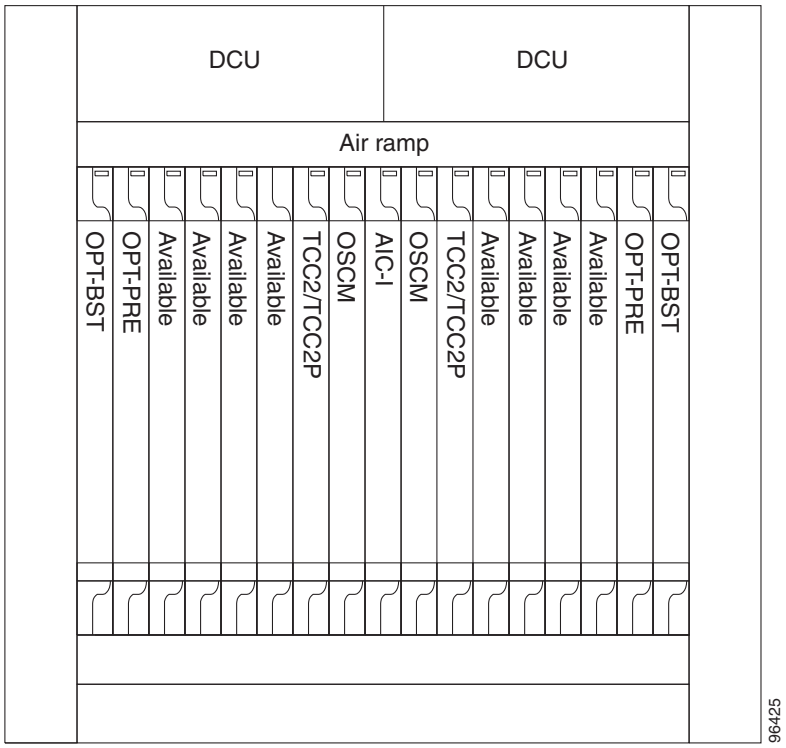
A line amplifier node is a single ONS 15454 node that is used to amplify the optical signal in long spans. The line amplifier node can be equipped with one of the following sets of cards:

- Two OPT-PRE cards, two OPT-BST cards, and two OSCM cards
- Two OPT-PRE cards and two OSC-CSM cards
- Two OPT-AMP-17-C cards and two OSCM cards

Attenuators might also be required between each preamplifier and OPT-BST amplifier to match the optical input power value and to maintain the amplifier gain tilt value.

Two OSCM cards are connected to the OPT-BST cards to multiplex the OSC signal with the pass-though channels. If the node does not contain an OPT-BST card, OSC-CSM cards must be installed instead of OSCM cards. Figure 9-16 shows an example of a line amplifier node configuration using OPT-BST, OPT-PRE, and OSCM cards.

Figure 9-16 Line Amplifier Node Configuration Example



9.1.7 OSC Regeneration Node

The OSC regeneration node is added to the DWDM networks for two purposes:

- To electrically regenerate the OSC channel whenever the span links are 37 dB or longer and payload amplification and add/drop capabilities are not present. Cisco TransportPlanner places an OSC regeneration node in spans longer than 37 dB. The span between the OSC regeneration node and the next DWDM network site cannot be longer than 31 dB.
- To add data communications network (DCN) capability wherever needed within the network.

OSC regeneration nodes require two OSC-CSM cards, as shown in Figure 9-17. The cards are installed in each side of the shelf.

Figure 9-17 OSC Regeneration Line Node Configuration Example

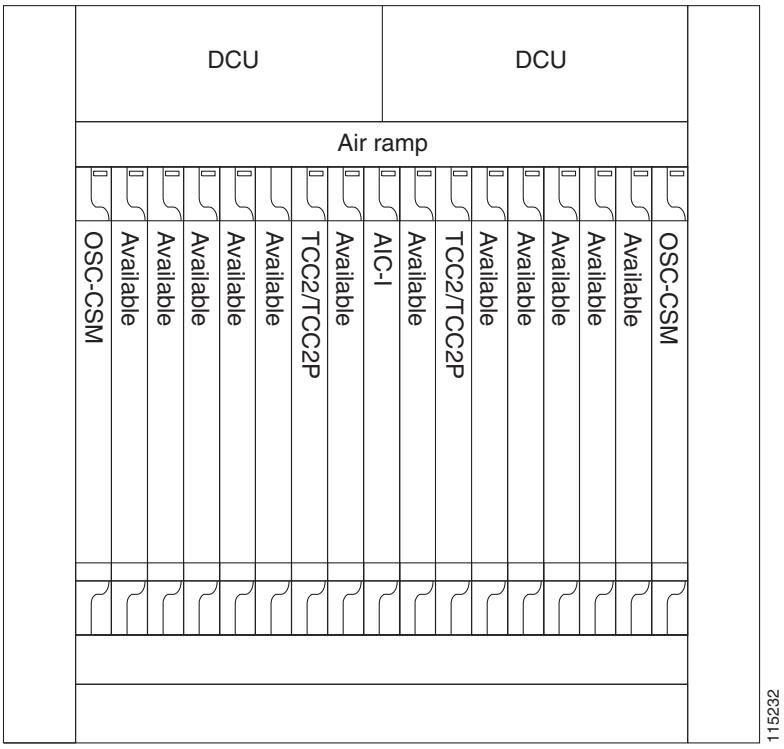
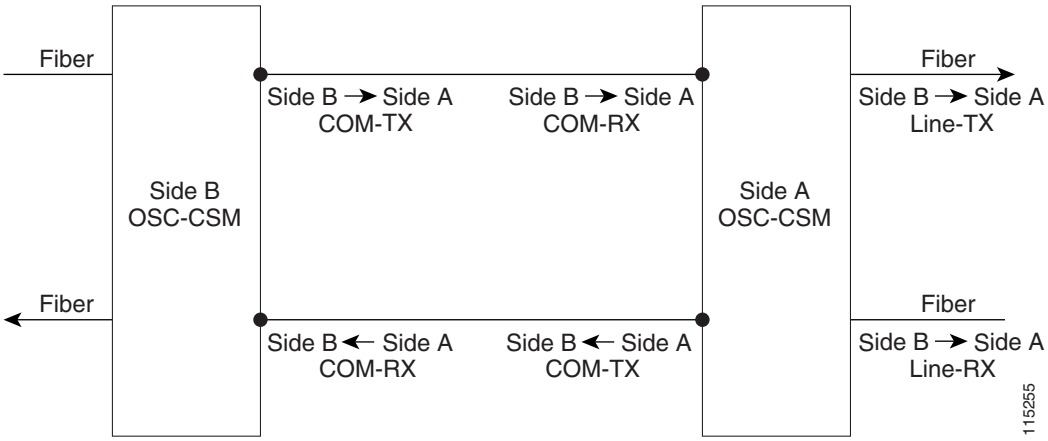


Figure 9-18 shows the OSC regeneration line node signal flow.

Figure 9-18 OSC Regeneration Line Node Flow



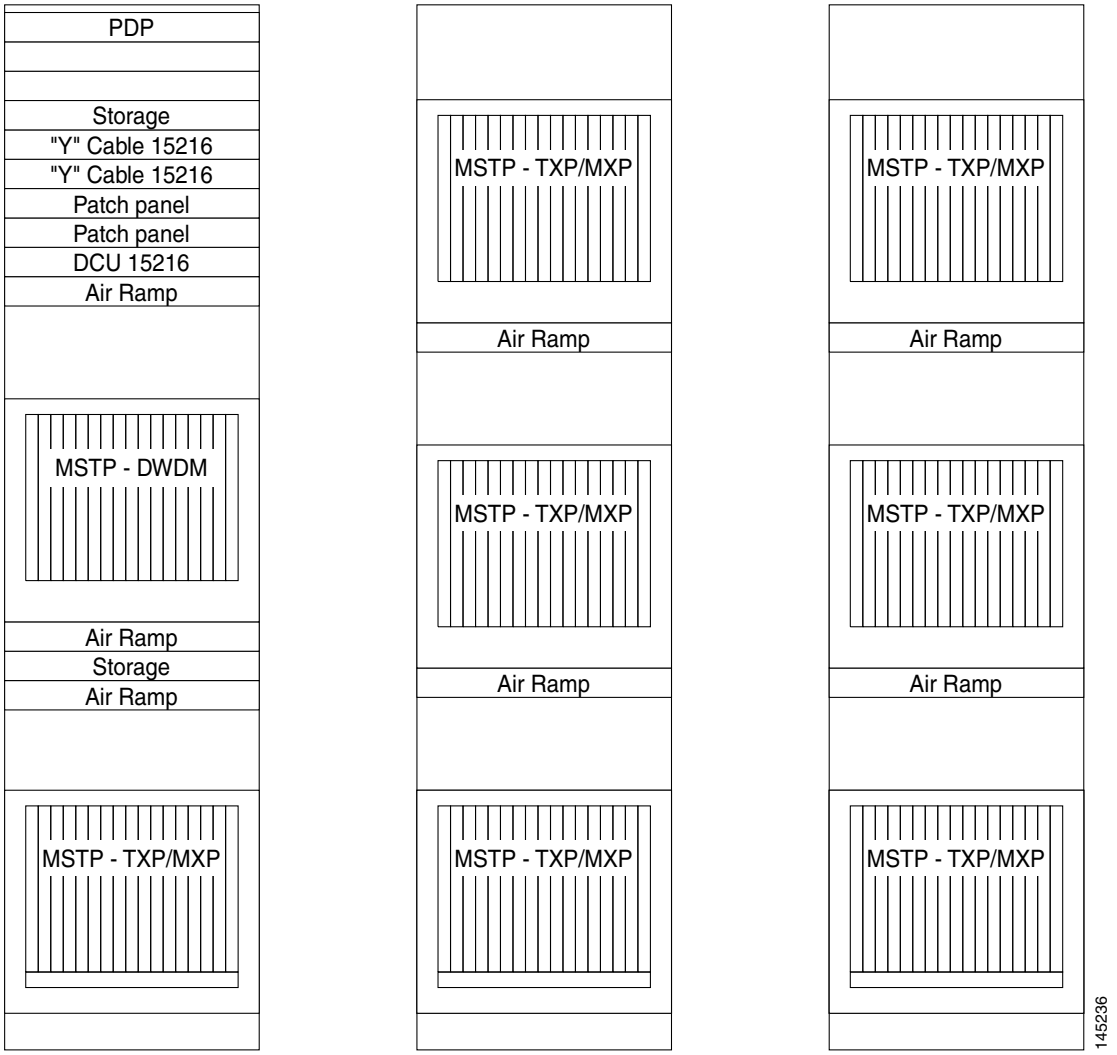
9.2 Multishelf Node

An ONS 15454 node provisioned as a multishelf node can manage up to 12 subtending shelves as a single entity.

Note The reason for extending the number of subtending shelves from eight to 12 is to accommodate and manage the new optical and DWDM cards that operate in the even band frequency grid.

The node controller is the main shelf; its TCC2/TCC2P cards run multishelf functions. Each subtending shelf must be equipped with TCC2/TCC2P cards, which run the shelf functions. For internal data exchange between the node controller shelf and subtending shelves, the node controller shelf must be equipped with redundant MS-ISC-100T cards or, as an alternative, the Catalyst 2950 switch. Cisco recommends using the MS-ISC-100T cards. If using the Catalyst 2950, it is installed on one of multishelf racks. All subtending shelves must be located in the same site at a maximum distance of 100 meters or 328 feet from the Ethernet switches used to support the communication LAN. Figure 9-19 shows an example of a multishelf node configuration.

Figure 9-19 Multishelf Node Configuration



A multishelf node has a single public IP address for all client interfaces (Cisco Transport Controller [CTC], Transaction Language One [TL1], Simple Network Management Protocol [SNMP], and HTTP); a client can only connect to the node controller shelf, not to the subtending shelves. The user interface and subtending shelves are connected to a patch panel using straight-through (CAT-5) LAN cables.

The node controller shelf has the following functions:

- IP packet routing and network topology discovery occur at the node controller level.
- Open Shortest Path First (OSPF) is centralized on the node controller shelf.

The subtending shelves have the following functions:

- Overhead circuits are not routed within a multishelf node but are managed at the subtending controller shelf only. To use overhead bytes, the AIC-I must be installed on the subtending shelf where it is terminated.
- Each subtending shelf will act as a single shelf node that can use as timing source line, TCC/TCC2P clock, or building integrated timing supply (BITS) source lines.

9.2.1 Multishelf Node Layout

Multishelf configurations are configured by Cisco TransportPlanner and are automatically discovered by the CTC software. In a typical multishelf installation, all optical units are equipped on the node controller shelf and TXP/MXP cards are equipped in the aggregated subtended shelves. In addition, all empty slots in the node controller shelf can be equipped with TXP/MXP cards. In a DWDM mesh network, up to eight optical sides can be configured with client and optical cards installed in different shelves to support mesh and ring-protected signal output.

Note When a DWDM ring or network has to be managed through a Telcordia operations support system (OSS), every node in the network must be set up as multi-shelf. OLA sites and nodes with one shelf must be set up as "multi-shelf stand-alone" to avoid the use of LAN switches.

9.2.2 DCC/GCC/OSC Terminations

A multishelf node provides the same communication channels as a single-shelf node:

- OSC links terminate on OSCM/OSC-CSM cards. Two links are required between each ONS 15454 node. An OSC link between two nodes cannot be substituted by an equivalent generic communications channel/data communications channel (GCC/DCC) link terminated on the same pair of nodes. OSC links are mandatory and they can be used to connect a node to a gateway network element (GNE).
- GCC/DCC links terminate on TXP/MXP cards.

The maximum number of DCC/GCC/OSC terminations that are supported in a multishelf node is 48.

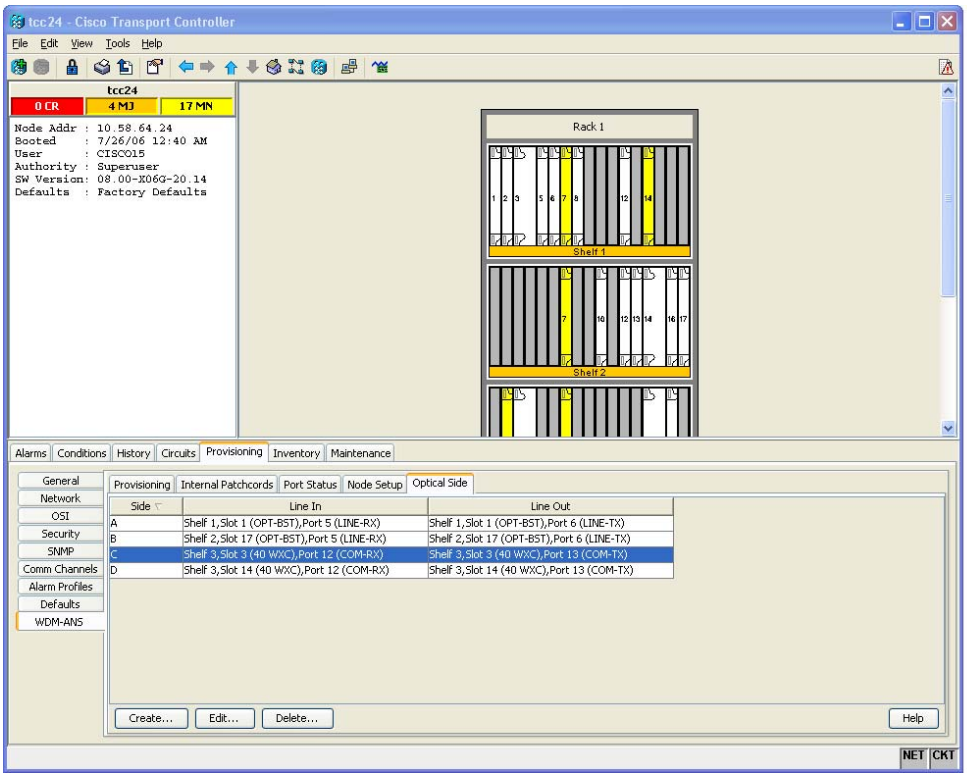
9.3 Optical Sides

From a topological point of view, all DWDM units equipped in an MSTP node belongs to a side. A side can be identified by a letter (A, B, C, D, E, F, G, or H), or by the ports (called as side line ports, see 9.3.2 Side line ports, page 9-25) that are physically connected to the spans. An MSTP node can be connected to a maximum of 8 different spans. Each side identifies one of the span the MSTP node is connected to.

Note Side A and Side B replace “west” and “east” when referring to the two sides of the ONS 15454 shelf. Side A refers to Slots 1 through 6 (formerly “west”), and Side B refers to Slots 12 through 17 (formerly “east”). The line direction port parameter, East-to-West and West-to-East, has been removed.

Sides are viewed and managed from the Provisioning > WDM-ANS > Optical Sides tab in CTC, shown in Figure 9-20.

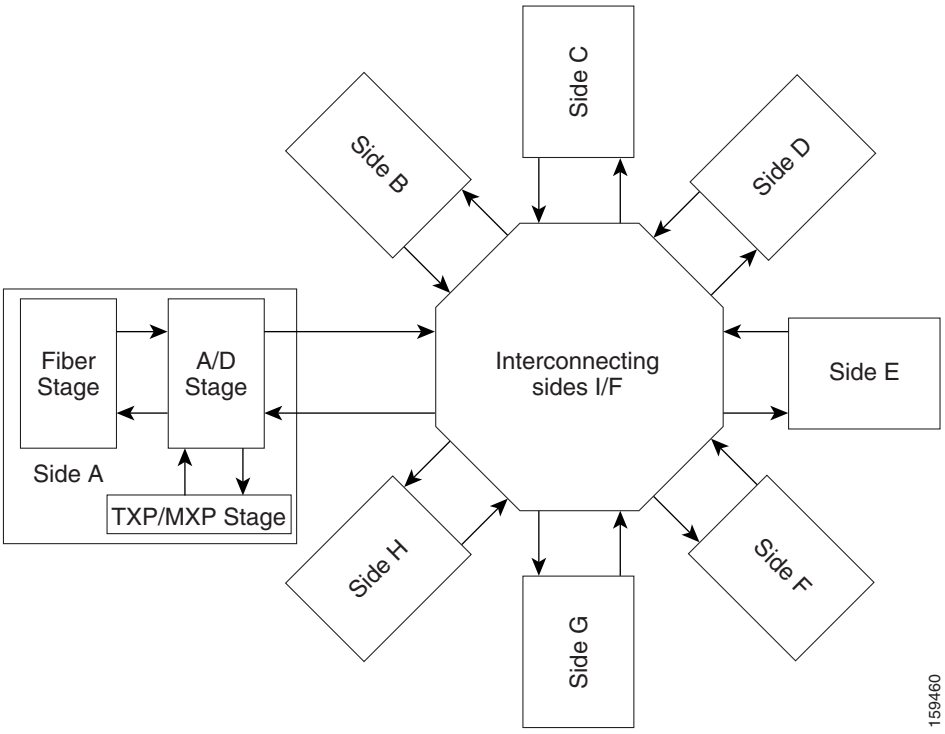
Figure 9-20 Optical Side Tab



9.3.1 Optical Side Stages

All MSTP nodes can be modelled according to Figure 9-21.

Figure 9-21 Interconnecting Sides Conceptual View



According to Figure 9-21, each MSTP node side includes DWDM units that can be conceptually divided into three stages.

- Fiber stage—The set of DWDM cards with ports that directly or indirectly face the span.
- A/D stage—The add/drop stage.
- TXP/MXP stage—The virtual grouping of all TXP or MXP cards with signals multiplexed or demultiplexed to and from the physical fiber stage.

9.3.1.1 Fiber Stage

The fiber stage includes DWDM cards that are used to amplify transmitted or received signal and cards that are used to add optical supervision channel. The fiber stage cards are:

- Booster amplifier cards that directly connect to the span, such as:
  - OPT-BST
  - OPT-BST-E
  - OPT-BST-L
  - OPT-AMP-C, when provisioned in OPT-LINE (booster amplifier) mode
  - OPT-AMP-L, when provisioned in OPT-LINE (booster amplifier) mode
  - OPT-AMP-17-C, when provisioned in OPT-LINE (booster amplifier) mode
- Preamplifier cards, such as:
  - OPT-PRE
  - OPT-AMP-C, when provisioned in OPT-PRE (preamplifier) mode

  - OPT-AMP-L, when provisioned in OPT-PRE (preamplifier) mode
  - OPT-AMP-17-C, when provisioned in OPT-PRE (preamplifier) mode
- OSC cards, such as:
  - OSCM
  - OSC-CSM

Table 9-1 shows the commonly deployed fiber stage layouts supported by DWDM mesh nodes. In the table, OPT-BST includes the OPT-BST, OPT-BST-E, and OPT-BST-L cards. OPT-AMP includes the OPT-AMP-L and OPT-AMP-17-C cards configured in either OPT-PRE or OPT-LINE mode.

Note In the table, L and C suffix is not reported because C-band and L-band amplifiers cannot be mixed in the same layout.

Table 9-1 Supported Fiber Stage Configurations

Layout	Cards	Configurations
A	OPT-BST <-> OPT-PRE/OPT-AMP (OPT-PRE mode)	• OPT-BST OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-BST LINE ports connected to the span • OPT-BST COM-TX ports connected to OPT-AMP (OPT-PRE mode) or OPT-PRE COM-RX ports • OPT-AMP (OPT-PRE mode) or OPT-PRE LINE-TX or COM-TX ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-RX port in a ROADM node) • OPT-BST COM-RX ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)
B	OPT-AMP (OPT-BST mode) <-> OPT-PRE/OPT-AMP (OPT-PRE mode)	• OPT-AMP (BST) OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-AMP (BST) LINE ports connected to the span • OPT-AMP (BST) COM-TX ports connected to OPT-AMP (PRE)/OPT-PRE COM-RX ports • OPT-AMP (PRE)/OPT-PRE LINE-TX/COM-TX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-RX port in a ROADM node) • OPT-AMP (BST) COM-RX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)

Table 9-1 Supported Fiber Stage Configurations (continued)

Layout	Cards	Configurations
C	OSC-CSM <-> OPT-PRE/OPT-AMP(OPT-PRE mode)	• OSC-CSM LINE ports connected to the span • OSC-CSM COM-TX ports connected to OPT-AMP COM-RX ports • OPT-AMP(PRE)/OPT-PRE LINE-TX/COM-TX port connected to the next stage (for example, 40-WSS-C/40-WSS-CE COM-RX ports in ROADM) • OSC-CSM COM-RX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)
D	OPT-BST	• OPT-BST OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-BST LINE ports connected to the span • OPT-BST COM ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM port in a ROADM node)
E	OPT-AMP (OPT-BST mode)	• OPT-AMP OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-AMP LINE ports connected to the span • OPT-AMP COM ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM port in a ROADM node)
F	OSC-CSM	• OSC-CSM LINE ports connected to the span • OSC-CSM COM ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM port in a ROADM node)

9.3.1.2 A/D Stage

The A/D stage includes DWDM cards that can add and drop traffic. The A/D stage is divided into three node types:

- Mesh nodes—ONS 15454 nodes configured in multishelf mode can connect to eight different sides. For more detail on mesh node, see 9.4 Configuring Mesh DWDM Networks, page 9-30.
- Legacy—Half of a ROADM node or an OADM node with cascaded AD-xB-xx-x or AD-xC-xx.x cards
- Non-A/D—A line node or a side that does not have A/D capability is included in the A/D stage

Stages are built by active cards and patchcords. However, the interconnecting sides are completed by the mesh patch panels (four-degree patch panel or eight-degree patch panel) in mesh nodes, or by patchcords connected to EXP-RX/EXP-TX ports in legacy nodes.

9.3.2 Side line ports

Side line ports are ports that are physically connected to the spans. Side line ports can be:

- All ports terminating the fiber stage and physically labeled as LINE, such as ports on the following cards:
  - Booster amplifier (OPT-BST, OPT-BST-E, or OPT-BST-L cards, and the OPT-AMP-C, OPT-AMP-L, or OPT-AMP-17-C cards when provisioned in OPT-LINE mode)
  - OSC-CSM
- All ports that can be physically connected to the external span using DCN terminations, such as:
  - Booster amplifier LINE-RX and LINE-TX ports
  - OSC-CSM LINE-RX and LINE-TX ports
  - 40-WXC-C COM-RX and COM-TX ports
  - MMU EXP-A-RX and EXP-A-TX ports
- All ports that can be physically connected to the external span using DCN terminations in a line node, such as:
  - Preamplifier (OPT-PRE card and the OPT-AMP-C, OPT-AMP-L, or OPT-AMP-17-C cards when provisioned in OPT-PRE mode) COM-RX and COM-TX ports
  - Booster amplifier COM-TX port
  - OSC-CSM COM-TX port
- All ports that can be physically connected to the external span using DCN terminations in a 40-channel MUX/DMX terminal node, such as:
  - 40-MUX-C COM-TX port
  - 40-DMX-C COM-RX port

9.3.3 Optical Side Configurations

You can use the following Side IDs depending on the type of node layout:

- In legacy nodes (that is, a node with no provisioned or installed 40-WXC-C cards), the permissible Side IDs are A and B only.
- In four-degree mesh nodes with four or less 40-WXC-C cards installed, the permissible Side IDs are A, B, C, and D.
- In eight-degree mesh nodes, with eight or less 40-WXC-C cards installed, the allowed Side IDs are A, B, C, D, E, F, G, and H.

Side IDs are assigned automatically by the system when you create default internal patchcords in CTC or when you import the CTP XML configuration file into CTC. You can create a side manually using CTC or TL1 if the following conditions are met:

- You use a permissible side identifier, A through H.
- The shelf contains a TX and an RX side line port (see "9.3.2 Side line ports" section on page 9-25).
- The side line ports are not connected to an internal patchcord.

Note Cisco does not recommend that you manually create or modify ONS 15454 sides.

The following tables show examples of how Side IDs are automatically assigned by the system for common DWDM layouts.

Table 9-2 shows a standard ROADM shelf with Sides A and B provisioned. The shelf is connected to seven shelves containing TXP, MXP, ADM-10G, GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

Table 9-2 Multishelf ROADM Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WSS+DMX	A	WSS+DMX	B
2	TXP/MXP	—	TXP/MXP	—
3	TXP/MXP	—	TXP/MXP	—
4	TXP/MXP	—	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 9-3 shows a protected ROADM shelf. In this example, Side A and B are Slots 1 through 6 in Shelves 1 and 2. 40-WSS-C/40-WSS-CE/40-DMX-C or 40-WSS-CE/40-DMX-CE cards are installed in Sides A and B. Slots 12 through 17 in Shelves 1 and 2 contain TXP, MXP, ADM-10G, GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards.

Table 9-3 Multishelf Protected ROADM Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WSS+DMX	A	TXP/MXP	—
2	WSS+DMX	B	TXP/MXP	—
3	TXP/MXP	n/a	TXP/MXP	—
4	TXP/MXP	n/a	TXP/MXP	—
5	TXP/MXP	n/a	TXP/MXP	—
6	TXP/MXP	n/a	TXP/MXP	—
7	TXP/MXP	n/a	TXP/MXP	—
8	TXP/MXP	n/a	TXP/MXP	—

Table 9-4 shows a four-degree mesh node. Side A is Shelf 1, Slots 1 through 6. Side B and C are Shelf 2, Slots 1 through 6 and 12 through 17, and Side D is Shelf 3, Slots 1 through 6. 40-WXC-C cards in line termination mode are installed in Sides A through D.

Table 9-4 Multishelf Four-Degree Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	WXC Line Termination	C

Table 9-4 Multishelf Four-Degree Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
3	WXC Line Termination	D	TXP/MXP	—
4	TXP/MXP	n/a	TXP/MXP	—
5	TXP/MXP	n/a	TXP/MXP	—
6	TXP/MXP	n/a	TXP/MXP	—
7	TXP/MXP	n/a	TXP/MXP	—
8	TXP/MXP	n/a	TXP/MXP	—

Table 9-5 shows a protected four-degree mesh node example. In the example, Sides A through D are assigned to Slots 1 through 6 in Shelves 1 through 4.

Table 9-5 Multishelf Four-Degree Protected Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—
4	WXC Line Termination	D	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 9-6 shows a protected four-degree mesh node example. In the example, Sides A through D are assigned to Slots 1 through 4 in Shelves 1 through 4, and TXP, MXP, ADM-10G, GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards are installed in Shelves 1 through 4, Slots 12-17, and Shelves 5 through 8, Slots 1 through 6 and 12 through 17.

Table 9-6 Multishelf Four-Degree Protected Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—

Table 9-6 Multishelf Four-Degree Protected Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
4	WXC Line Termination	D	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 9-7 shows a four-degree mesh node provisioned as an upgrade. In the example, Sides A through D are assigned to Slots 1 through 4. and 12 through 17 in Shelves 1and 2. 40-WXC-C cards in XC termination mode are installed in Sides A and B, and 40-WXC-C cards in line termination mode are installed in Sides C and D.

Table 9-7 Multishelf Four-Degree Mesh Node Upgrade Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC XC Termination	A	WXC XC Termination	B
2	WXC Line Termination	C	WXC Line Termination	D
3	TXP/MXP	—	TXP/MXP	—
4	TXP/MXP	—	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 9-8 shows an eight-degree mesh node. In the example, Sides A through H are assigned to Slots 1 through 6 in Shelf 1, Slots 1 through 6 and 12 through 17 in Shelves 2 through 4, and Slots 1 through 6 in Shelf 5. 40-WXC-C cards in line termination mode are installed in Sides A through H.

Table 9-8 Multishelf Eight-Degree Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	WXC Line Termination	C
3	WXC Line Termination	D	WXC Line Termination	E
4	WXC Line Termination	F	WXC Line Termination	G

Table 9-8 Multishelf Eight-Degree Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
5	WXC Line Termination	H	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 9-9 shows another eight-degree mesh node. In the example, Sides A through H are assigned to Slots 1 through 6 in all shelves (Shelves 1 through 8). 40-WXC-C cards in line termination mode are installed in Sides A through H.

Table 9-9 Multishelf Four-Degree Mesh Node Upgrade Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—
4	WXC Line Termination	D	TXP/MXP	—
5	WXC Line Termination	E	TXP/MXP	—
6	WXC Line Termination	F	TXP/MXP	—
7	WXC Line Termination	G	TXP/MXP	—
8	WXC Line Termination	H	TXP/MXP	—

Table 9-10 shows a four-degree mesh node with a user-defined side. Because the software assigns sides consecutively, and because the mesh node is four-degrees, the side assigned to Shelf 5, Slots 1 through 6 is “Unknown.”

Table 9-10 Multishelf Four-Degree Mesh Node User-Defined Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	TXP/MXP	—	WXC Line Termination	C[1]
3	WXC Line Termination	D	TXP/MXP	—

Table 9-10 Multishelf Four-Degree Mesh Node User-Defined Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
4	TXP/MXP	—	TXP/MXP	—
5	WXC Line Termination	U[2]	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

1. User-defined
2. Unknown

9.4 Configuring Mesh DWDM Networks

ONS 15454 shelves can be configured in mesh DWDM networks using the 40-WXC-C wavelength cross-connect cards, multishelf provisioning, and the 40-channel patch panel, four-degree patch panel, and eight-degree patch panels. ONS 15454 DWDM mesh configurations can be up to four degrees (four optical directions) when the four-degree patch panel patch panel is installed, and up to eight degrees (eight optical directions) when the eight-degree patch panel is installed. Two mesh node types are available, the line termination mesh node and the cross-connect (XC) termination mesh node.

9.4.1 Line Termination Mesh Node

The line termination mesh node is installed in native Software Release 8.5 mesh networks. Line termination mesh nodes can support between one and eight line terminations. Each line direction requires the following cards: 40-WXC-C, 40-MUX-C, 40-DMX-C or 40-DMX-CE, a preamplifier and a booster. Within this configuration, the following substitutions can be used:

- The 40-MUX-C cards can be replaced with 40-WSS-C/40-WSS-CE cards.
- The 40-DMX-C cards can be replaced with 32DMX cards, if a 32WSS is used.
- The 40-MUX-C cards can be replaced with 40-WSS-C or 32WSS cards.
- The OPT-BST cards can be replaced with OPT-AMP-C (in OPT-BST mode), OPT-AMP-17-C (in OPT-BST mode) and/or OPT-BST-E cards.
- The OPT-RAMP-C can be added based on specific network design.
- The OPT-PRE can be replaced with an OPT-AMP-C (in OPT-LINE mode) OPT-AMP-17-C (in OPT-LINE mode) card.

Each side of the line termination mesh node is connected as follows:

- The 40-WXC-C COM-RX port is connected to the preamplifier output port.
- The 40-WXC-C COM-TX port is connected to the booster amplifier COM-RX port.
- The 40-WXC-C DROP TX port is connected to the 40-DMX-C (or 32DMX) COM-RX port.
- The 40-WXC-C ADD-RX port is connected to the 40-MUX-C (or 40-WSS-C or 32WSS) COM-TX port.
- The 40-WXC-C EXP-TX port is connected to the COM-RX through an LC-LC patchcord.

- T The 40-WXC-C EXP-RX port is connected to the EXP-TX patch panel through an MPO-MPO multicable.

Note The PP-MESH interconnects 40-WXC-C cards according to following rule: The EXP-TX port of 40-WXC-C in side “i” is connected to the 40-WXC-C EXP-j-RX port of all the other equipped or provisioned 40-WXC-C cards. The side "i" goes from A to H and side "j" goes from ports 1 to 8 (Side “j” has the same cardinality of the side letter (A<->1, B<->2, ...H<->8). These connections are relevant for routing pourposes or to list the ports that are involved in an OCH-NC network. However, they are not reported in CTC under node view -> Maintenance -> DWDM -> -> Mesh Patch Panel Internal Patchcords.

Figure 9-22 shows one shelf from a line termination node. (Examples of line termination nodes in four-degree and eight-degree mesh networks are shown in Figure 9-29 on page 9-38 and Figure 9-30 on page 9-39.)

Figure 9-22 Line Termination Mesh Node Shelf

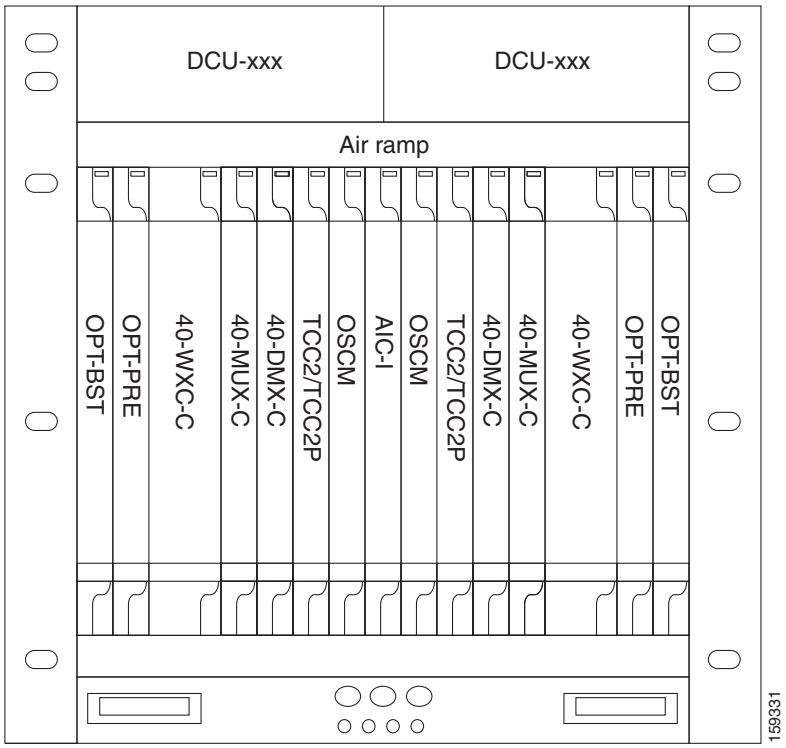


Figure 9-23 shows a functional block diagram of one line termination side using 40-WXC-C and 40-MUX-C cards.

Figure 9-23 Line Termination Mesh Node Side—40-MUX-C Cards

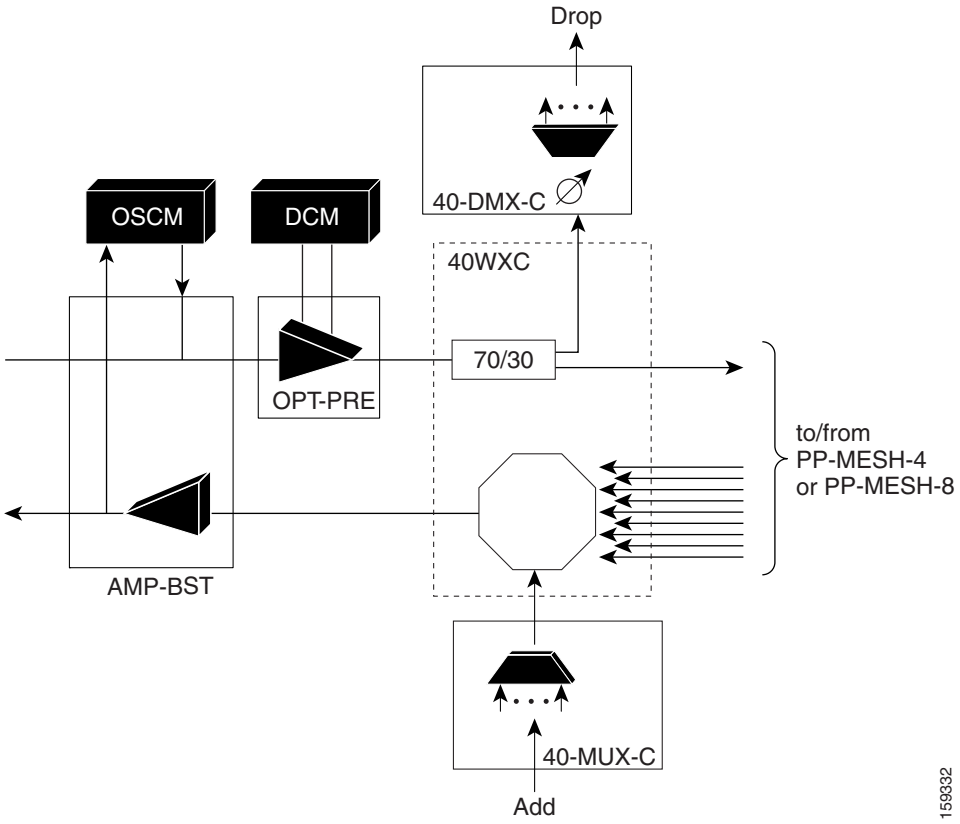


Figure 9-24 shows a functional block diagram line termination side using 40-WXC-C and 40-WSS-C cards.

Figure 9-24 Line Termination Mesh Node Side—40-WSS-C Cards

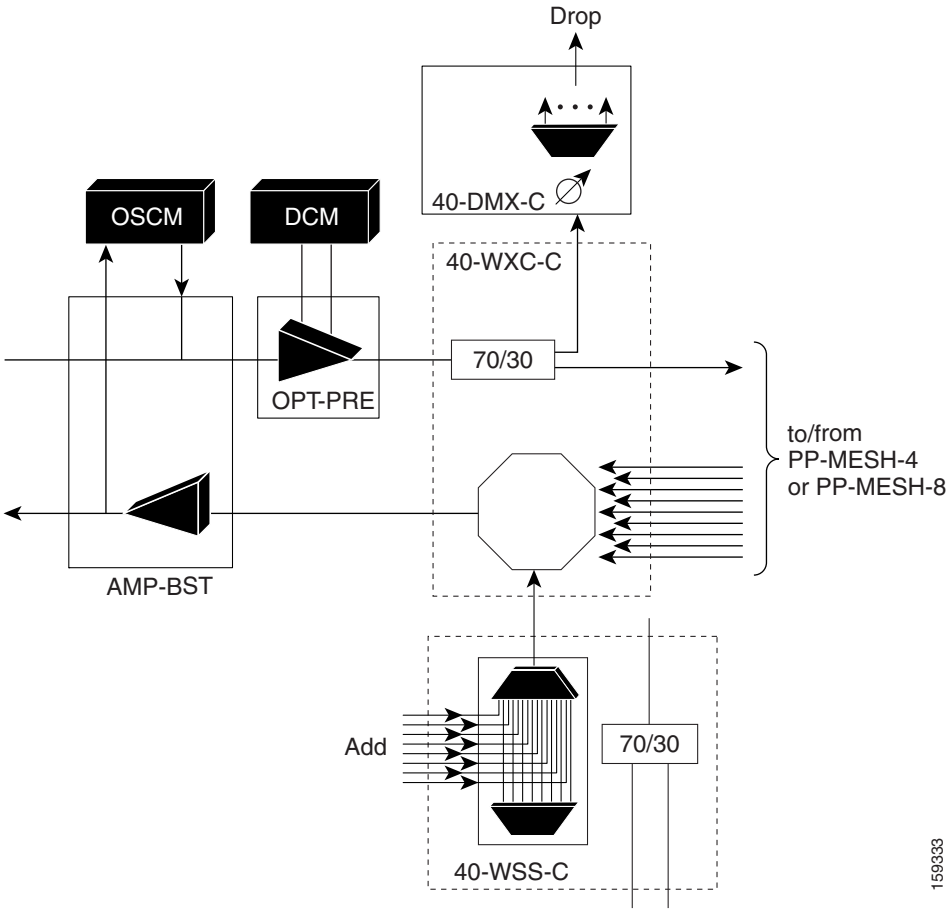
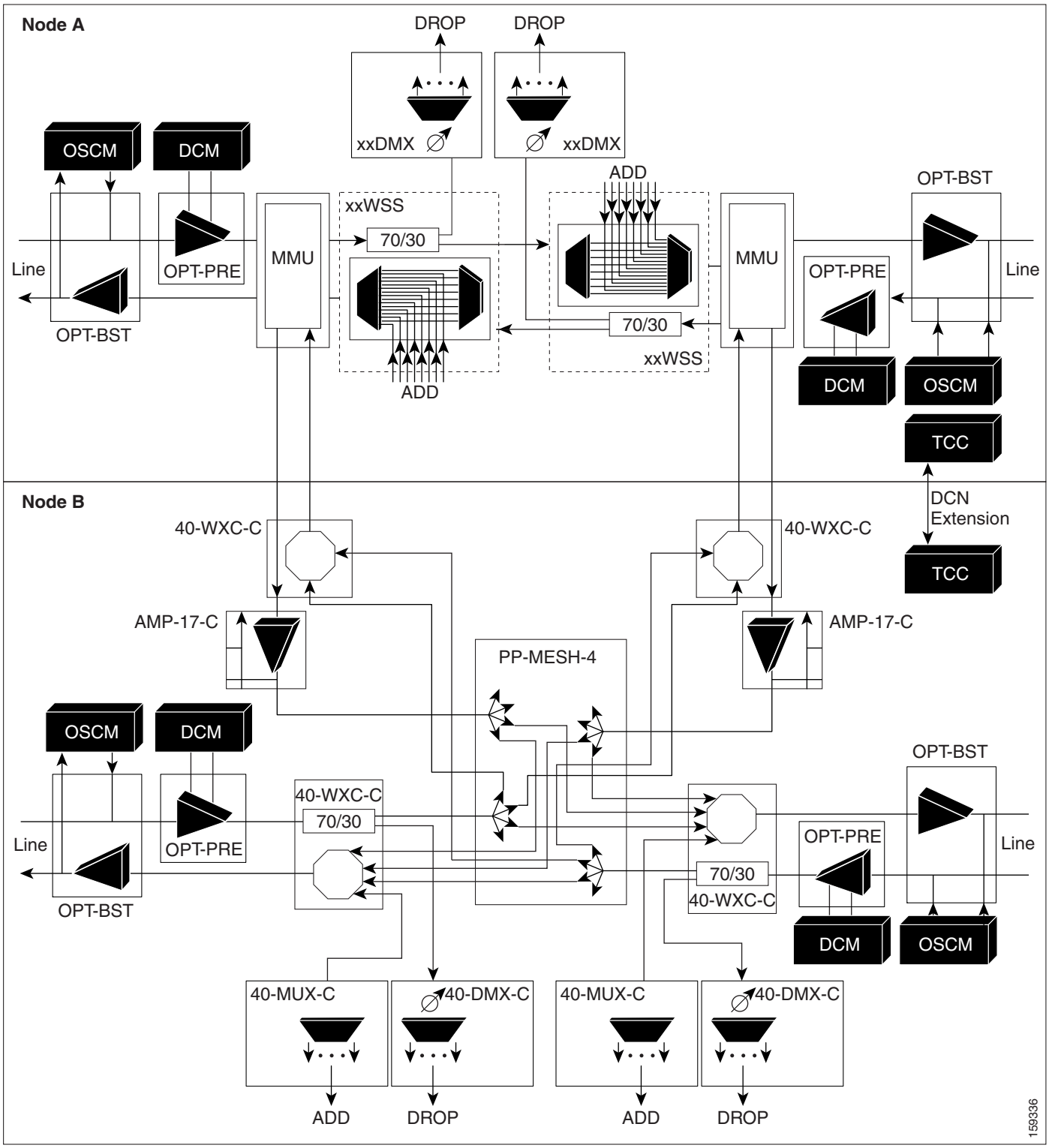


Figure 9-25 shows a functional block diagram of a node that interconnects a ROADM with MMU cards with two native line termination mesh sides.

Figure 9-25 Line Termination Mesh Nodes—ROADM With MMU Cards



9.4.2 XC Termination Mesh Node

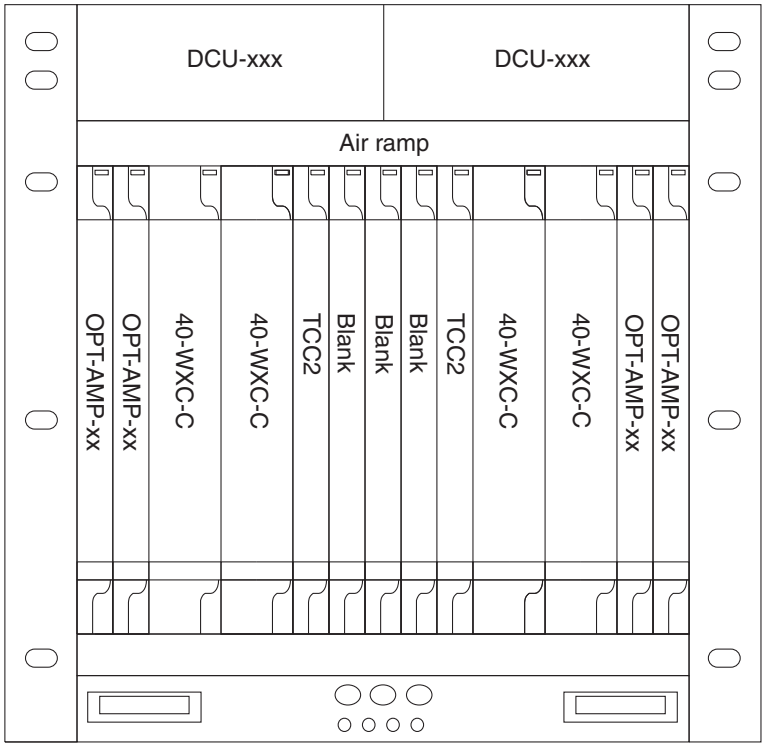
The XC termination mesh node, shown in Figure 9-26, is the second mesh node type. It is used to upgrade a non-mesh node to a mesh node or to interconnect two non-mesh nodes. The XC termination mesh nodes contain the following cards:

- 40-WXC-C cards
- OPT-AMP-17-C cards configured in OPT-PRE mode

The XC termination mesh node is connected as follows:

- The 40-WXC-C COM-RX port is connected to the MMU EXP-A-TX port.
- The 40-WXC-C COM-TX port is connected to the MMU EXP-A-RX port.
- 40-WXC-C EXP-TX port is connected to the OPT-AMP-17-C COM-RX port.
- 40-WXC-C EXP-RX port is connected to the OPT-AMP-17-C COM-TX port.
- The 40-WXC-C EXP-TX port is connected to the mesh patch panel.
- The 40-WXC-C EXP-RX port is connected to the mesh patch panel.

Figure 9-26 XC Termination Mesh Node Shelf

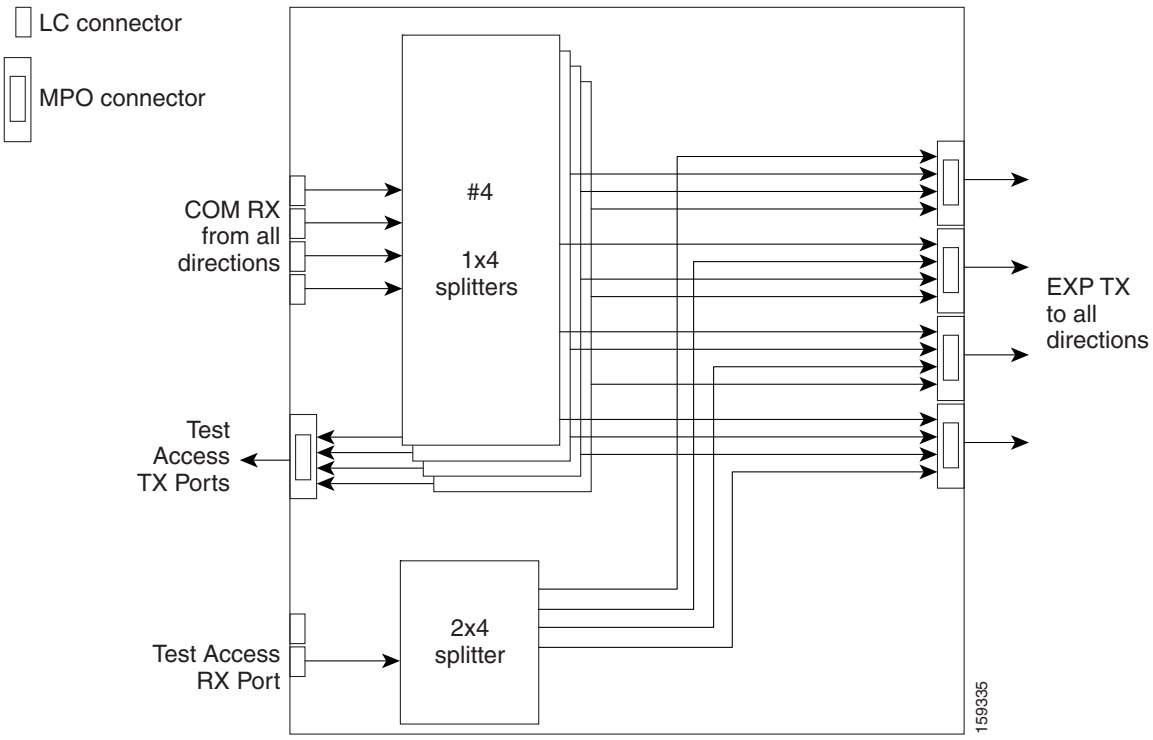


9.4.3 Mesh Patch Panels and Shelf Layouts

ONS 15454 mesh topologies require the installation of a four-degree patch panel (PP-MESH-4) or eight-degree patch panel (PP-MESH-8). If the four-degree patch panel is installed, mesh topologies of up to four degrees can be created. If the eight-degree patch panel patch panel is installed, mesh

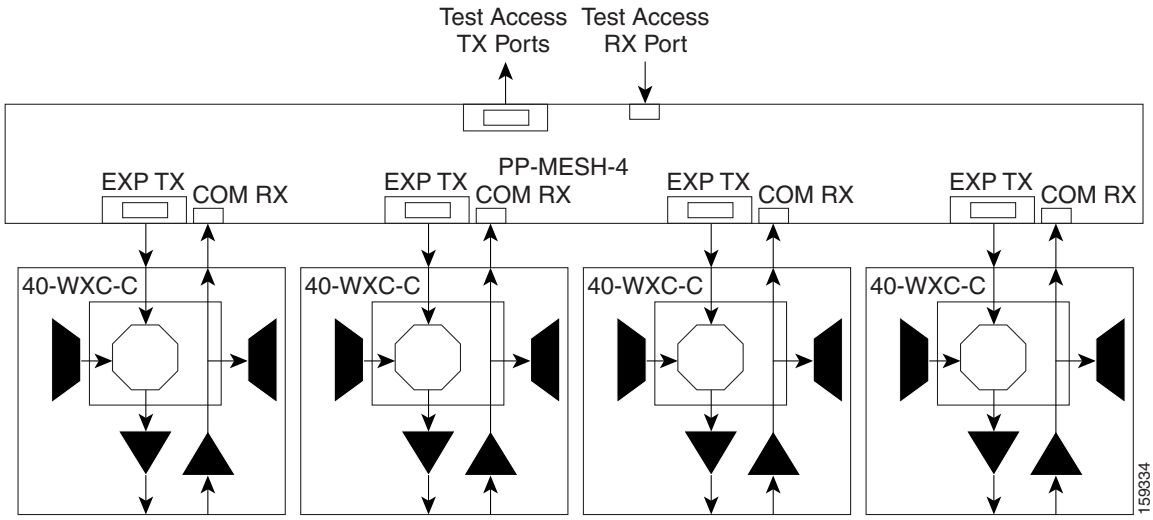
topologies of up to eight degrees can be created. The four-degree patch panel contains four 1x4 optical splitters, and the eight-degree patch panel contains eight 1x8 splitters. Each mesh patch panel contains a 2x8 splitter that is used for the test access transmit and receive ports. Figure 9-27 shows a block diagram for the four-degree patch panel.

Figure 9-27 Four-Degree Patch Panel Block Diagram



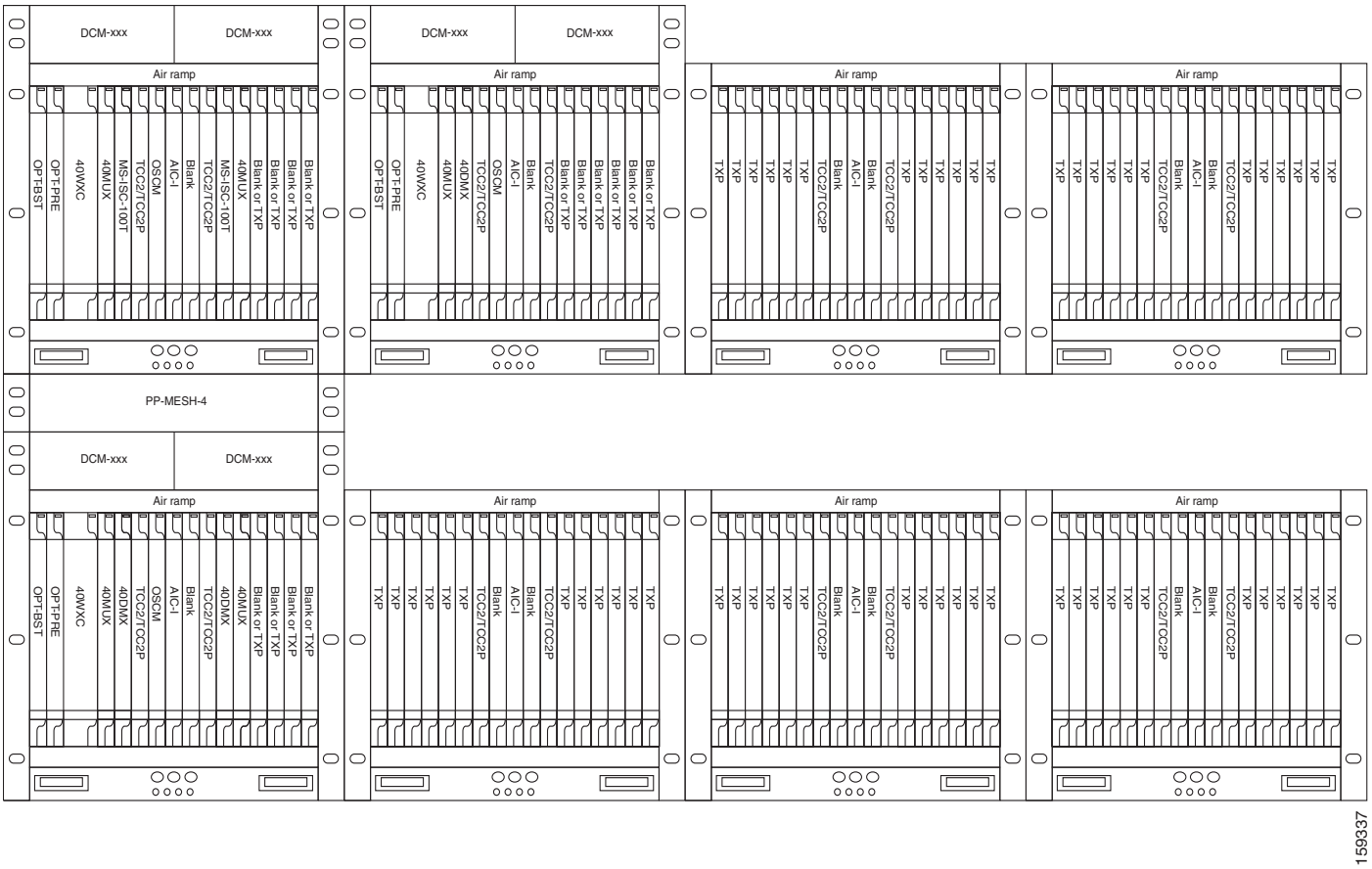
At the mesh patch panel, the signal is split into four signals (if four-degree patch panel is used) or eight signals (if an eight-degree patch panel is used). Figure 9-28 shows the signal flow at the four-degree patch panel. 40-WXC-C cards connect to the four-degree patch panel at the EXP TX and COM RX ports.

Figure 9-28 Four-Degree Patch Panel Signal Flow



The mesh patch panels interconnect 40-WXC-C cards to create mesh networks, including four-degree and eight-degree mesh topologies. In addition, shelves with 40-WXC-C cards can be configured with mesh patch panels to create multiring, MMU-based mesh nodes. 40-WXC-C cards can be installed in ROADM nodes with MMU cards to upgrade a two-degree MMU-based ROADM node into four-degree or eight-degree mesh nodes. Figure 9-29 shows the ROADM node with MMU cards configuration after it has been upgraded into a four-degree mesh topology.

Figure 9-29 Layout for ROADM Node with MMU Cards and Four-Degree Mesh Topology



The following figures show different mesh configurations at the shelf level. Figure 9-30 shows a basic four-degree mesh node layout based on the shelf configuration shown in Figure 9-22 on page 9-31.

Figure 9-30 Four-Degree Line Termination Mesh Node Layout

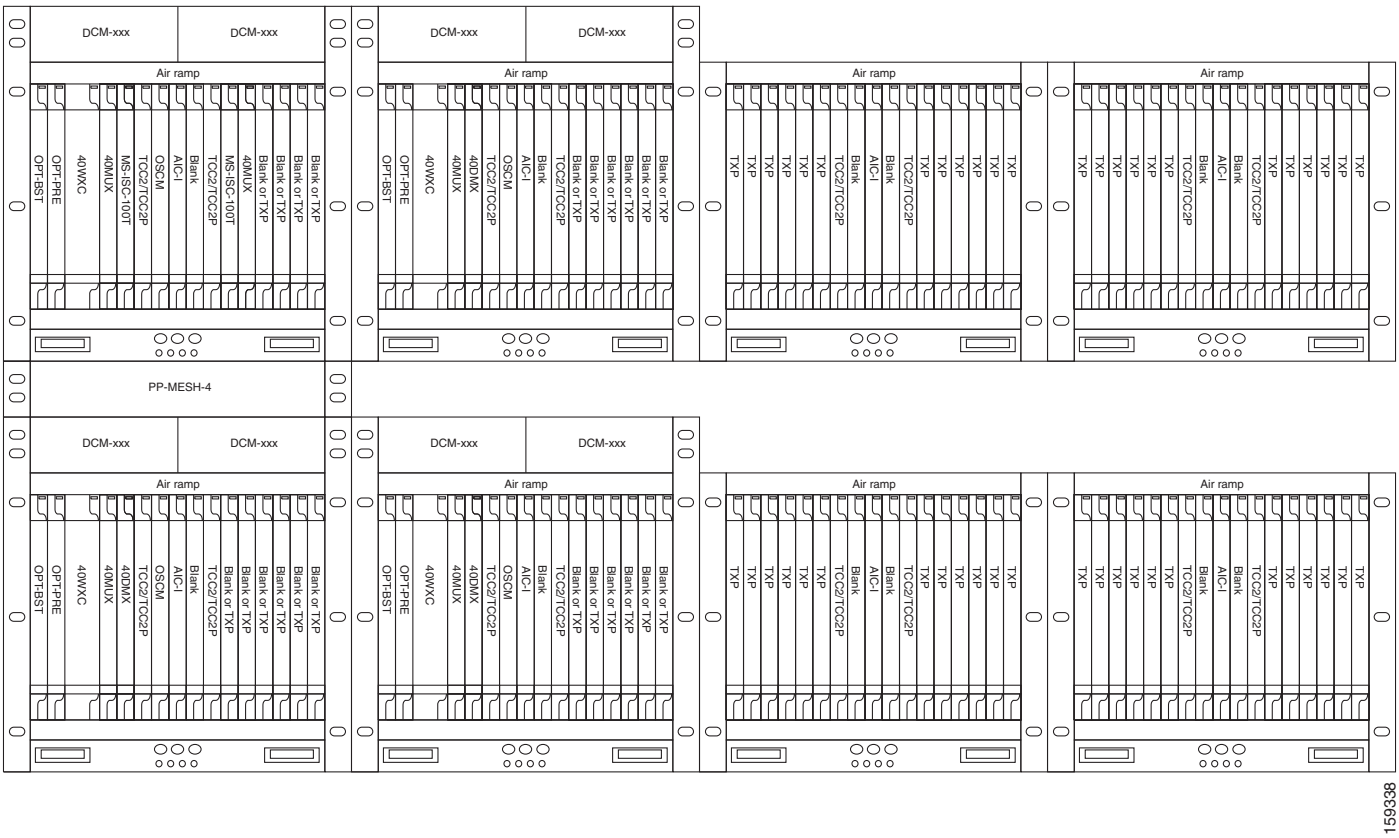
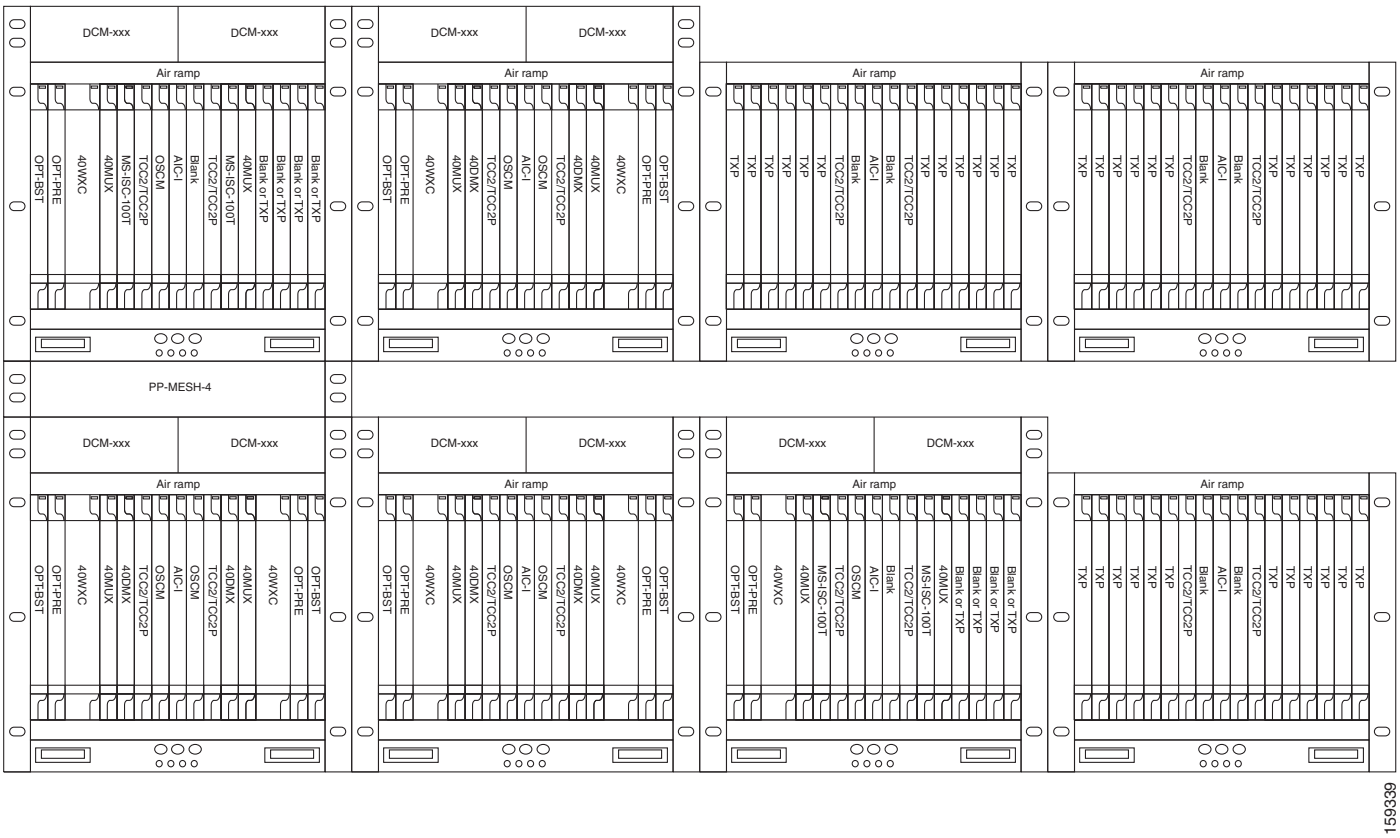


Figure 9-31 shows a protected four-degree mesh node layout based on the shelf configuration shown in Figure 9-22 on page 9-31.

Figure 9-31 Four-Degree Protected Line Termination Mesh Node Layout



9.4.4 Using a Mesh Node for Local Add/Drop Channel Management

Normally, a multidegree mesh node uses four or eight 40-WXC-C cards and a four- or eight-degree patch panel. Each of the 40-WXC-C cards uses a 40-MUX-C card to add wavelengths going to the span and a 40-DMX-C or 40-DMX-CE card to drop wavelengths coming in from the span. The 40-MUX-C and 40-DMX-C or 40-DMX-CE cards connect to their respective TXP or MXP cards. In this new local add/drop channel management configuration, at least one of the directions of a multidegree node can be used to manage local add/drop traffic. The advantage of this configuration is to consolidate all of the TXP, MXP, 40-MUX-C, and 40-DMX-C or 40-DMX-CE cards where they are needed for adding or dropping wavelengths locally. Figure 9-32 shows an example of how to set up a local add/drop configuration.

By setting up network elements (NE) as shown in the figure, it is possible to connect the transmit ports of TXP or MXP cards to a 40-MUX-C card and then connect the output of the 40-MUX-C card to an OPT-BST card, which then connects to a preferred 40-WXC-C card in an NE that has been set up as a four-degree or eight-degree mesh node. Through software configuration, the wavelengths entering the preferred 40-WXC-C card can be selectively sent out through a multidegree patch panel and the other 40-WXC-C cards in that NE in any desired outbound direction. In the inbound direction, any of the wavelengths entering the NE through the 40-WXC-C cards and multidegree patch panel can be selectively routed to the preferred 40-WXC-C card facing the NE containing an OPT-PRE card and a

40-DMX-C or 40-DMX-CE card. These wavelengths are then sent along to the corresponding TXP/MXP receive port. The NEs are in separate shelves with separate IP addresses and communicate through DCN extensions.

The advantage of this configuration is that all of the transponder cards, 40-MUX-C cards, and 40-DMX-C or 40-DMX-CE cards can be located in a single NE, which then communicates with a second mesh NE containing only 40-WXC-C cards and a multidegree patch panel. Normally, each 40-WXC-C card in the multidegree node would have its own 40-MUX-C and 40-DMX-C or 40-DMX-CE card and corresponding TXP/MXP cards. Using this new configuration, the extra 40-MUX-C cards, 40-DMX-C or 40-DMX-CE cards, and corresponding TXP and MXP cards are eliminated. You now also have a dedicated NE from which you can send and receive wavelengths to and from any desired direction in the multidegree node. In addition, the wavelengths and the direction in which they leave the node are reconfigurable through software and require no manual recabling.

An example of using a mesh node for local add/drop channel management is shown in Figure 9-32.

Figure 9-32 Local Add/Drop Management Using Two Network Elements

9.5 DWDM Node Cabling

DWDM node cabling is specified by the Cisco TransportPlanner Internal Connections table. The following sections provide examples of the cabling that you will typically install for common DWDM node types.

Note The cabling illustrations shown in the following sections are examples. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

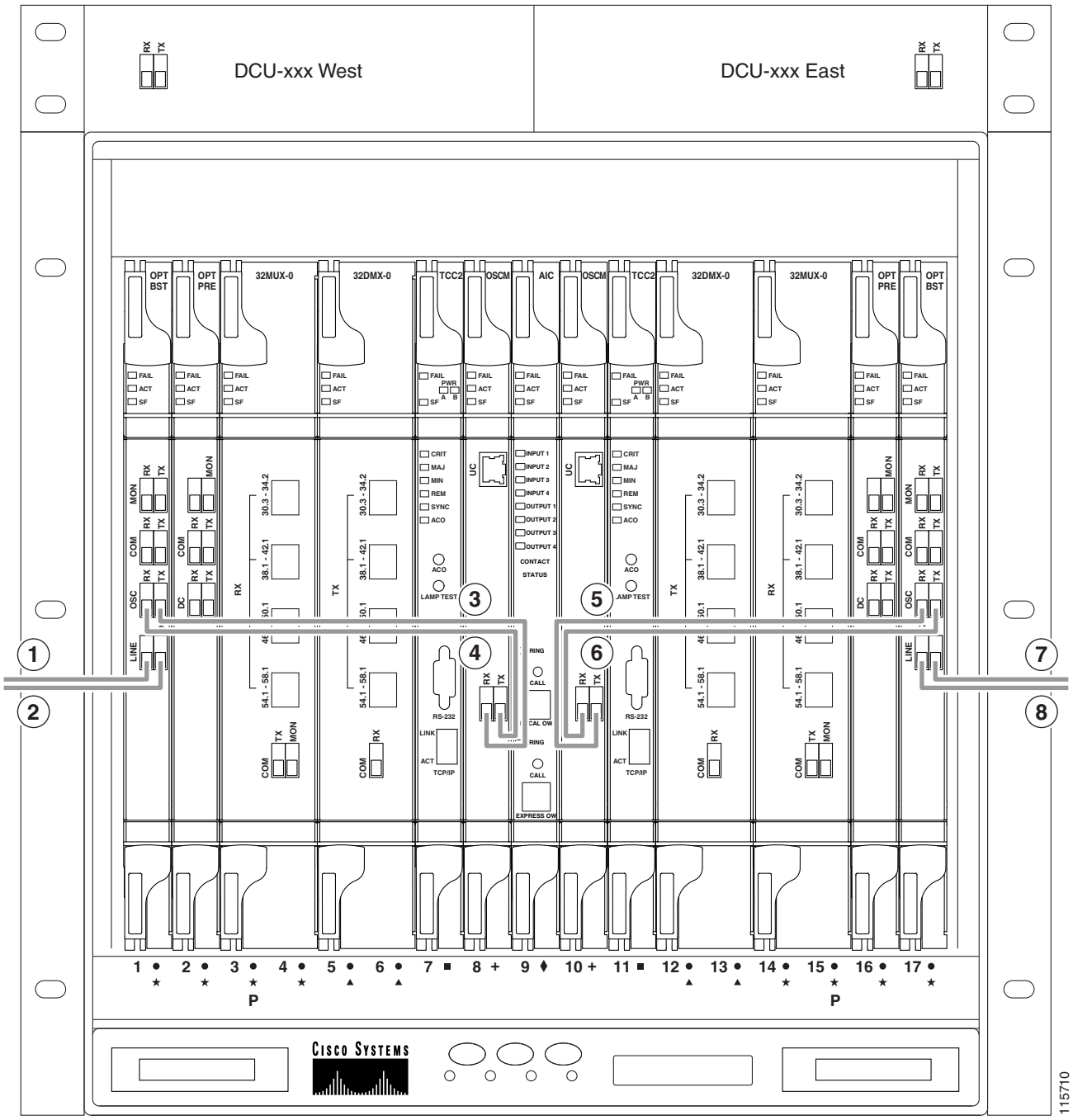
9.5.1 OSC Link Termination Fiber-Optic Cabling

OSC link termination cabling include the following characteristics:

- The OPT-BST and OSC-CSM cards are the only cards that directly interface with the line (span) fiber.
- The OSCM card only carries optical service channels, not DWDM channels.
- The OSCM and OSC-CSM cards cannot both be installed on the same side of the shelf (Side B or Side A). You can have different cards on each side, for example an OSCM card on Side A and an OSC-CSM card on Side B.
- When an OPT-BST card and an OSC-CSM card are both used on the same side of the node, the OPT-BST card combines the supervision channel with the DWDM channels and the OSC-CSM card acts as an OSCM card; it does not carry DWDM traffic.
- If an OPT-BST and an OSCM card are installed on Side B, the Side B OPT-BST OSC RX port is connected to the Side B OSCM TX port, and the Side B OPT-BST OSC TX port is connected to the Side B OSCM RX port.
- If an OPT-BST and an OSC-CSM card are installed on Side B, the Side B OPT-BST OSC RX port is connected to the Side B OSC-CSM LINE TX port, and the Side B OPT-BST OSC TX port is connected to the Side B OSC-CSM LINE RX port.
- If an OPT-BST and an OSCM card are installed on Side A, The Side A OPT-BST OSC TX port is connected to the Side A OSCM RX port, and the Side A OPT-BST OSC RX port is connected to the Side A OSCM TX port.
- If an OPT-BST and an OSC-CSM card are installed on Side A, the Side A OPT-BST OSC TX port is connected to the Side A OSC-CSM LINE RX port, and the Side A OPT-BST OSC RX port is connected to the Side A OSC-CSM LINE TX port.

Figure 9-33 shows an example of OSC fibering for a hub node with OSCM cards installed.

Figure 9-33 Fibering OSC Terminations—Hub Node with OSCM Cards



1	Side A OPT-BST LINE RX to Side B OPT-BST or OSC-CSM LINE TX on adjacent node	**5**	Side B OSCM TX to Side B OPT-BST OSC RX

2	Side A OPT-BST LINE TX to Side B OPT-BST or OSC-CSM LINE RX on adjacent node	**6**	Side B OSCM RX to Side B OPT-BST OSC TX
3	Side A OPT-BST OSC TX to Side A OSCM RX	**7**	Side B OPT-BST LINE TX to Side A OPT-BST or OSC-CSM LINE RX on adjacent node
4	Side A OPT-BST OSC RX to Side A OSCM TX	**8**	Side B OPT-BST LINE RX to Side A OPT-BST or OSC-CSM LINE TX on adjacent node

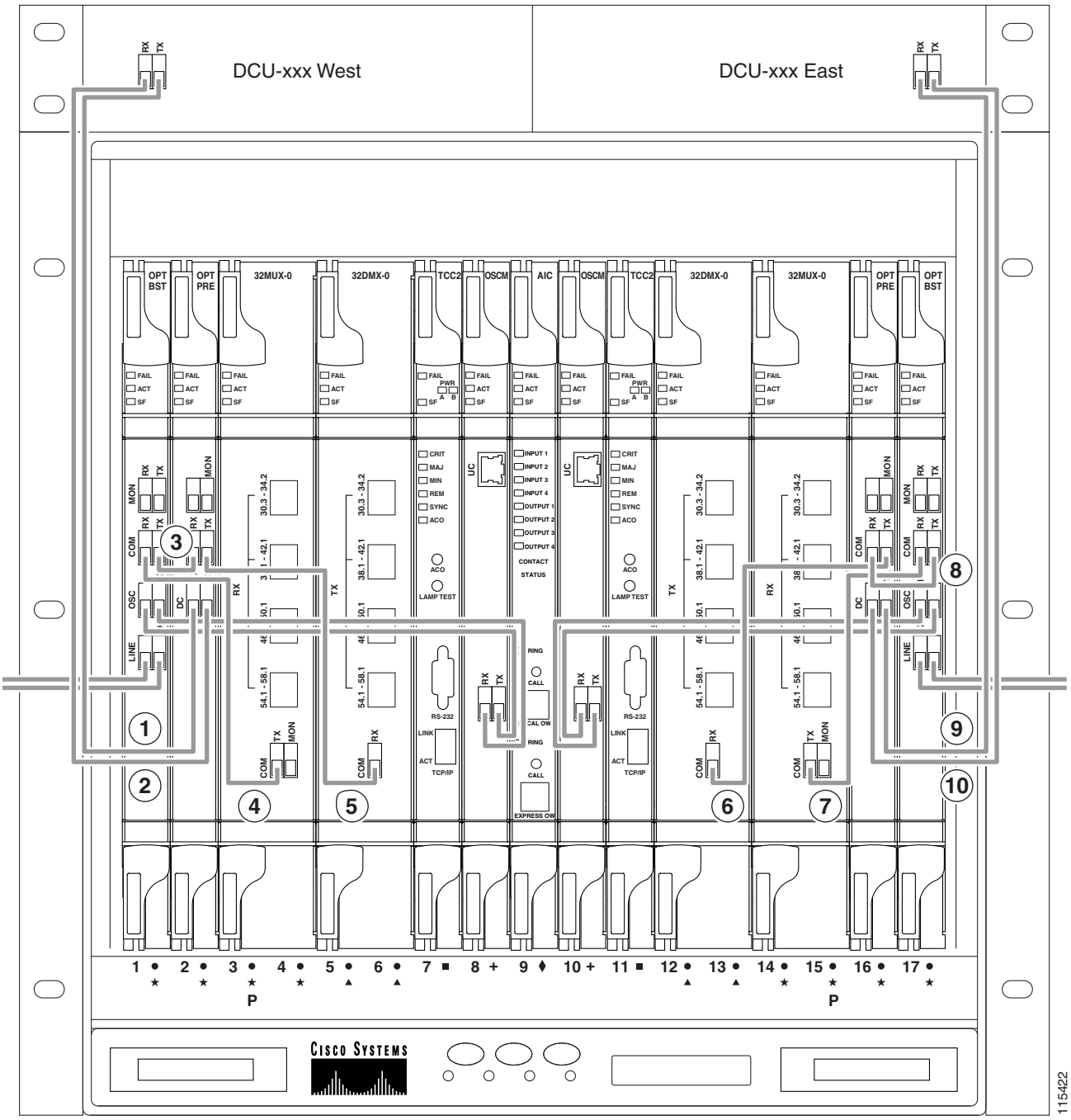
9.5.2 Hub Node Fiber-Optic Cabling

The following rules generally apply to hub node cabling:

- The Side A OPT-BST or OSC-CSM card common (COM) TX port is connected to the Side A OPT-PRE COM RX port or the Side A 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The Side A OPT-PRE COM TX port is connected to the Side A 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The Side A 32MUX-O/32WSS/32WSS-L COM TX port is connected to the Side A OPT-BST or Side A OSC-CSM COM RX port.
- The Side B 32MUX-O/32WSS/32WSS-L COM TX port is connected to the Side B OPT-BST or Side B OSC-CSM COM RX port.
- The Side B OPT-BST or Side B OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port or the Side B 32DMX-O/32DMX COM RX port.
- The Side B OPT-PRE COM TX port is connected to the Side B 32DMX-O/32DMX COM RX port.

Figure 9-34 shows an example of a hub node with cabling. In the example, OSCM cards are installed. If OSC-CSM cards are installed, they are usually installed in Slots 1 and 17.

Figure 9-34 Fibering a Hub Node



1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**6**	Side B 32DMX-O COM RX to Side B OPT-PRE COM TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**7**	Side B 32MUX-O COM TX to Side B OPT-BST COM RX

3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**8**	Side B OPT-PRE COM RX to Side B OPT-BST COM TX
4	Side A OPT-BST COM RX to Side A 32MUX-O COM TX	**9**	Side B DCU TX to Side B OPT-PRE DC RX[1]
5	Side A OPT-PRE COM TX to Side A 32DMX-O COM RX	**10**	Side B DCU RX to Side B OPT-PRE DC TX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/– 1 dB must be installed between the OPT-PRE DC ports.

9.5.3 Terminal Node Fiber-Optic Cabling

The following rules generally apply to terminal node cabling:

- A terminal site has only one side (as compared to a hub node, which has two sides). The terminal side can be either Side B or Side A.
- The terminal side OPT-BST or OSC-CSM card COM TX port is connected to the terminal side OPT-PRE COM RX port or the 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The terminal side OPT-PRE COM TX port is connected to the terminal side 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The terminal side 32MUX-O/40-MUX-C COM TX port is connected to the terminal side OPT-BST or OSC-CSM COM RX port.

9.5.4 Line Amplifier Node Fiber-Optic Cabling

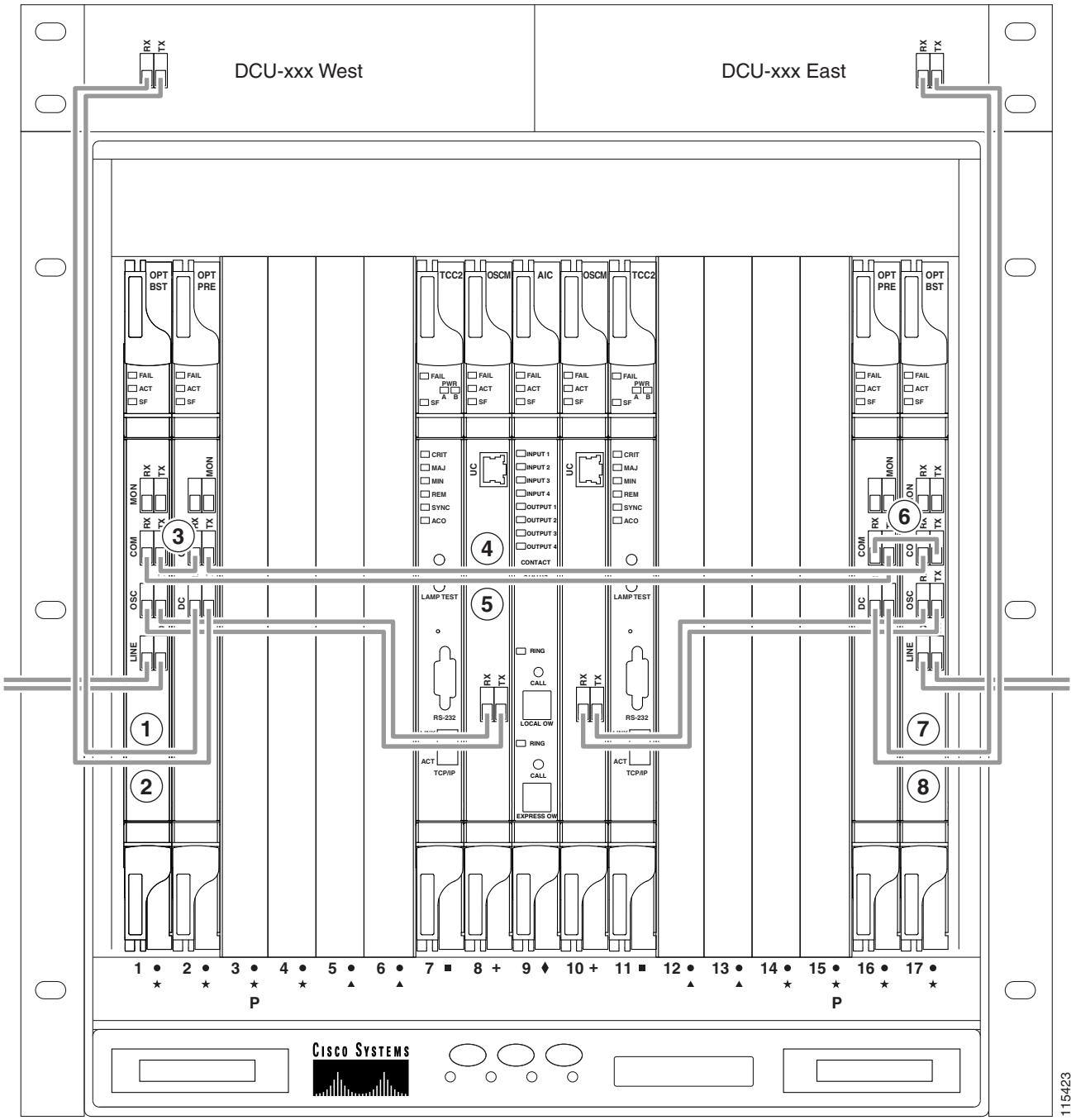
The following rules generally apply to line amplifier node cabling:

- The line amplifier node layout allows all combinations of OPT-PRE and OPT-BST cards and allows you to use asymmetrical card choices in Side A-to-Side B and Side B-to-Side A configurations. For a given line direction, you can configure the four following possibilities:
  - Only preamplification (OPT-PRE)
  - Only booster amplification (OPT-BST)
  - Both preamplification and booster amplification (where a line amplifier node has amplification in at least one direction)
  - Neither preamplification nor booster amplification
- If a Side A OPT-PRE card is installed:
  - The Side A OSC-CSM or OPT-BST COM TX is connected to the Side A OPT-PRE COM RX port.
  - The Side A OPT-PRE COM TX port is connected to the Side B OSC-CSM or OPT-BST COM RX port.
- If a Side A OPT-PRE card is not installed, the Side A OSC-CSM or OPT-BST COM TX port is connected to the Side B OSC-CSM or OPT-BST COM RX port.
- If an Side B OPT-PRE card is installed:
  - The Side B OSC-CSM or OPT-BST COM TX port is connected to the Side B OPT-PRE COM RX port.

  - The Side B OPT-PRE COM TX port is connected to the Side A OSC-CSM or OPT-BST COM RX port.
- If an Side B OPT-PRE card is not installed, the Side B OSC-CSM or OPT-BST COM TX port is connected to the Side A OSC-CSM or OPT-BST COM RX port.

Figure 9-35 shows an example of a line amplifier node with cabling.

Figure 9-35 Fibering a Line Amplifier Node



1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**5**	Side A OPT-BST COM RX to Side B OPT-PRE COM TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**6**	Side A OPT-BST COM RX to Side B OPT-PRE COM TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**7**	Side B DCU TX to Side B OPT-PRE DC RX[1]
4	Side A OPT-PRE COM TX to Side B OPT-BST COM RX	**8**	Side B DCU RX to Side B OPT-PRE DC TX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/– 1 dB, must be installed between the OPT-PRE DC ports.

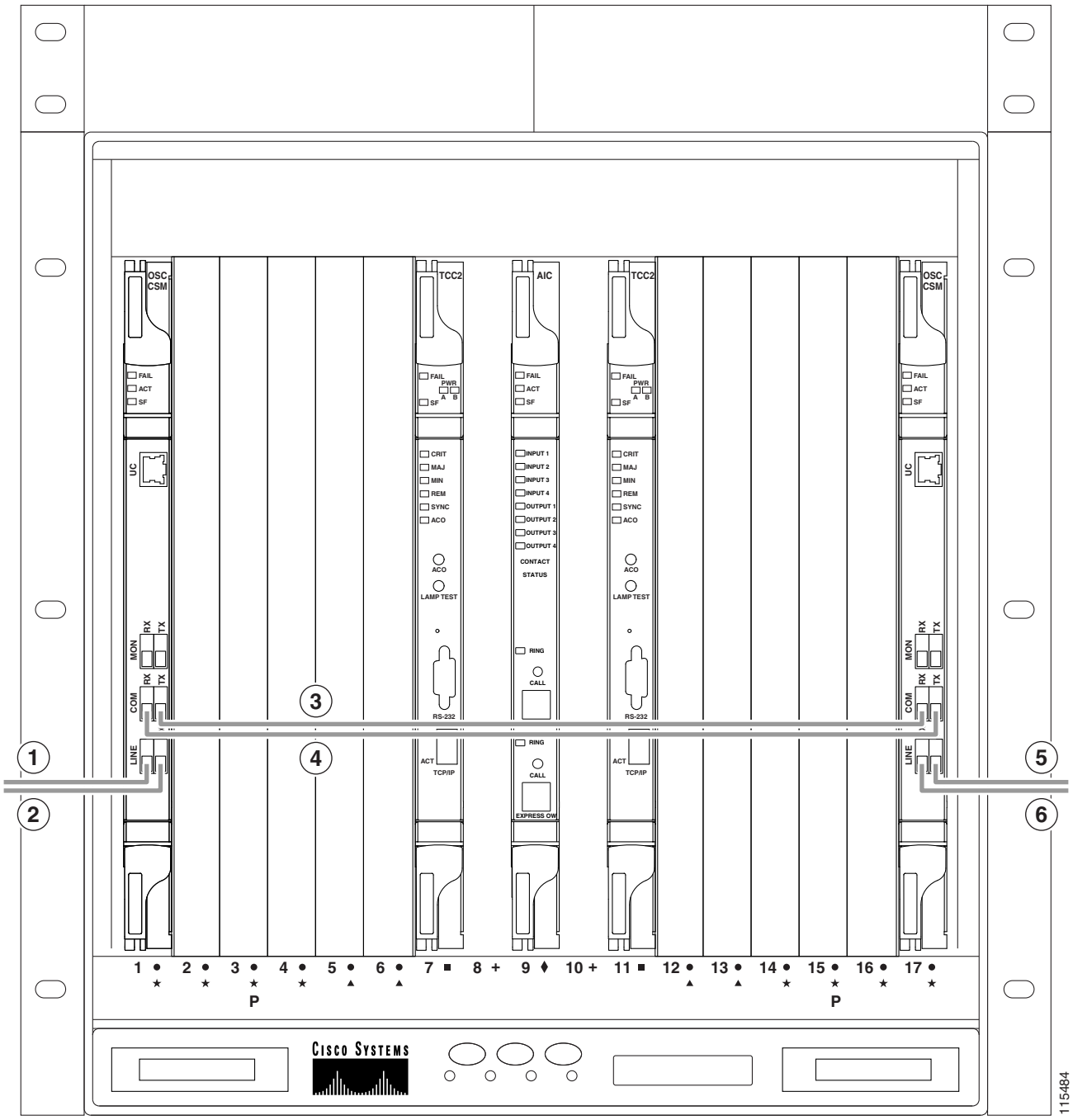
9.5.5 OSC Regeneration Node Fiber-Optic Cabling

The following rules generally apply to OSC regeneration node cabling:

- The Side A OSC-CSM COM TX port connects to the Side B OSC-CSM COM RX port.
- The Side A OSC-CSM COM RX port connects to the Side B OSC-CSM COM TX port.
- Slots 2 through 5 and 12 through 16 can be used for TXP and MXP cards.

Figure 9-36 shows an example of an OSC regeneration node with cabling.

Figure 9-36 Fibering an OSC Regeneration Node



1	Side A OSC-CSM LINE RX to Side B OSC-CSM or OPT-BST LINE TX on adjacent node	**4**	Side A OSC-CSM COM RX to Side B OSC-CSM COM TX
2	Side A OSC-CSM LINE TX to Side B OSC-CSM or OPT-BST LINE RX on adjacent node	**5**	Side B OSC-CSM LINE RX to Side A OSC-CSM or OPT-BST LINE TX on adjacent node
3	Side A OSC-CSM COM TX to Side B OSC-CSM COM RX	**6**	Side B OSC-CSM LINE TX to Side A OSC-CSM or OPT-BST LINE RX on adjacent node

9.5.6 Amplified or Passive OADM Node Fiber-Optic Cabling

The two sides of the OADM node do not need to be symmetrical. On each side, Cisco TransportPlanner can create one of the following four configurations:

- OPT-BST and OPT-PRE
- OSC-CSM and OPT-PRE
- Only OSC-CSM
- Only OPT-BST

Note Amplified OADM nodes contain OPT-PRE cards and/or OPT-BST cards. Passive OADM nodes do not. Both contain add/drop channel or band cards.

The following rules generally apply for OADM node express path cabled connections:

- TX ports should only be connected to RX ports.
- EXP ports are connected only to COM ports in between AD-xC-xx.x or AD-xB-xx.x cards that all belong to Side B (that is, they are daisy-chained).
- EXP ports are connected only to COM ports in between AD-xC-xx.x or AD-xB-xx.x cards that all belong to Side A (that is, they are daisy-chained).
- The EXP port of the last AD-xC-xx.x or AD-xB-xx.x card on Side A is connected to the EXP port of the first AD-xC-xx.x or AD-xB-xx.x card on Side B.
- The OPT-BST COM RX port is connected to the nearest (in slot position) AD-xC-xx.x or AD-xB-xx.x COM TX port.
- The OPT-PRE COM TX port is connected to the nearest (in slot position) AD-xC-xx.x or AD-xB-xx.x COM RX port.
- If OADM cards are located in adjacent slots, the TCC2/TCC2P card assumes that they are connected in a daisy-chain between the EXP ports and COM ports as noted previously.
- The first Side A AD-xC-xx.x or AD-xB-xx.x card COM RX port is connected to the Side A OPT-PRE or OSC-CSM COM TX port.
- The first Side A AD-xC-xx.x or AD-xB-xx.x card COM TX port is connected to the Side A OPT-BST or OSC-CSM COM RX port.
- The first Side B AD-xC-xx.x or AD-xB-xx.x card COM RX port is connected to the Side B OPT-PRE or OSC-CSM COM TX port.

- The first Side B AD-xC-xx.x or AD-xB-xx.x card COM TX port is connected to the Side B OPT-BST or OSC-CSM RX port.
- If a Side A OPT-PRE is present, the Side A OPT-BST or OSC-CSM COM TX port is connected to the Side A OPT-PRE COM RX port.
- If an Side B OPT-PRE is present, the Side B OPT-BST or OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port.

The following rules generally apply for OADM node add/drop path cabled connections:

- AD-xB-xx.x add/drop (RX or TX) ports are only connected to the following ports:
  - 4MD-xx.x COM TX or 4MD-xx.x COM RX ports
  - Another AD-xB-xx.x add/drop port (a pass-through configuration)
- An AD-xB-xx.x add/drop band port is only connected to a 4MD-xx.x card belonging to the same band.
- For each specific AD-xB-xx.x card, the add and drop ports for that band card are connected to the COM TX and COM RX ports of the same 4MD-xx.x card.
- The AD-xB-xx.x and 4MD-xx.x cards are located in the same side (the connected ports all have the same line direction).

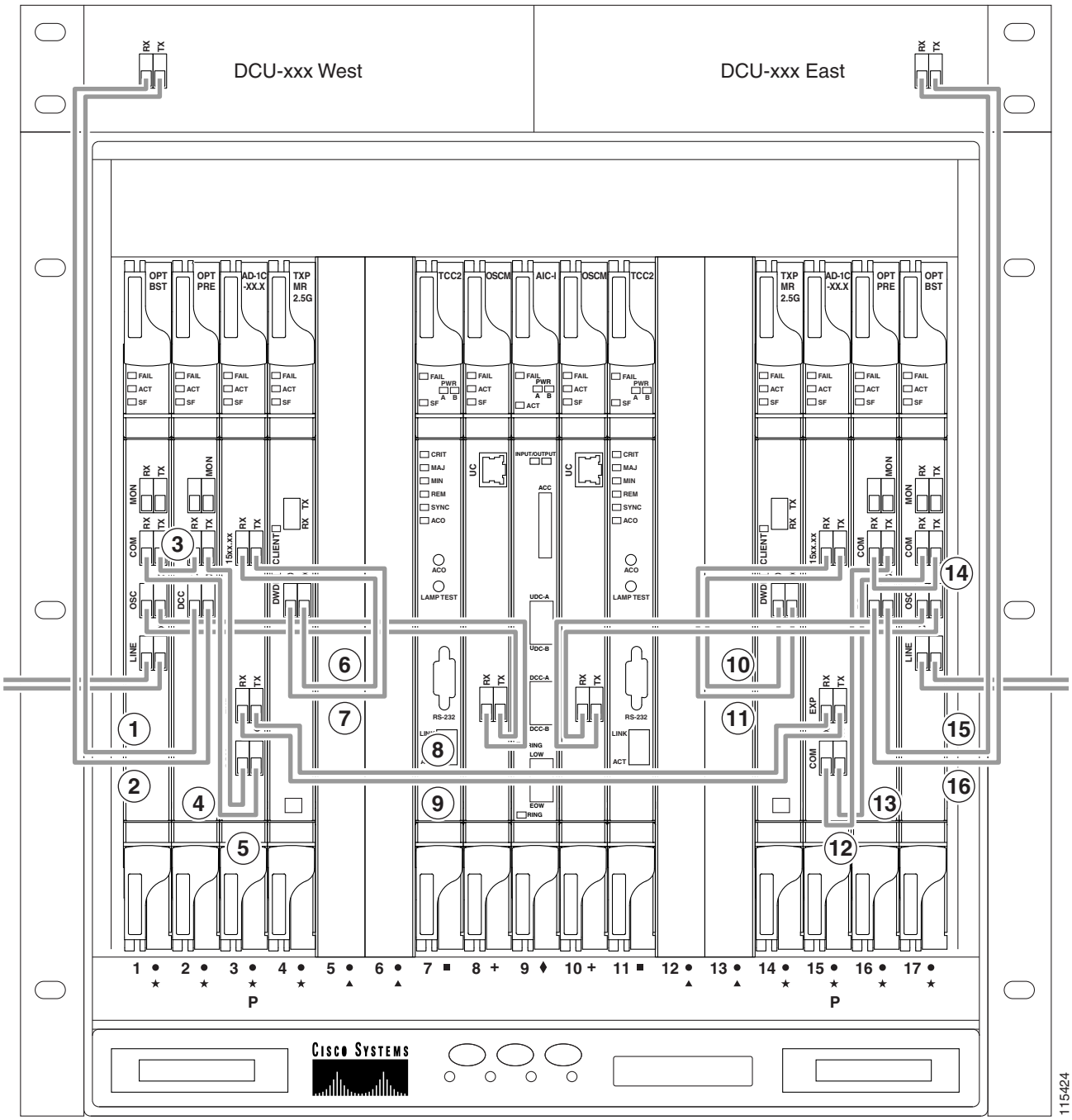
The following rules generally apply for OADM node pass-through path cabled connections:

- Pass-through connections are only established between add and drop ports on the same band or channel and in the same line direction.
- AD-xC-xx.x or AD-xB-xx.x add/drop ports must be connected to other AD-xC-xx.x or AD-xB-xx.x add/drop ports (as pass-through configurations).
- Add (RX) ports must be connected to drop (TX) ports.
- 4MD-xx.x client input/output ports must be connected to other 4MD-xx.x client input/output ports.
- A Side A AD-xB-xx.x drop (TX) port is connected to the corresponding Side A 4MD-xx.x COM RX port.
- A Side A AD-xB-xx.x add (RX) port is connected to the corresponding Side A 4MD-xx.x COM TX port.
- An Side B AD-xB-xx.x drop (TX) port is connected to the corresponding Side B 4MD-xx.x COM RX port.
- An Side B AD-xB-xx.x add (RX) port is connected to the corresponding Side B 4MD-xx.x COM TX port.

Figure 9-37 shows an example of an amplified OADM node with AD-1C-xx.x cards installed.

Note Figure 9-37 is an example. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

Figure 9-37 Fibering an Amplified OADM Node



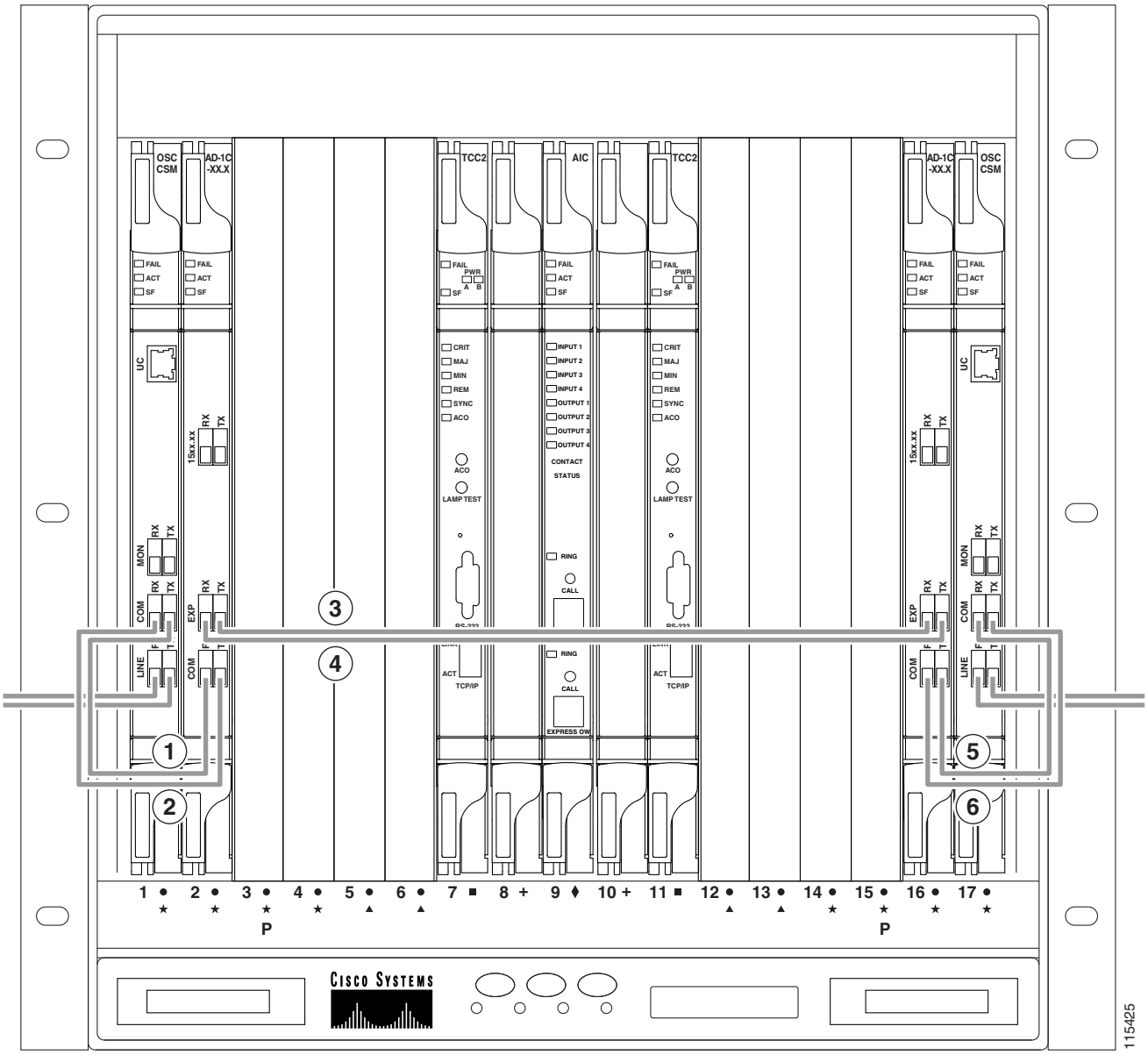
1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**9**	Side A AD-1C-xx.x EXP RX to Side B AD-1C-xx.x EXP TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**10**	Side B TXP_MR_2.5G DWDM RX to Side B AD-1C-xx.x (15xx.xx) TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**11**	Side B TXP_MR_2.5G DWDM TX to Side B AD-1C-xx.x (15xx.xx) RX

4	Side A OPT-BST COM RX to Side A AD-1C-xx.x COM TX	**12**	Side B AD-1C-xx.x COM RX to OPT-PRE COM TX
5	Side A OPT-PRE COM TX to Side A AD-1C-xx.x COM RX	**13**	Side B AD-1C-xx.x COM TX to OPT-BST COM RX
6	Side A AD-1C-xx.x (15xx.xx) RX to Side A TXP_MR_2.5G DWDM TX	**14**	Side B OPT-PRE COM RX to Side B OPT-BST COM TX
7	Side A AD-1C-xx.x (15xx.xx) TX to Side A TXP_MR_2.5G DWDM RX	**15**	Side B DCU TX to Side B OPT-PRE DC RX[1]
8	Side A AD-1C-xx.x EXP TX to Side B AD-1C-xx.x EXP RX	**16**	Side B DCU RX to Side B OPT-PRE DC TX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/ 1 dB, must be installed between the OPT-PRE DC ports.

Figure 9-38 shows an example of a passive OADM node with two AD-1C-xx.x cards installed.

Figure 9-38 Fibering a Passive OADM Node



1	Side A OSC-CSM COM TX to Side A AD-1C-xx.x COM RX	**4**	Side A OSC-CSM EXP RX to Side B AD-1C-xx.x EXP TX
2	Side A OSC-CSM COM RX to Side A AD-1C-xx.x COM TX	**5**	Side B AD-1C-xx.x COM TX to Side B OSC-CSM COM RX
3	Side A OSC-CSM EXP TX to Side B AD-1C-xx.x EXP RX	**6**	Side B AD-1C-xx.x COM RX to Side B OSC-CSM COM TX

9.5.7 ROADM Node Fiber-Optic Cabling

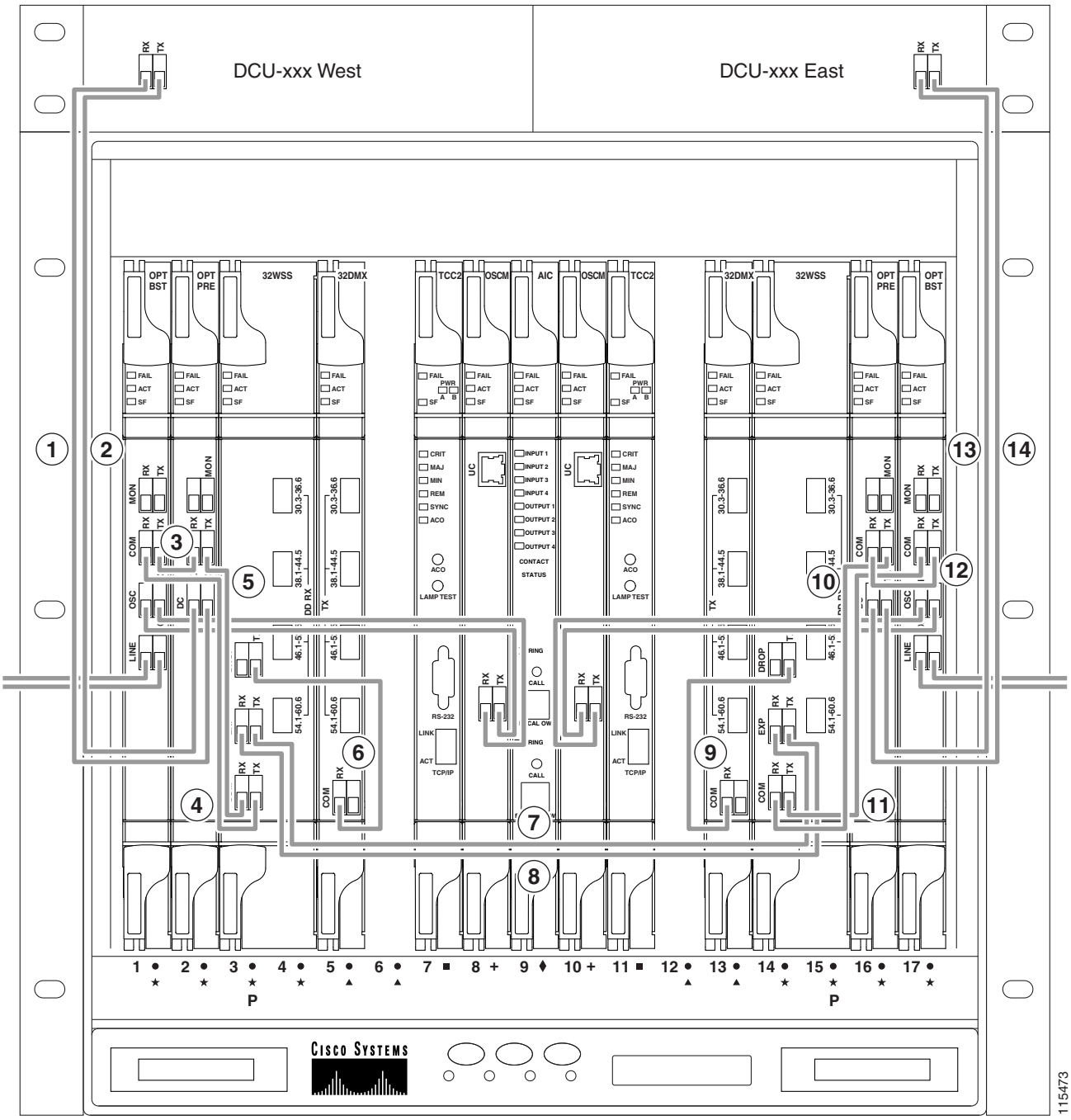
The following rules generally apply to ROADM node cabling:

- The Side A OPT-BST or OSC-CSM COM TX port is connected to the Side A OPT-PRE COM RX port.
- The Side A OPT-PRE COM TX port is connected to the Side A 32WSS COM RX port.
- The Side A OPT-BST or OSC-CSM COM RX port is connected to the Side A 32WSS COM TX port.
- The Side A OPT-BST (if installed) OSC TX port is connected to the Side A OSCM RX port.
- The Side A OPT-BST (if installed) OSC RX port is connected to the Side A OSCM TX port.
- The Side A 32WSS EXP TX port is connected to the Side B 32WSS EXP RX port.
- The Side A 32WSS EXP RX port is connected to the Side B 32WSS EXP TX port.
- The Side A 32WSS DROP TX port is connected to the Side A 32DMX COM RX port.
- The Side A 40-WSS-C/40-WSS-CE DROP TX port is connected to the Side A 40-DMX-C or 40-DMX-CE COM RX port.
- The Side B OPT-BST or OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port.
- The Side B OPT-PRE COM TX port is connected to the Side B 32WSS COM RX port.
- The Side B OPT-BST or OSC-CSM COM RX port is connected to the Side B 32WSS COM TX port.
- The Side B OPT-BST (if installed) OSC TX port is connected to the Side B OSCM RX port.
- The Side B OPT-BST (if installed) OSC RX port is connected to the Side B OSCM TX port.
- The Side B 32WSS DROP TX port is connected to the Side B 32DMX COM RX port.
- The Side B 40-WSS-C/40-WSS-CE DROP TX port is connected to the Side B 40-DMX-C or 40-DMX-CE COM RX port.

Figure 9-39 shows an example of an amplified ROADM node with cabling.

Note Figure 9-39 is an example. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

Figure 9-39 Fibering a ROADM Node



1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**8**	Side A 32WSS EXP RX to Side B 32WSS EXP TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**9**	Side B 32DMX COM RX to Side B 32WSS DROP TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**10**	Side B 32WSS COM RX to Side B OPT-PRE COM TX

4	Side A 32WSS COM TX to Side A OPT-BST COM RX	**11**	Side B 32WSS COM TX to Side B OPT-BST COM RX
5	Side A 32WSS COM RX to Side A OPT-PRE COM TX	**12**	Side B OPT-BST COM TX to Side B OPT-PRE COM RX
6	Side A 32DMX COM RX to Side A 32WSS DROP TX	**13**	Side B DCU RX to Side B OPT-PRE DC TX[1]
7	Side A 32WSS EXP TX to Side B 32WSS EXP RX	**14**	Side B DCU TX to Side B OPT-PRE DC RX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/–1 dB must be installed between the OPT-PRE DC ports.

9.6 Automatic Node Setup

Automatic node setup (ANS) is a TCC2/TCC2P function that adjusts values of the variable optical attenuators (VOAs) on the DWDM channel paths to equalize the per-channel power at the amplifier input. This power equalization means that at launch, all channels have the same amplifier power, 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, integrated VOAs and photodiodes are provided in the following cards:

- AD-xB-xx.x card express and drop paths
- AD-xC-xx.x card express and add paths
- 4MD-xx.x card add paths
- 32MUX-O card add paths
- 32WSS/40-WSS-C/40-WSS-CE/40-WXC-C add and pass through paths
- 32DMX-O card drop paths
- 32DMX, 40-DMX-C, 40-DMX-CE card input port
- 40-MUX-C card output port

Optical power is equalized by regulating the VOAs. Based on 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 VOAs associated to aggregated paths.
- 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 VOAs associated to a single channel path.

ANS calculates the following VOA provisioning parameters:

- Target attenuation
- Target power

To allow you to modify ANS values based on your DWDM network requirements, provisioning parameters are divided into two contributions:

- Reference Contribution—(Display only) This value is set by ANS.
- Calibration Contribution—This value can be set by the user.

To complete the equalization, ANS requires the following information:

- The order in which DWDM cards are connected together on the express paths.
- The number of channels that are add or dropped.
- The number of channels and/or bands that are configured as passthrough.

ANS assumes that every DWDM port is associated to one on the node side. The port-to-side association is based on node layout deriving from provisioned (or automatically calculated) internal patchcords. From CTC or TL1 you can:

- 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.

After you launch ANS, one of the following statuses is provided for each ANS parameter:

- Success - Changed—The parameter setpoint was recalculated successfully.
- Success - Unchanged—The parameter setpoint did not need recalculation.
- Unchanged - Port in IS state—ANS could not modify the setpoint because the ports in an IS state.
- Not Applicable—The parameter setpoint does not apply to this node type.
- Fail - Out of Range—The calculated setpoint is outside the expected range.
- Fail - Missing Input Parameter—The parameter could not be calculated because the required provisioning data is unknown or not available.

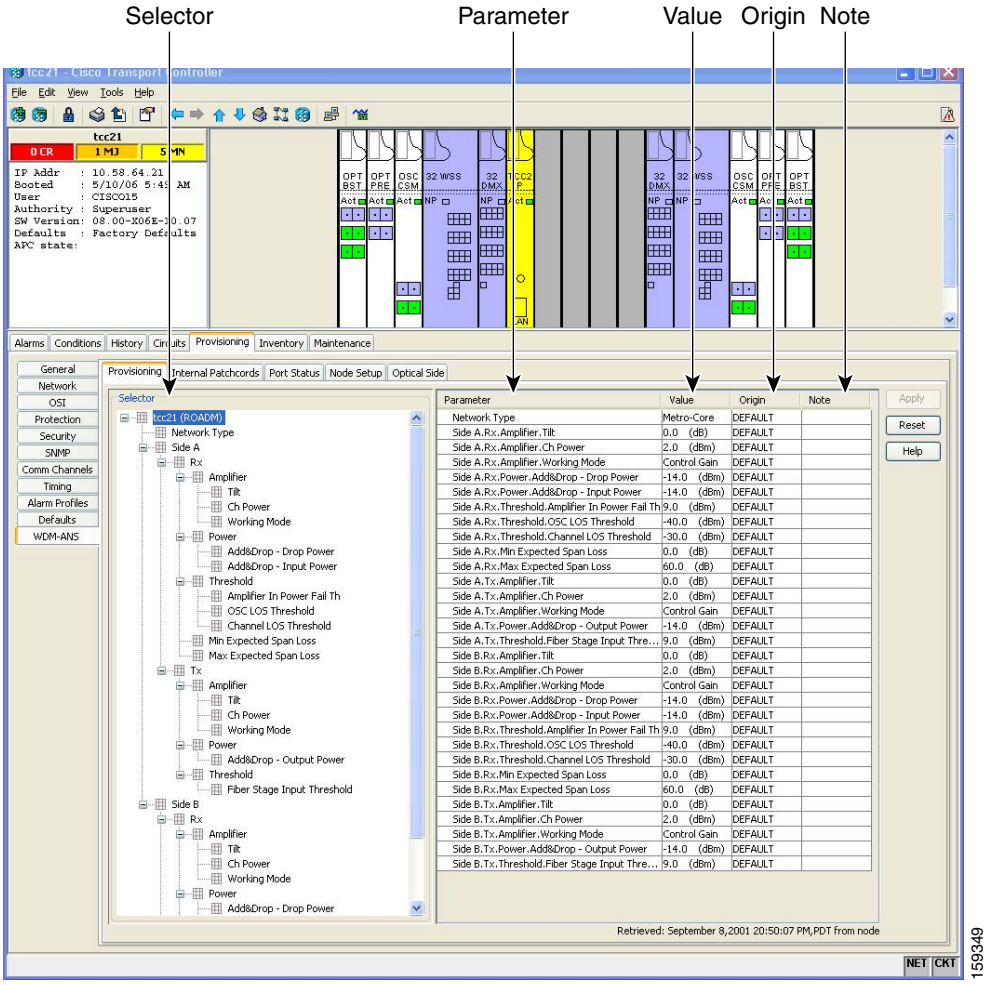
Optical patchcords are passive devices that are modeled by the two termination points, each with an assigned slot and port. If user-provisioned optical patchcords exist, ANS checks that the new connection is feasible (according to internal connection rules) and returns a denied message if the user connection violates one of the rules. ANS requires the expected wavelength to be provisioned. 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-xx.x for all two-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.

ONS 15454 ANS parameters set the values required for the node to operate successfully. Cisco TransportPlanner calculates the ANS parameters based on the requirements for a planned network. Cisco TransportPlanner exports the parameters to an ASCII, NE Update file. The NE Update file can

then be imported by CTC to automatically provision the node for the network. All ANS parameters can be viewed and manually modified from the node view Provisioning > WDM-ANS > Provisioning tab, shown in Figure 9-40.

Figure 9-40 WDM-ANS Provisioning



The Provisioning > WDM-ANS > Provisioning tab presents the following information:

- Selector—Presents the ANS parameters in a tree view. Clicking the + or – expands or collapses individual tree elements. Clicking a tree element displays the element parameters in the table on the right. For example, clicking the node name at the top displays all the node ANS parameters. Clicking Rx > Amplifier displays the amplifier receive parameters only.
- Parameter—displays the parameter name.
- Value—Displays the parameter value. Values can be modified manually, although manual modification of ANS parameters is not recommended. If ANS could not calculate a parameter, “Unknown” is displayed in the Value column.
- Origin—Indicates how the parameter was calculated:
  - Default—The value is the default provided with the node.
  - Calculated—The value was calculated by Cisco TransportPlanner.

  - Provisioned—The value was manually provisioned.

- Note—Displays information for parameters that could not be calculated, that is, parameters with Unknown appearing in the Value column.

Table 9-11 shows the following information displayed for ANS parameters on the Provisioning > WDM-ANS > Provisioning tab.

- Side—The optical side, which can be A (Slots 1 through 6) or B (Slots 12 through 17) for DWDM nodes in non-mesh DWDM networks, or A, B, C, D, E, F, G, or H for nodes in DWDM mesh networks.
- Rx/Tx—Indicates whether the parameter is transmit or receive.
- Category—The parameter category as displayed in the ANS parameter tree.
- Min—Minimum value in decibels.
- Max—Maximum value in decibels.
- Def—Default value in decibels. Other defaults include MC (metro core), CG (control gain), U (unknown).
- Optical Type—Parameter optical type: T (Terminal), FC (flexible channel count terminal), O (OADM), H (hub), L (line amplifier), R (ROADM), or U (unknown).

Table 9-11 Provisioning > ANS-WDM > Provisioning Tab Parameters

Side	Rx/Tx	Category	Parameters	Min	Max	Def	Optical Types
i[1]	—	Network Type	Network Type	—	—	MC	U, T, FC, O, H, L, R
	Rx	Amplifier	Side *i*.Rx.Amplifier.Tilt	0	30	0	T, FC, O, H, L, R
			Side *i*.Rx.Amplifier.Gain	0	30	0	T, FC, O, H, L, R
			Side *i*.Rx.Amplifier.Ch Power	–10	17	2	T, FC, O, H, L, R
			Side *i*.Rx.Amplifier.Working Mode	—	—	CG	T, FC, O, H, L, R
		—	Side *i*.Rx.Max Expected Span Loss	0	60	60	T, FC, O, H, L, R
			Side *i*.Rx.Min Expected Span Loss	0	60	60	T, FC, O, H, L, R
		Power	Side *i* Rx.Power.Far End	–50	30	U	T, FC, O, H, L, R
			Side *i* Rx.Power.Add&Drop - Input Power	–50	30	14	T, FC, O, H, R
			Side *i*.Rx.Power.Add&Drop - Drop Power	–50	30	14	T, FC, O, H, R
			Side *i*.Rx.Power.Band *n*.Drop Power (where *n* = 1–8)	–50	30	14	FC, O
			Side *i*.Rx.Power.Channel *n*.Drop Power Side B (where *n* = 1–32[2] or 1–40[3])	–50	30	14	T, H, R
		Thresholds	Side *i*.Rx.Threshold.OSC LOS Threshold	–50	30	U	T, FC, O, H, L, R
			Side *i*.Rx.Threshold.Channel LOS Threshold	–50	30	U	T, FC, O, H, L, R
			Side *i* Rx Amplifier In Power Fail Th	–50	30		
	Tx	Amplifier	Side *i*.Tx.Amplifier.Tilt	0	30	0	T, FC, O, H, L, R
			Side *i*.Tx.Amplifier.Gain	0	30	0	T, FC, O, H, L, R
			Side *i*.Tx.Amplifier.Ch Power	–10	17	2	T, FC, O, H, L, R
			Side *i*.Tx.Amplifier.Working Mode	—	—	CG	T, FC, O, H, L, R
		Power	Side *i*.Tx.Power.Add&Drop - Output Power	–50	30	14	T, FC, O, H, R
			Side *i*.Tx.Power.Add&Drop - By-Pass Power	–50	30	14	H
		Threshold	Side *i*.Tx.Threshold.Fiber Stage Input Threshold	–50	30	U	

1. Where *i* = A, B, C, D, E, F, G, H
2. If 32-channel cards are installed
3. If 40-channel cards are installed

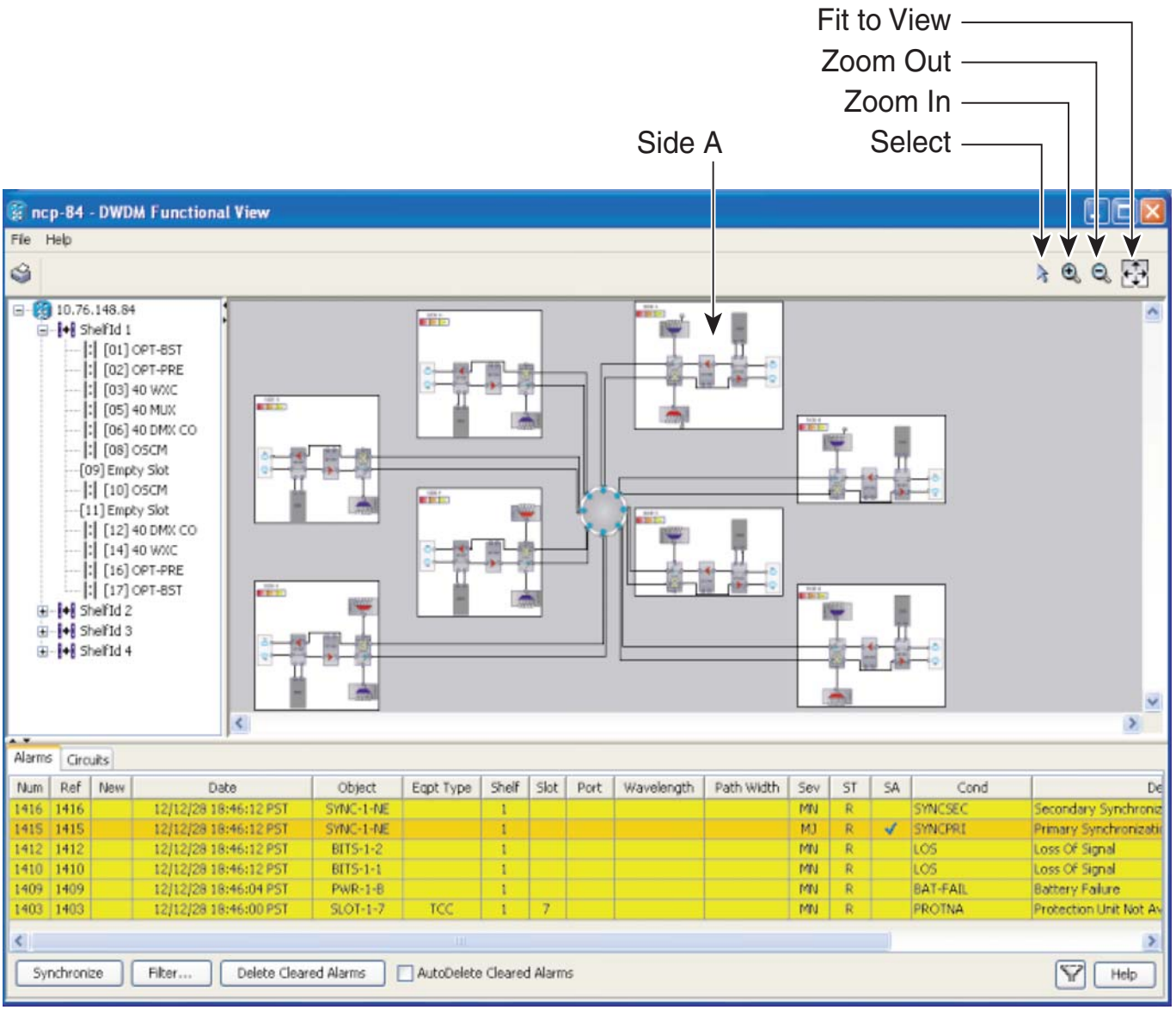
9.7 DWDM Functional View

DWDM functional view offers a graphical view of the DWDM cards and the internal connections between them in an MSTP node. The functional view also shows cards and connections for multidegree MSTP nodes (up to eight sides). To navigate to the functional view of a DWDM node, use the following navigational path in CTC when you are in node view:

Provisioning > WDM-ANS > Internal Patchcords > Functional View

An example of the functional view for an eight-sided node is shown in Figure 9-41.

Figure 9-41 Functional View for an Eight-Sided Node



9.7.1 Navigating Functional View

The functional view has two main panes. The upper pane contains a tree view of the shelves and a graphical view of the shelf equipment. The lower pane describes alarms and circuits in a tabular format.

The upper pane in Figure 9-41 is divided into a left pane and a right pane. The left pane shows a tree structure view of the shelf or shelves in the MSTP system. You can expand the tree view of a shelf to show the slot usage in that shelf. The right-hand pane is a graphical view of the sides in the shelf. In the case of Figure 9-41, there are eight sides (A through H). Side A is located as shown in the figure. All of the cards in each side are grouped together.

The meanings of the icons in the upper right corner are as follows:

- Select—use this icon to select a graphical element in the graphical view pane.
- Patchcord—Use this icon to create an internal patchcord between cards.

Note The Patchcord icon is not functional for Software Release 8.5.

- Zoom In/Zoom Out—Use these icons to zoom in or zoom out in the graphical display pane.
- Fit to View—Use this icon to have the graphical view fit the space available on your screen.

The bottom pane can be used to display alarms (using the Alarms tab) or Circuits (using the Circuits tab). Clicking the Alarms tab displays the same information as the Alarms tab in the network, node, or card view. Clicking the Circuits tab displays the same information as the Alarms tab in the network, node, or card view.

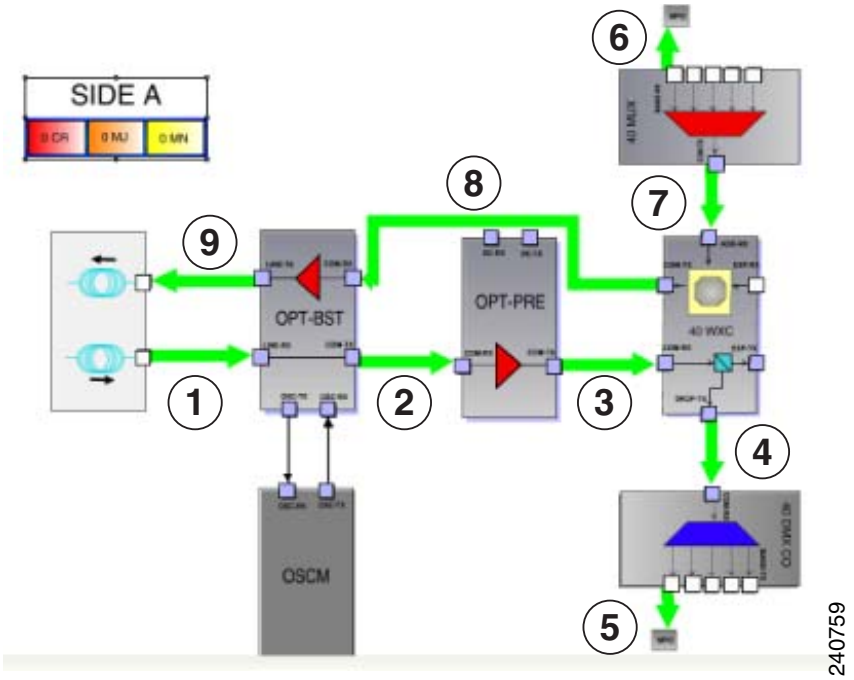
9.7.2 Using the Graphical Display

This section explains how to use the graphical portion of the display to gather information about the cards and ports.

9.7.2.1 Displaying a Side

Double-click a side to show the details of that side. For example, if you double-click Side A in Figure 9-41, the result is as shown in Figure 9-42.

Figure 9-42 Side A Details



The green arrows in the diagram represent the DWDM optical path within the selected side. The optical path in this instance is summarized as follows:

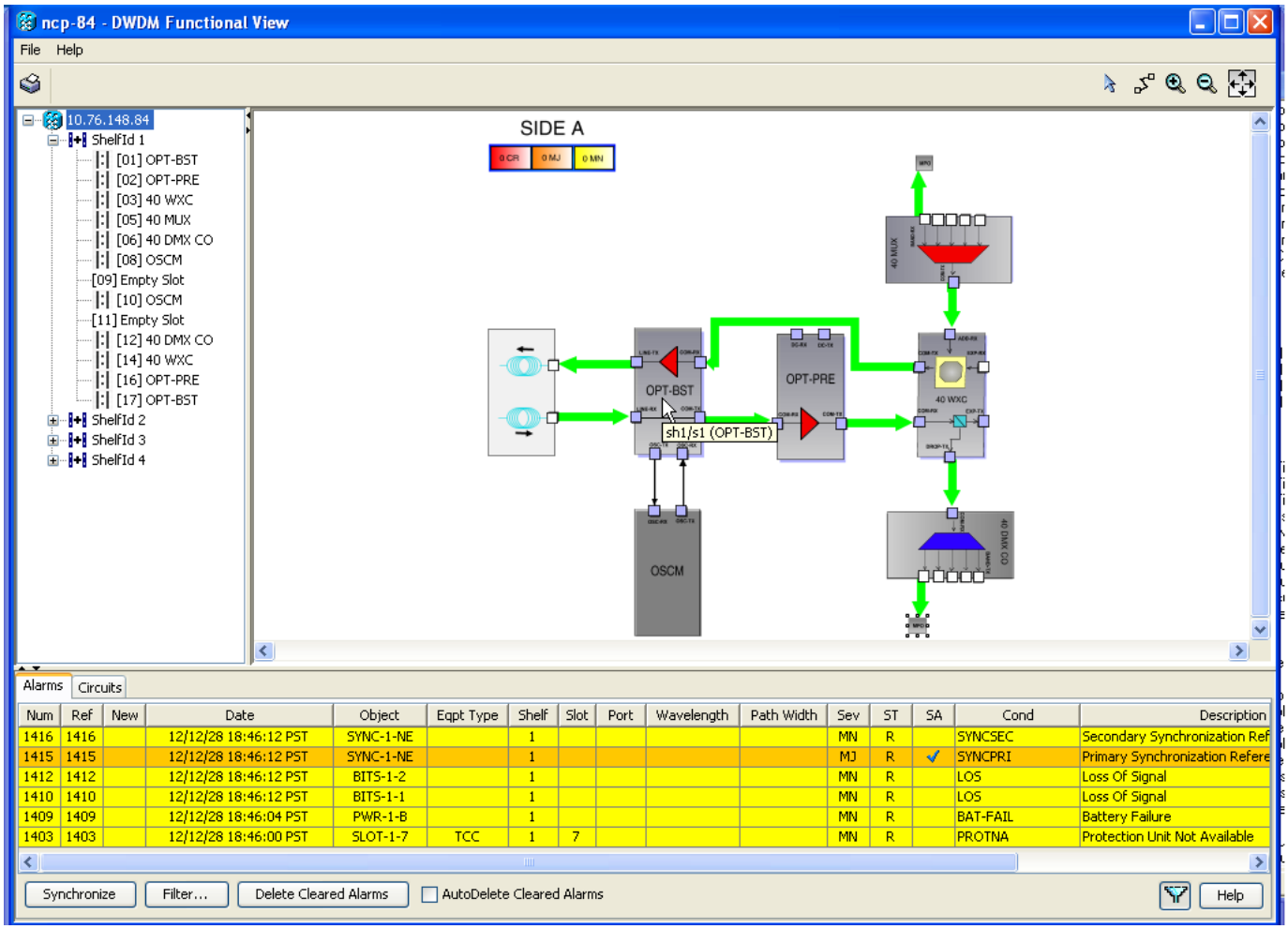
1. The light enters the OPT-BST card LINE-RX port from the optical span.
2. The path continues out of the OPT-BST card COM-TX port to the COM-RX port of the OPT-PRE card.
3. The OPT-PRE card sends the optical signal out of its COM-TX port to the 40-WXC COM-RX input port.
4. The 40-WXC card sends the signal to be locally dropped out of its DROP-TX port to the 40-DMX/40-DMX-CE card COM-RX port.
5. The 40-DMX/40-DMX-CE card sends the dropped signal out on one of its multifiber push on (MPO) connectors to the block labeled MPO. When you expand the MPO block (double-click it or right-click it and select **Down**), you will see a muxponder (MUX) card inside the MPO block. One of the eight optical fibers in the MPO cable is connected to the MUX trunk port.
6. The optical signal from the trunk port of the MXP card inside the MPO block enters the 40-MUX card at one of its five MPO connectors.
7. The 40-MUX card sends the optical signal out of its COM-TX port to the ADD-RX port of the 40-WXC card.
8. The added signal from the MXP gets sent out on the COM-TX port of the 40-WXC card to the COM-RX port of the OPT-BST card.
9. Finally, the OPT-BST card sends the optical signal out onto the span from its LINE-TX port.

9.7.2.2 Displaying Card Information

In the functional view graphical pane, you can double-click a card to bring up the usual CTC card view.

You can also move the mouse over a card to display information about the card. For example, when the mouse is placed over the OPT-BST card in Side A, the tooltip text displays sh1/s1 (OPT-BST), indicating that the OPT-BST card for Side A is located in Shelf 1, Slot 1. See Figure 9-43.

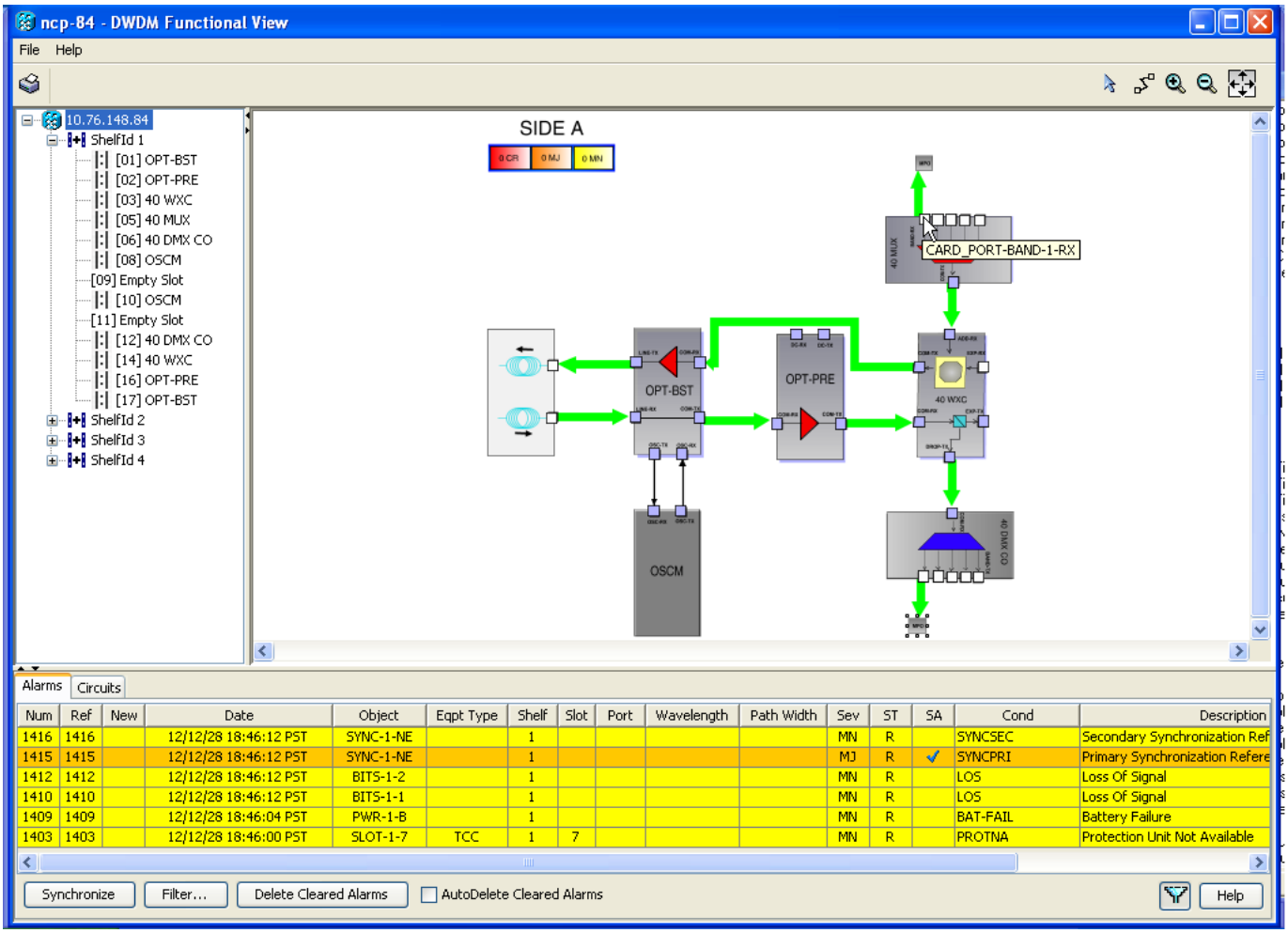
Figure 9-43 Side A OPT-BST Card Shelf and Slot Information



9.7.2.3 Displaying Port Information

Move the mouse over a port on a card to display information about the port. For example, when the mouse is placed over the top left port of the 40-MUX card in Side A, the tooltip text displays CARD_PORT-BAND-1-RX, indicating that the 40-MUX port being pointed to is for the first band of wavelengths (wavelengths 1 to 8) to be added into the optical path at the 40-MUX card. These wavelengths come into the 40-MUX card from a transponder (TXP) or muxponder (MXP) on an MPO connector, which contains eight integrated optical fibers. See Figure 9-44.

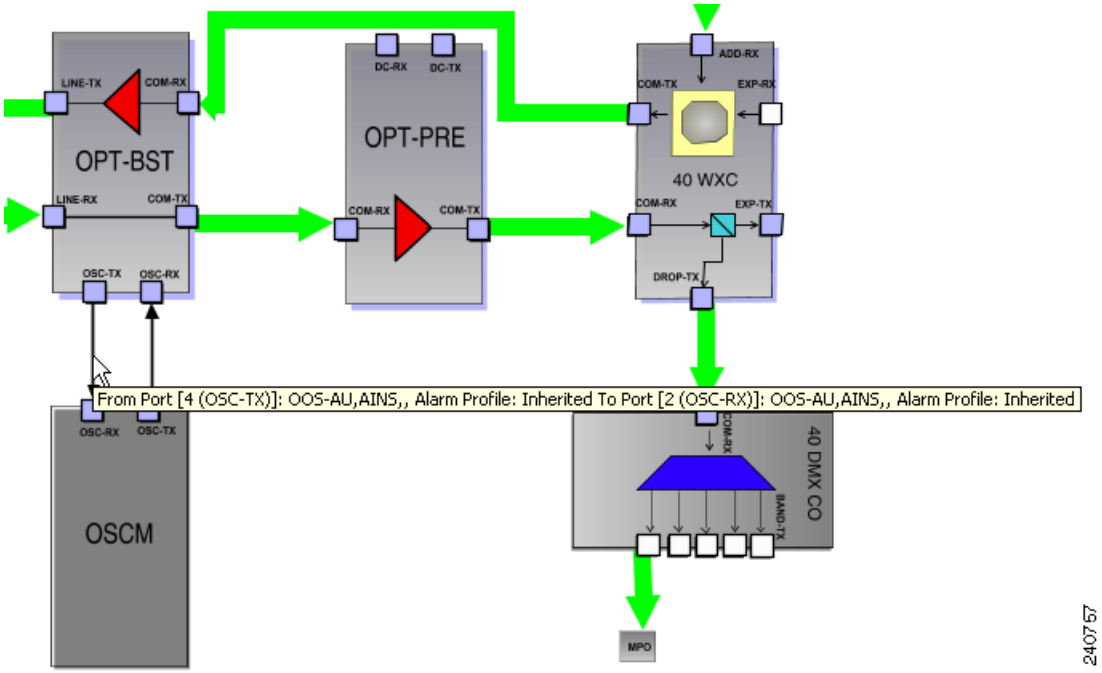
Figure 9-44 Side A 40-MUX Port Information



9.7.2.4 Displaying Patchcord Information

Move the mouse over a patchcord to see the state of the output and input port associated with that patchcord. See Figure 9-45.

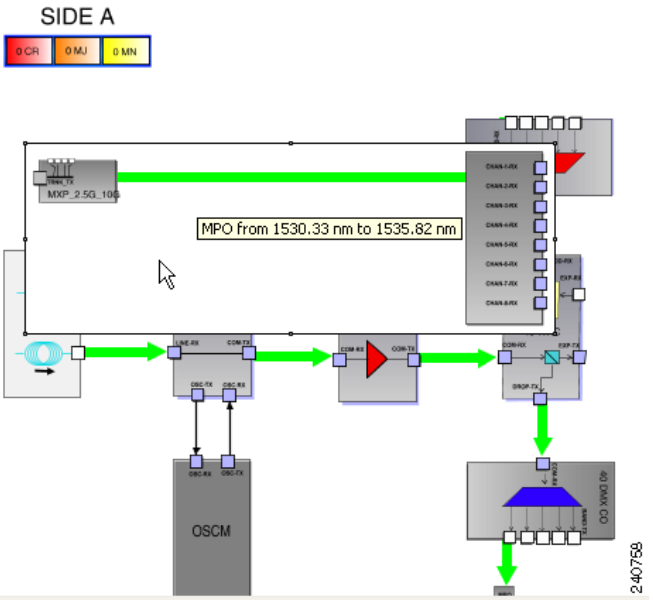
Figure 9-45 Patchcord Input and Output Port State Information



9.7.2.5 Displaying MPO Information

To show the details inside an MPO block, double-click it or right-click it and select **Down**. When the detailed view is visible, right-click inside the MPO block and select **Upper View** to collapse the block. When you move the mouse over the MPO block, the associated wavelengths are displayed as a tool tip (see Figure 9-46).

Figure 9-46 MPO Information



9.7.2.6 Alarm Box Information

Within the side display, an alarm box is shown that gives the alarm count for the Critical, Major, and Minor alarms that affect that side. This alarm summary is only for the side, and is different from the alarms under the Alarms tab, where all of the alarms for the system are summarized. If an alarm under the Alarms tab appears that has to do with Side A, for example, only the appropriate alarm count in the Alarm box for Side A is incremented. The alarm counts in the Alarm boxes for the other nodes (B through H) are not incremented. In the graphical view of a side, the card icon or port icon changes color to reflect the severity of an alarm associated with the card (red, orange, or yellow). The color of the MPO block reflects the color of highest alarm severity for the elements in the MPO block.

9.7.2.7 Transponder and Muxponder Information

All of the TXP and MXP cards connected with patchcords are grouped together under the MPO icon. In node shown in Figure 9-41, there is an MXP card in Side A that is connected to the 40-MUX card and to the 40-DMX/40-DMX-CE card. The MXP card is connected through the 40-MUX card to the add port on the 40-WXC card and it is also connected through the 40-DMX/40-DMX-CE card to the drop port on the 40-WXC card. To view the connections to the MXP card from the 40-MUX card, double-click the MPO icon. Figure 9-47 shows the MPO icon before double-clicking it and Figure 9-48 shows the result after double-clicking it.

Note In the case of a protected TXP (TXPP) or MXP (MXPP) card, the card icon has a label indicating the active trunk and the protected trunk.

Figure 9-47 Side A MPO Connection to an MXP Before Double-Clicking

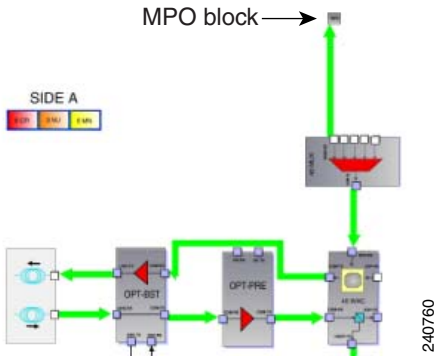
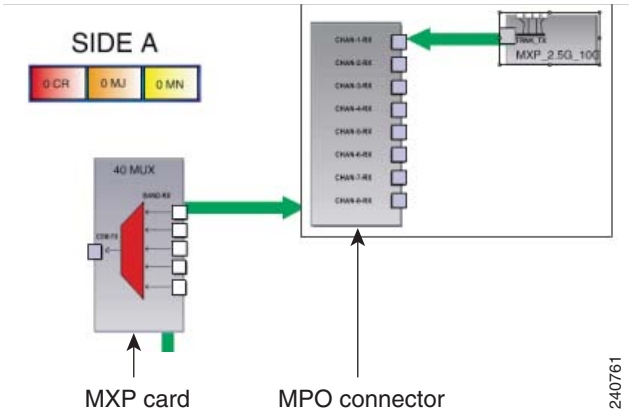


Figure 9-48 Side A MPO Connection to an MXP After Double-Clicking



9.7.2.8 Changing the Views

When you right-click inside of a side view, a shortcut menu allows you to do the following (see Figure 9-49):

- Fit to View—Fits the side view into the available display space.
- Delete Side—Deletes the selected side.
- Rotate Left—Rotates the side 90 degrees counterclockwise (all connections are maintained).
- Rotate Right—Rotates the side 90 degrees clockwise (all connections are maintained).
- Horizontal Flip—Flips the side horizontally (all connections are maintained).

- Vertical Flip—Flips the side vertically (all connections are maintained).

After you have selected Fit to View for a side, you can right-click in the side view to bring up a new menu with the following selections (see Figure 9-50):

- Go to Upper View—Returns to the previous view.
- Perform AutoLayout—Optimizes the placement of the cards and the connections between them.

Figure 9-49 Side A View Options

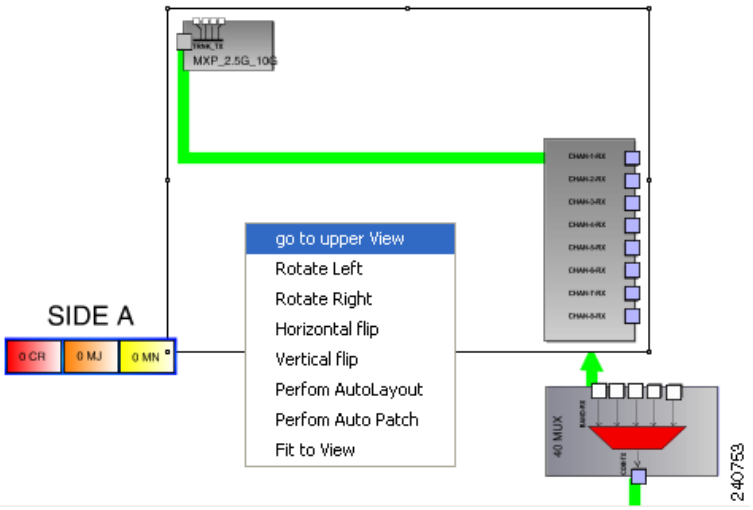
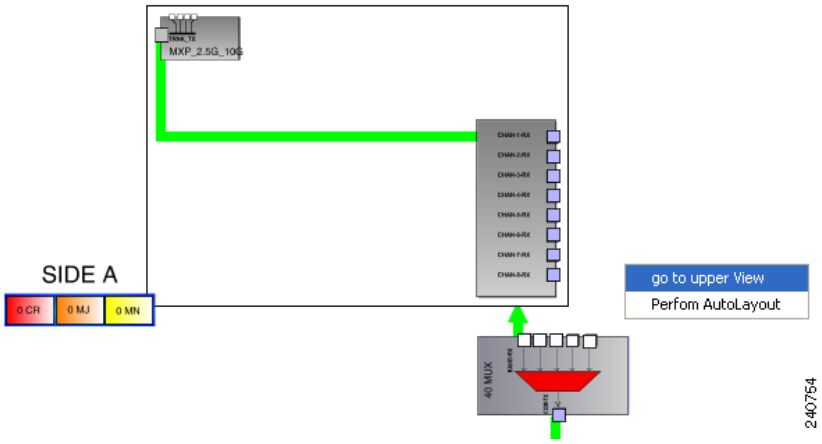


Figure 9-50 Side A View Options (after Selecting Fit to View)



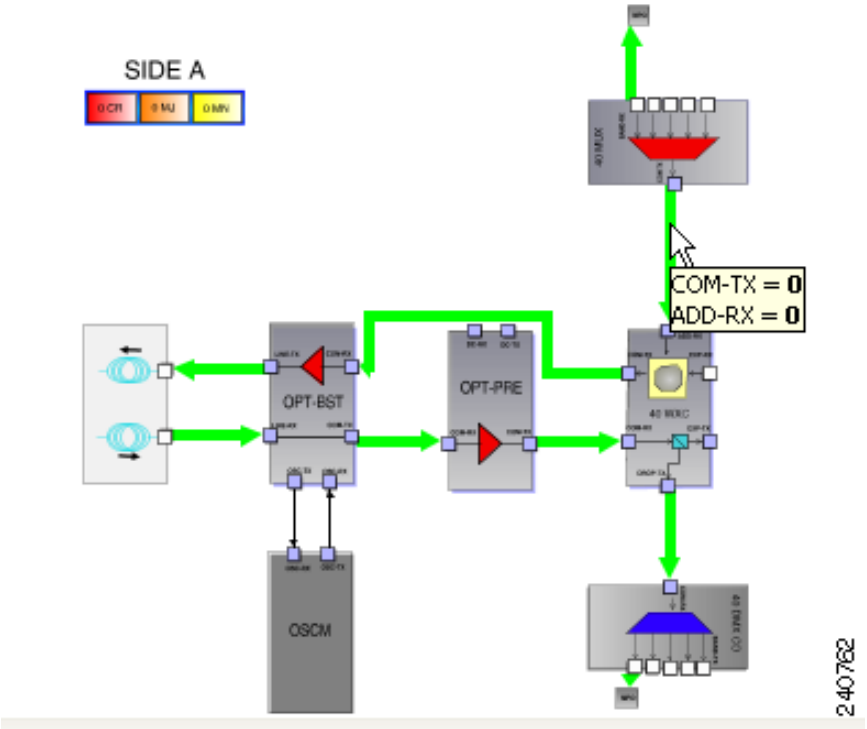
9.7.2.9 Selecting Circuits

When the Circuits tab is selected, the circuits for the functional view are shown. The patchcord lines in the graphical display are normally black in color. A patchcord line becomes green only when you select a circuit associated with the patchcord that carries the selected circuit.

9.7.2.10 Displaying Optical Path Power

To show the optical power present in an optical path, move the mouse over the desired optical path (green line). A tooltip shows the power along the optical path in dBm (see Figure 9-51).

Figure 9-51 Optical Path Power



9.8 Non-DWDM (TDM) Networks

Non-DWDM (TDM) Networks take synchronous and asynchronous signals and multiplexes them to a single higher bit rate for transmission at a single wavelength over fiber. When the node is configured as a Non-DWDM Network, the supported MSTP cards — amplifiers, transponders, and muxponders, are used in the standalone mode. MSTP applications like Circuit Provisioning, NLAC and APC are not supported in amplified TDM networks. For more information on how to configure a node as a Non-DWDM network, see the "NTP-G320 Configure the Node as a Non-DWDM Network" section in "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

When the node is configured as a Not-DWDM network, all the amplifiers are configured by default with the following values:

- Working mode = Control Gain
- Channel Power Ref. = +1dBm.

Booster(LINE) amplifiers enable optical safety when used in Non-DWDM. ALS configuration is set to "Auto Restart" by default. A manual restart request is therefore needed to turn up the bidirectional link, in addition with an appropriated cabling (bi-directional) of LINE TX/RX ports.

In NOT-DWDM mode, you must configure significant optical parameters and thresholds before launching the ANS application. For information on how to configure the amplifier, see the "DLP-G693 Configure the Amplifier" section in "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*. For information on how to configure the PSM behavior, see the "DLP-G694 Configure the PSM" section in "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

When the ANS application is launched, amplifier ports move into IS state and Gain Setpoint is automatically calculated by the card, after initial APR cycle. Gain Setpoint must be equal to MAX [Min Gain Setpoint of the card ; (Power Ref-Pinput)]; where Pinput is the optical power value at the ingress port (COM-RX) of the amplification stage.

CHAPTER 10

Network Reference

This chapter explains the ONS 15454 dense wavelength division multiplexing (DWDM) network applications and topologies. The chapter also provides network-level optical performance references.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Note In this chapter, "OPT-BST" refers to the OPT-BST, OPT-BST-E, OPT-BST-L cards, and to the OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards when they are provisioned in OPT-LINE (optical booster) mode. "OPT-PRE" refers to the OPT-PRE card and to the OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards provisioned in OPT-PRE (pre-amplifier) mode.

Note OPT-BST-L, 32WSS-L, 32DMX-L, and OPT-AMP-L cards can only be installed in L-band-compatible nodes and networks. OPT-BST, OPT-BST-E, 32WSS, 32DMX, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, 40-WXC-C, OPT-AMP-C, and OPT-AMP-17-C cards can only be installed in C-band-compatible nodes and networks.

Chapter topics include:

- 10.1 Network Applications, page 10-2
- 10.2 Network Topologies, page 10-2
- 10.3 Optical Performance, page 10-9
- 10.4 Automatic Power Control, page 10-10
- 10.5 ROADM Power Equalization Monitoring, page 10-16
- 10.6 Span Loss Verification, page 10-17
- 10.7 Network Optical Safety, page 10-18
- 10.8 Network-Level Gain—Tilt Management of Optical Amplifiers, page 10-28
- 10.9 Optical Data Rate Derivations, page 10-34
- 10.10 Even Band Management, page 10-36

10.1 Network Applications

Cisco ONS 15454 nodes can be provisioned for metro core DWDM network applications. Metro core networks often include multiple spans and amplifiers, so the optical signal-to-noise ratio (OSNR) is the limiting factor for channel performance.

Within DWDM networks, the ONS 15454 uses a communications protocol, called Node Services Protocol (NSP), to communicate with other nodes. NSP automatically updates nodes whenever a change in the network occurs. Each ONS 15454 DWDM node can:

- Identify other ONS 15454 DWDM nodes in the network.
- Identify the different types of DWDM networks.
- Identify when the DWDM network is complete and when it is incomplete.

10.2 Network Topologies

The ONS 15454 DWDM network topologies include ring networks, linear networks, and mesh networks.

10.2.1 Ring Networks

Ring networks support hubbed, multi-hubbed, any-to-any, and mesh traffic topologies.

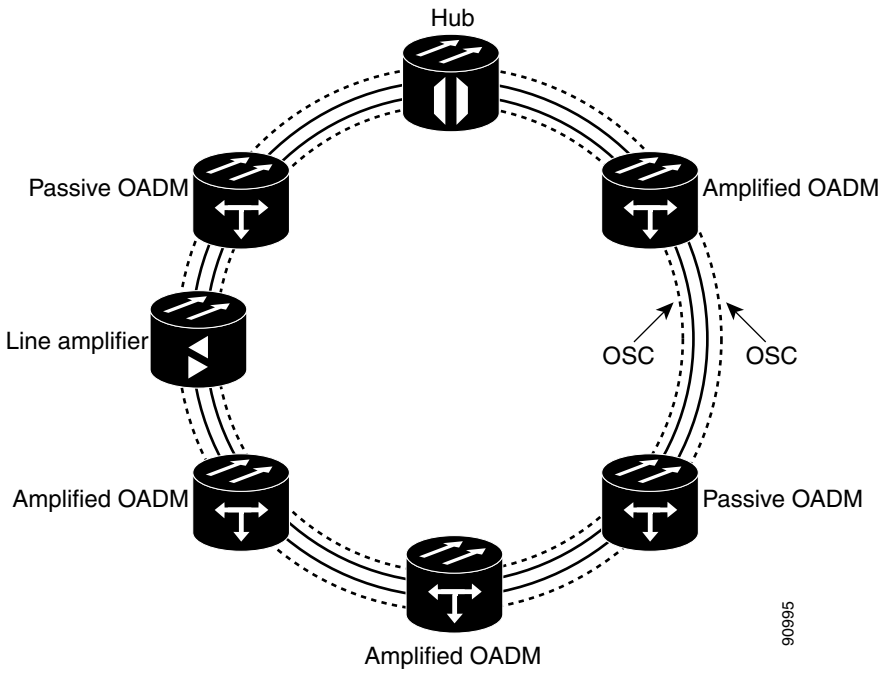
10.2.1.1 Hubbed Traffic Topology

In the hubbed traffic topology (Figure 10-1), 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 optical add/drop multiplexing (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 topology, that is, no channel reuse is possible. However, the same channel can be reused in different 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.

For more information about hub nodes, see the "9.1.1 Hub Node" section on page 9-2.

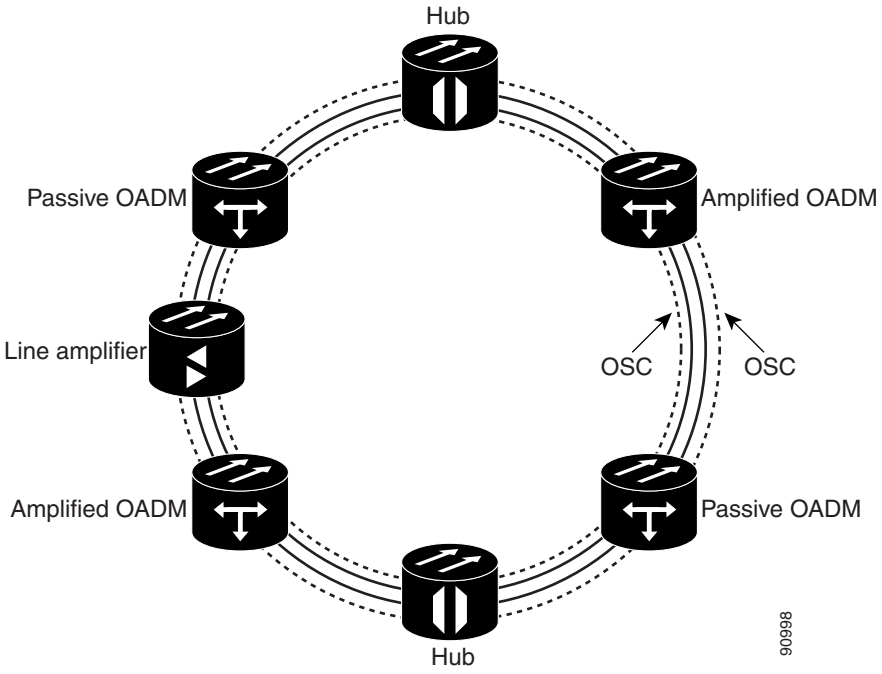
Figure 10-1 Hubbed Traffic Topology



10.2.1.2 Multihubbed Traffic Topology

A multihubbed traffic topology (Figure 10-2) is based on the hubbed traffic 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 10-2 Multihubbed Traffic Topology

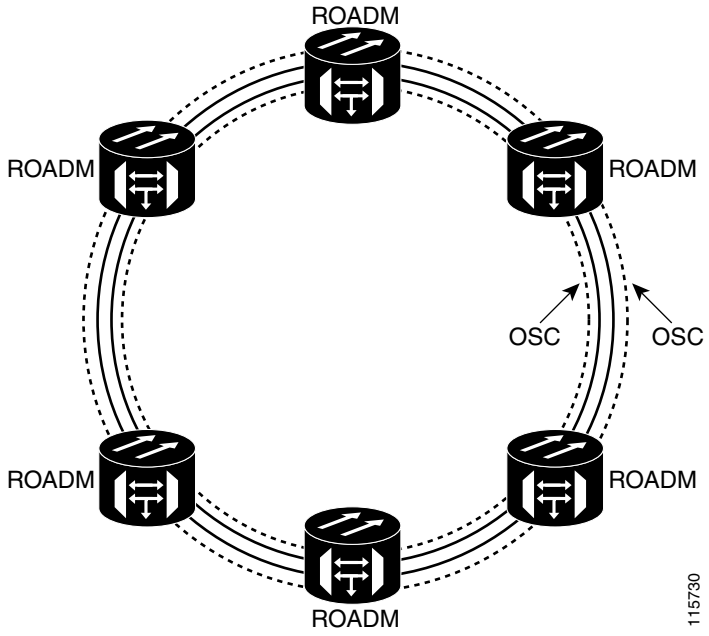


10.2.1.3 Any-to-Any Traffic Topology

The any-to-any traffic topology (Figure 10-3) contains only reconfigurable OADM (ROADM) nodes (with or without optical service channel [OSC] regeneration) or optical amplifier nodes. This topology potentially allows you to route every wavelength from any source to any destination node inside the network.

See the "9.1.4 ROADM Node" section on page 9-12 for more information.

Figure 10-3 Any-to-Any Traffic Topology



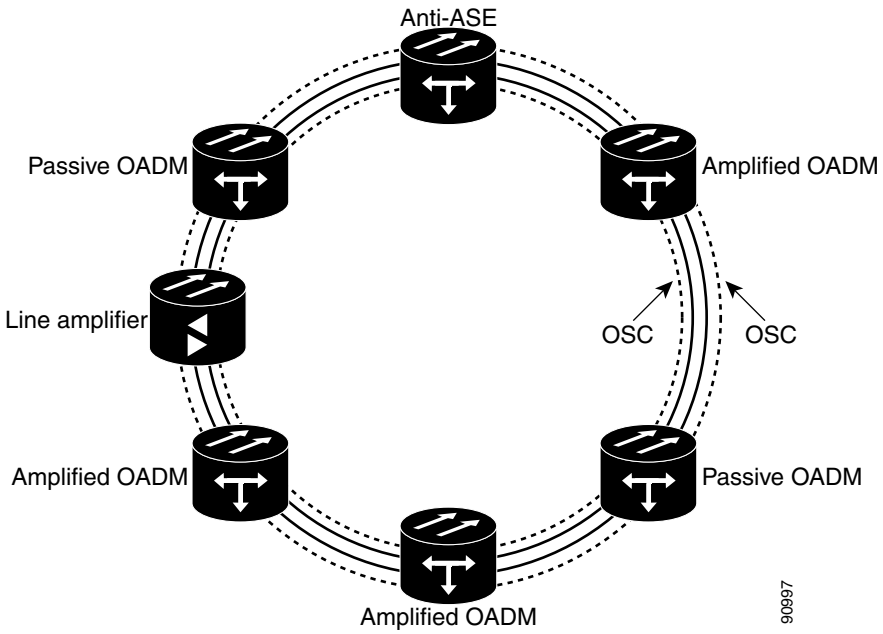
10.2.1.4 Meshed Traffic Topology

The meshed traffic topology (Figure 10-4) 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 amplified spontaneous emission (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 32MUX-O cards and 32DMX-O cards. This solution is adopted when the total number of wavelengths deployed in the ring is higher than ten. OADM nodes equipped with 32MUX-O cards and 32DMX-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 OADM nodes, see the "9.1.3 OADM Node" section on page 9-8. For more information about anti-ASE nodes, see the "9.1.5 Anti-ASE Node" section on page 9-15.

Figure 10-4 Meshed Traffic Topology



10.2.2 Linear Networks

Linear configurations are characterized by the use of two terminal nodes, east and west. The 32-channel terminal nodes can be equipped with a 32MUX-O card and a 32DMX-O card, or with a 32WSS card and a 32DMX or 32DMX-O card. The 40-channel terminal nodes can be equipped with a 40-MUX-C card and a 40-DMX-C/40-DMX-CE card or a 40-WSS-C/40-WSS-CE card with a 40-DMX-C/40-DMX-CE 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 10-5 shows five ONS 15454 nodes in a linear configuration with an amplified and a passive OADM node.

Figure 10-5 Linear Configuration with an OADM Node

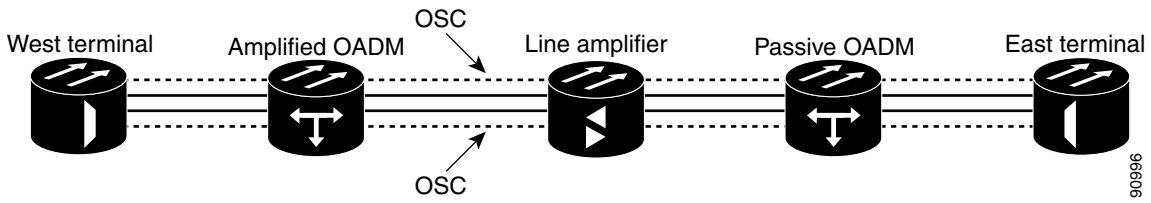
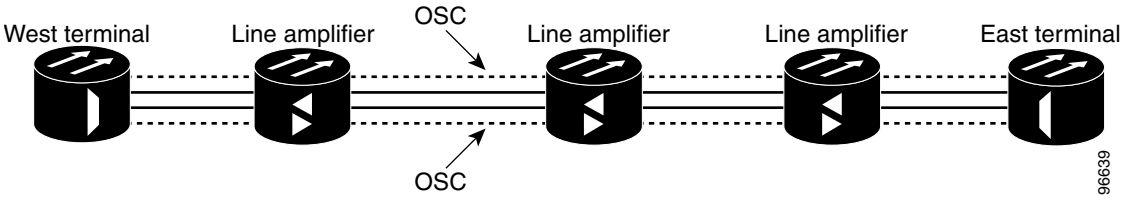


Figure 10-6 shows five ONS 15454 nodes in a linear configuration without an OADM node. See the "9.1.2 Terminal Node" section on page 9-5 for more information.

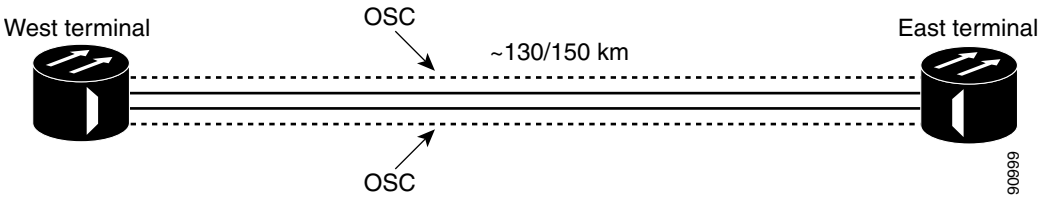
Figure 10-6 Linear Configuration without an OADM Node



A single-span link is a type of linear configuration characterized by a single-span link with preamplification and post-amplification. A single-span link is also characterized by the use of two terminal nodes, east and west. Only unprotected traffic can be provisioned on a single-span link.

Figure 10-7 shows ONS 15454s in a single-span link. Eight channels are carried on one span. Single-span link losses apply to OC-192/STM-64 LR ITU cards. The optical performance values are valid assuming that the sum of the OADM passive node insertion losses and the span losses does not exceed 35 dB.

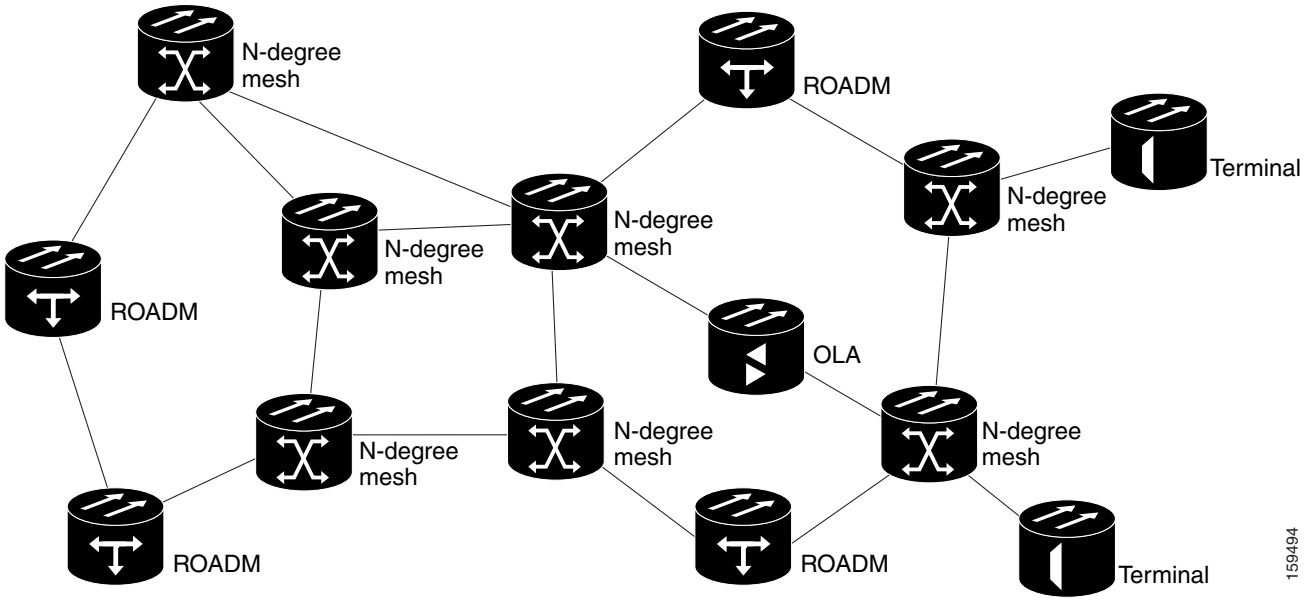
Figure 10-7 Single-Span Link



10.2.3 Mesh Networks

A mesh network can be native or multiring. In a native mesh network (Figure 10-8), any combination of four-degree and eight-degree mesh nodes can work together. Four-degree mesh nodes transmit an optical signal in four directions, while an eight-degree mesh node transmits an optical signal in eight directions. For additional information about mesh nodes, see the "9.4 Configuring Mesh DWDM Networks" section on page 9-30. The intermediate nodes are ROADM nodes. In a mesh node, all wavelengths can be routed through four (four-degree mesh node) to eight (eight-degree mesh node) different optical line termination ports using a 40-WXC-C card without any optical-electrical-optical (OEO) regeneration. It is possible to combine 40-WSS-C/40-WSS-CE, 40-WXC-C, and 32WSS cards in the same mesh network without impacting system performance. For nodes equipped with 32WSS cards, the maximum system capacity is 32 channels. Terminal sites are connected to the mesh network as a spur.

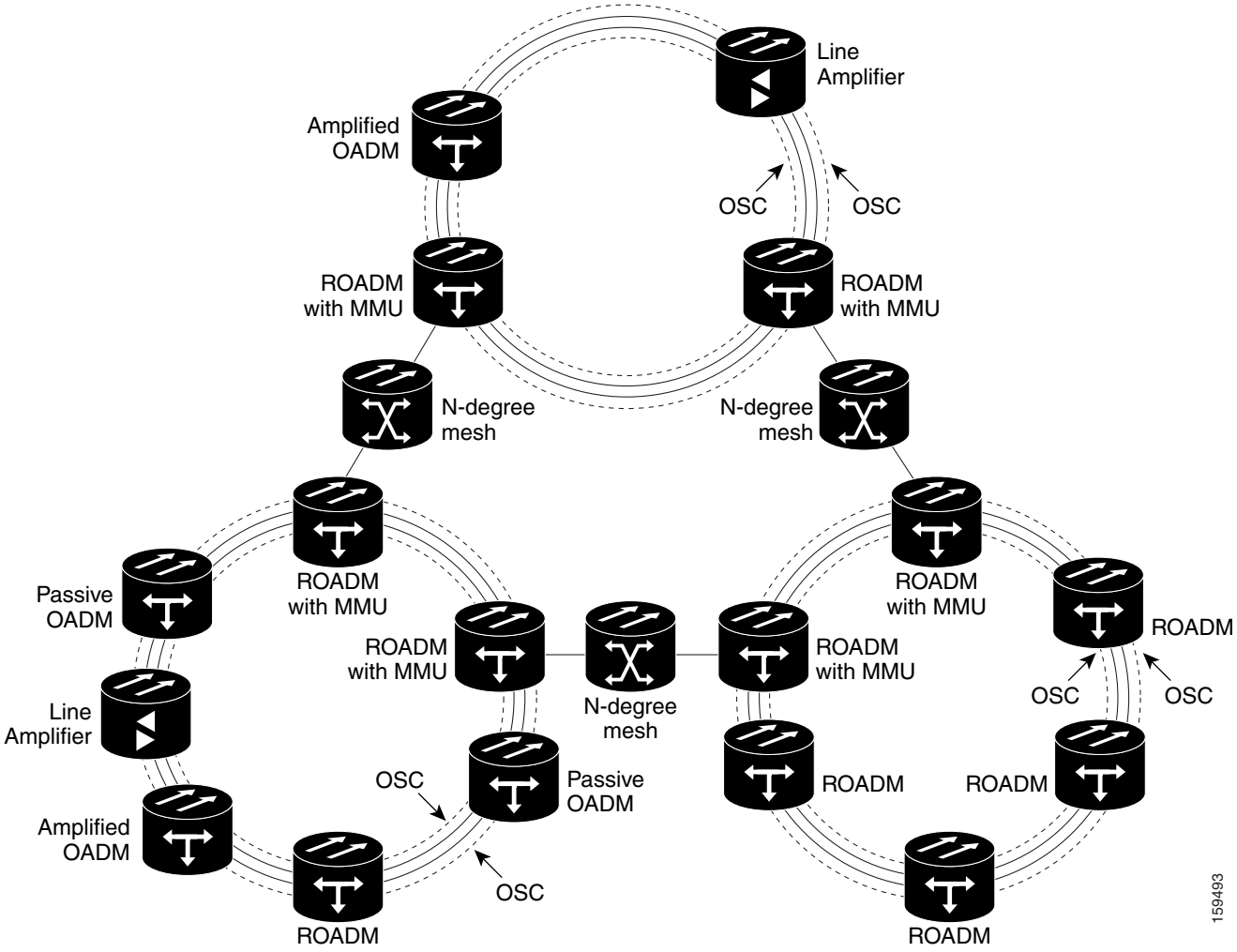
Figure 10-8 Mesh Network



In a multiring mesh network (Figure 10-9), several rings are connected with four-degree or eight-degree mesh nodes. The intermediate ROADM nodes are equipped with MMU cards. All wavelengths can be routed among two or more rings using a 40-WXC-C card without any optical-electrical-optical (OEO) regeneration. As in a native mesh network, is possible to combine 40-WSS-C/40-WSS-CE , 40-WXC-C, and 32WSS cards in the same multiring network without impacting system performance. For nodes equipped with 32WSS cards, maximum system capacity is limited to 32 channels. A terminal node is connected to a multiring node as a spur.

For information on node configurations for both native mesh and multiring networks, see the "9.4 Configuring Mesh DWDM Networks" section on page 9-30.

Figure 10-9 Multiring Network



10.3 Optical Performance

This section provides optical performance information for ONS 15454 DWDM networks. The performance data is a general guideline based upon the network topology, node type, client cards, fiber type, number of spans, and number of channels. The maximum number of nodes that can be in an ONS 15454 DWDM network is 16. The DWDM topologies and node types that are supported are shown in Table 10-1.

Table 10-1 Supported Topologies and Node Types

Number of Channels	Fiber	Topologies	Node Types
32 channels	SMF-28[1]	Ring	Hub
	E-LEAF[2]	Linear	Active OADM
	TW-RS[3]	Linear without OADM	Passive OADM
			Terminal
			Line
			OSC regeneration
16 channels	SMF-28	Ring	Hub
		Linear	Active OADM
		Linear without OADM	Passive OADM
			Terminal
			Line
			OSC regeneration
8 channels	SMF-28	Linear without OADM	Terminal
			Line

1. SMF-28 = single-mode fiber 28.
2. E-LEAF = enhanced large effective area fiber.
3. TW-RS = TrueWave reduced slope fiber.

10.4 Automatic Power Control

The ONS 15454 automatic power control (APC) feature performs the following functions:

- Maintains constant per-channel power when desired or accidental changes to the number of channels occur. Constant per-channel power increases optical network resilience.
- Compensates for optical network degradation (aging effects).
- Simplifies the installation and upgrade of DWDM optical networks by automatically calculating the amplifier setpoints.

Note APC algorithms manage the optical parameters of the OPT-BST, OPT-PRE, OPT-AMP-17-C, 32DMX, 40-DMX-C, 40-DMX-CE, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, and 32DMX-L 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 proportionately 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/TCC2P 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/TCC2P compares the actual amplifier output power with the expected amplifier output power and modifies the setpoints if any discrepancies occur.

10.4.1 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 traffic being carried. The letters m and n in the following formula represent two different channel numbers. Pin/ch represents the input power per channel.

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.

The per-channel power and working mode (gain or power) are set by automatic node setup (ANS). The provisioning is conducted on a per-side basis. A preamplifier or a booster amplifier facing Side *i* is provisioned using the Side *i* parameters present in the node database, where *i* - A, B, C, D, E, F, G, or H.

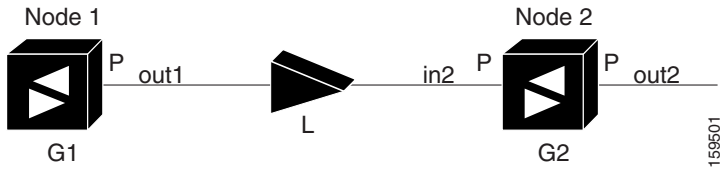
Starting from the expected per-channel power, the amplifiers automatically calculate the gain setpoint after the first channel is provisioned. An amplifier gain setpoint is calculated in order to make it equal to the loss of the span preceding the amplifier itself. After the gain is calculated, the setpoint 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.

10.4.2 APC at the Shelf Controller Layer

Amplifiers are managed through software to control changes in the input power caused by changes in the number of channels. The software adjusts the output total power to maintain a constant per-channel power value when the number of input channel changes.

Changes in the network characteristics have an impact on the amplifier input power. Changes in the input power are compensated for only by modifying the original calculated gain, because input power changes imply changes in the span loss. As a consequence, the gain to span loss established at amplifier start-up is no longer satisfied, as shown in Figure 10-10.

Figure 10-10 Using Amplifier Gain Adjustment to Compensate for System Degradation



In Figure 10-10, Node 1 and Node 2 are equipped with booster amplifiers and preamplifiers. The input power received at the preamplifier on Node 2 (Pin2) depends on the total power launched by the booster amplifier on Node1, Pout1(n) (where n is the number of channels), and the effect of the span attenuation (L) between the two nodes. Span loss changes due to aging fiber and components or changes in operating conditions. The power into Node 2 is given by the following formula:

Pin2 = LPout1(n)

The phase gain of the preamplifier on Node 2 (GPre-2) is set during provisioning in order to compensate for the span loss so that the Node 2 preamplifier output power (Pout-Pre-2) is equal to the original transmitted power, as represented in the following formula:

Pout-Pre-2 = L x GPre-2 x Pout1(n)

In cases of system degradation, the power received at Node 2 decreases due to the change of span insertion loss (from L to L'). As a consequence of the preamplifier gain control working mode, the Node 2 preamplifier output power (Pout-Pre-2) also decreases. The goal of APC at the shelf controller layer is simply to detect if an amplifier output change is needed because of changes in the number of channels or to other factors. If factors other than changes in the number of channels occur, APC provisions a new gain at the Node 2 preamplifier (GPre-2') to compensate for the new span loss, as shown in the formula:

GPre-2' = GPre-2 (L/ L') = GPre-2 + [Pout-Pre-2 –Exp(Pout-Pre-2)]

Generalizing on the above relationship, APC is able to compensate for system degradation by adjusting working amplifier gain or variable optical attenuation (VOA) and to eliminate the difference between the power value read by the photodiodes and the expected power value. The expected power values are 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 that is distributed among different nodes. An APC domain is a set of nodes that is controlled by the same instance of APC at the network level. An APC domain optically identifies a portion of the network that can be independently regulated. An optical network can be divided into several different domains, with the following characteristics:

- Every domain is terminated by two node sides. The node sides terminating domains are:
  - Terminal node (any type)
  - ROADM node
  - Hub node
  - Cross-connect (XC) termination mesh node
  - Line termination mesh node
- APC domains are shown in both Cisco Transport Controller (CTC) and Transaction Language One (TL1).

- In CTC, domains are shown in the network view and reported as a list of spans. Each span is identified by a node/side pair, for example:

  APC Domain Node_1 Side A, Node_4 Side B
  + Span 1: Node_1 Side A, Node_2 Side B
  + Span 2: Node_2 Side A, Node_3 Side B
  + Span 3: Node_3 Side A, Node_4 Side B

- APC domains are not refreshed automatically; instead, they are refreshed using a Refresh button.

Inside a domain, 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 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.

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 compensates for it by using all margins that you provision during installation.

If no margin is available, adjustments cannot be made because setpoints exceed the ranges. APC communicates the event to CTC, Cisco Transport Manager (CTM), and TL1 through an APC Fail condition. APC clears the APC fail condition when the setpoints return to the allowed ranges.

APC can be manually disabled. In addition, APC automatically disables itself when:

- An Hardware Fail (HF) alarm is raised by any card in any of the domain nodes.
- A Mismatch Equipment Alarm (MEA) is raised by any card in any of the domain nodes.
- An Improper Removal (IMPROPRMVL) alarm is raised by any card in any of the domain nodes.
- Gain Degrade (GAIN-HDEG), Power Degrade (OPWR-HDEG), and Power Fail (PWR-FAIL) alarms are raised by the output port of any amplifier card in any of the domain nodes.
- A VOA degrade or fail alarm is raised by any of the cards in any of the domain nodes.
- The signaling protocol detects that one of the APC instances in any of the domain nodes is no longer reachable.

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 is disabled on all the other nodes and the APC state changes to DISABLE - INTERNAL. The disabled state is raised only by the node where the problem occurred to simplify troubleshooting.

APC raises the following minor, non-service-affecting alarms at the port level in CTC, TL1, and Simple Network Management Protocol (SNMP):

- APC Out of Range—APC cannot assign a new setpoint for a parameter that is allocated to a port because the new setpoint exceeds the parameter range.
- APC Correction Skipped—APC skipped a correction to one parameter allocated to a port because the difference between the expected and current values exceeds the +/– 3 dB security range.

- APC Disabled—APC is disabled, either by a user or internal action.

After the error condition is cleared, the signaling protocol enables APC on the network and the APC DISABLE - INTERNAL condition is cleared. Because APC is required after channel provisioning to compensate for ASE effects, all optical channel network connection (OCHNC) and optical channel client connection (OCHCC) circuits that you provision during the disabled APC state are kept in the Out-of-Service and Autonomous, Automatic In-Service (OOS-AU,AINS) (ANSI) or Unlocked-disabled,automaticInService (ETSI) service state until APC is enabled. OCHNCs and OCHCCs automatically go into the In-Service and Normal (IS-NR) (ANSI) or Unlocked-enabled (ETSI) service state only after APC is enabled.

10.4.3 Managing APC

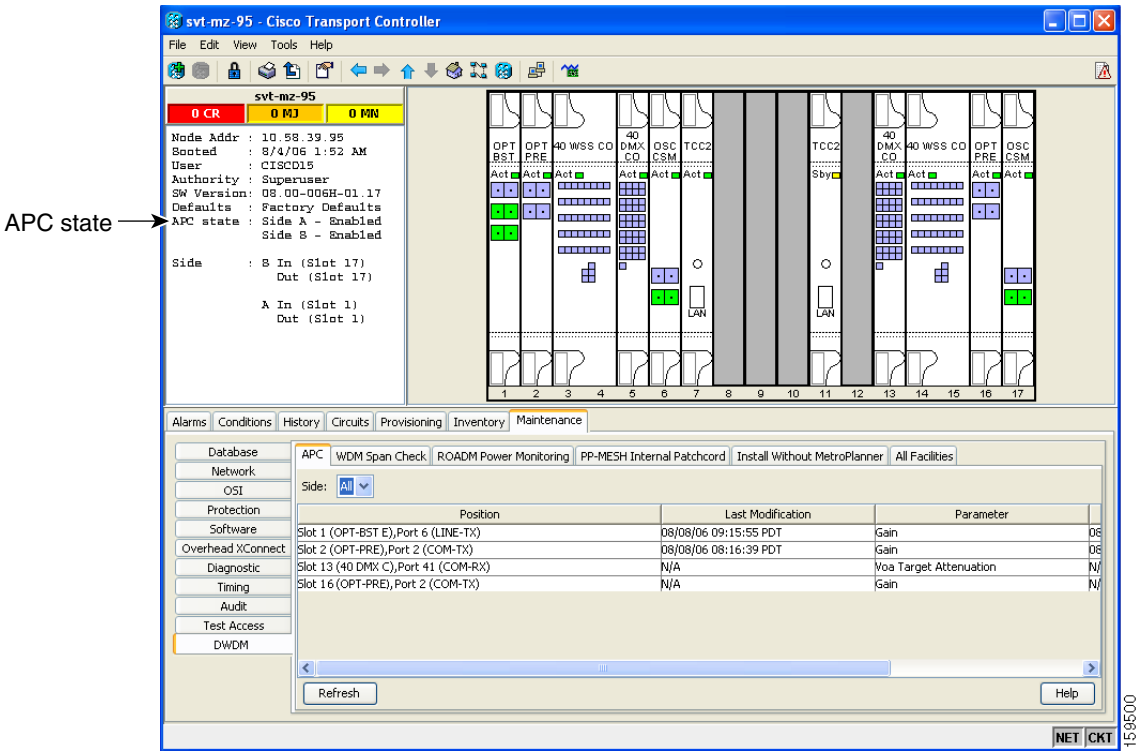
The APC status is indicated by four APC states shown in the node view status area:

- Enabled—APC is enabled.
- Disabled—APC was disabled manually by a user.
- Disable - Internal—APC has been automatically disabled for an internal cause.
- Not Applicable—The node is provisioned to Not DWDM, which does not support APC.

You can view the APC information and disable and enable APC manually on the Maintenance > DWDM > APC tab. See Figure 10-11 for an example of how the information is displayed.

Caution When APC is disabled, aging compensation is not applied and circuits cannot be activated. Do not disable APC unless it is required for specific maintenance or troubleshooting tasks. Always enable APC as soon as the tasks are completed.

Figure 10-11 Automatic Power Control



The APC subtab provides the following information:

- Position—The slot number, card, and port for which APC information is shown.
- Last Modification—Date and time APC parameter setpoints were last modified.
- Parameter—The parameter that APC last modified.
- Last Check—Date and time APC parameter setpoints were last verified.
- Side—The side where the APC information for the card and port is shown.
- State—The APC state.

A wrong use of maintenance procedures (for example, the procedures to be applied in case of fiber cut repair) can lead the system to raise the APC Correction Skipped alarm. The APC Correction Skipped alarm strongly limits network management (for example, a new circuit cannot be turned into IS). The Force APC Correction button helps to restore normal conditions by clearing the APC Correction Skipped alarm.

The Force APC Correction button must be used under the Cisco TAC surveillance since its misuse can lead to traffic loss.

The Force APC Correction button is available in the **Card View > Maintenance > APC** tab pane in CTC for the following cards:

- OPT-PRE
- OPT-BST-E
- OPT-BST
- OPT-AMP-C
- OPT-AMP-17C

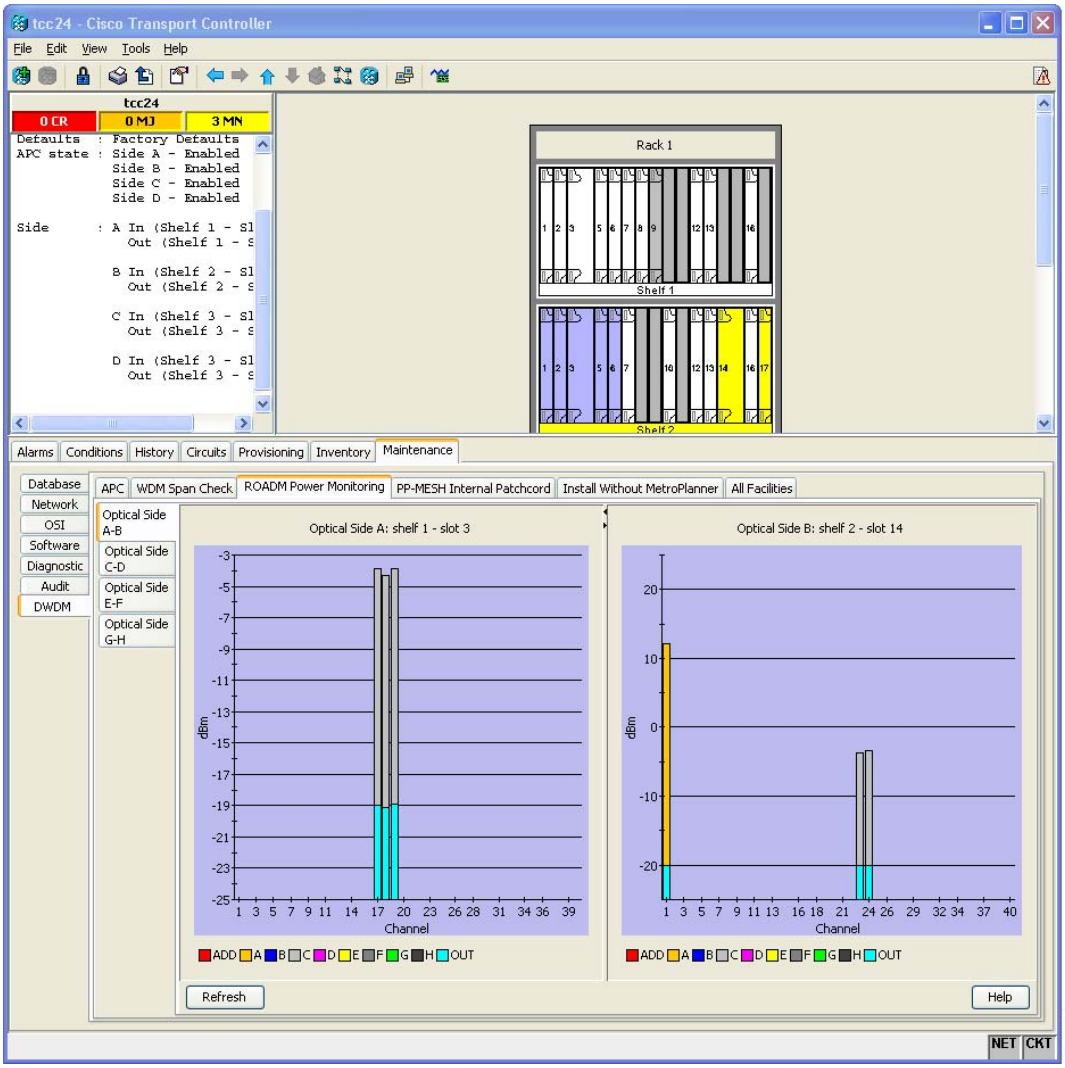
- AD-xB
- AD-xC

This feature is not available for the TL1 interface.

10.5 ROADM Power Equalization Monitoring

ROADM nodes allow you to monitor the 32WSS, 40-WSS-C/40-WSS-CE, and 40-WXC-C card equalization functions on the Maintenance > DWDM > ROADM Power Monitoring > Optical Side *n-n* tab, where *n-n* is A-B, C-D, E-F, or G-H (Figure 10-12). The tab shows the input channel power (Padd), the express or pass-through power (Ppt) and the power level at output (Pout).

Figure 10-12 ROADM Power Monitoring Subtab



10.6 Span Loss Verification

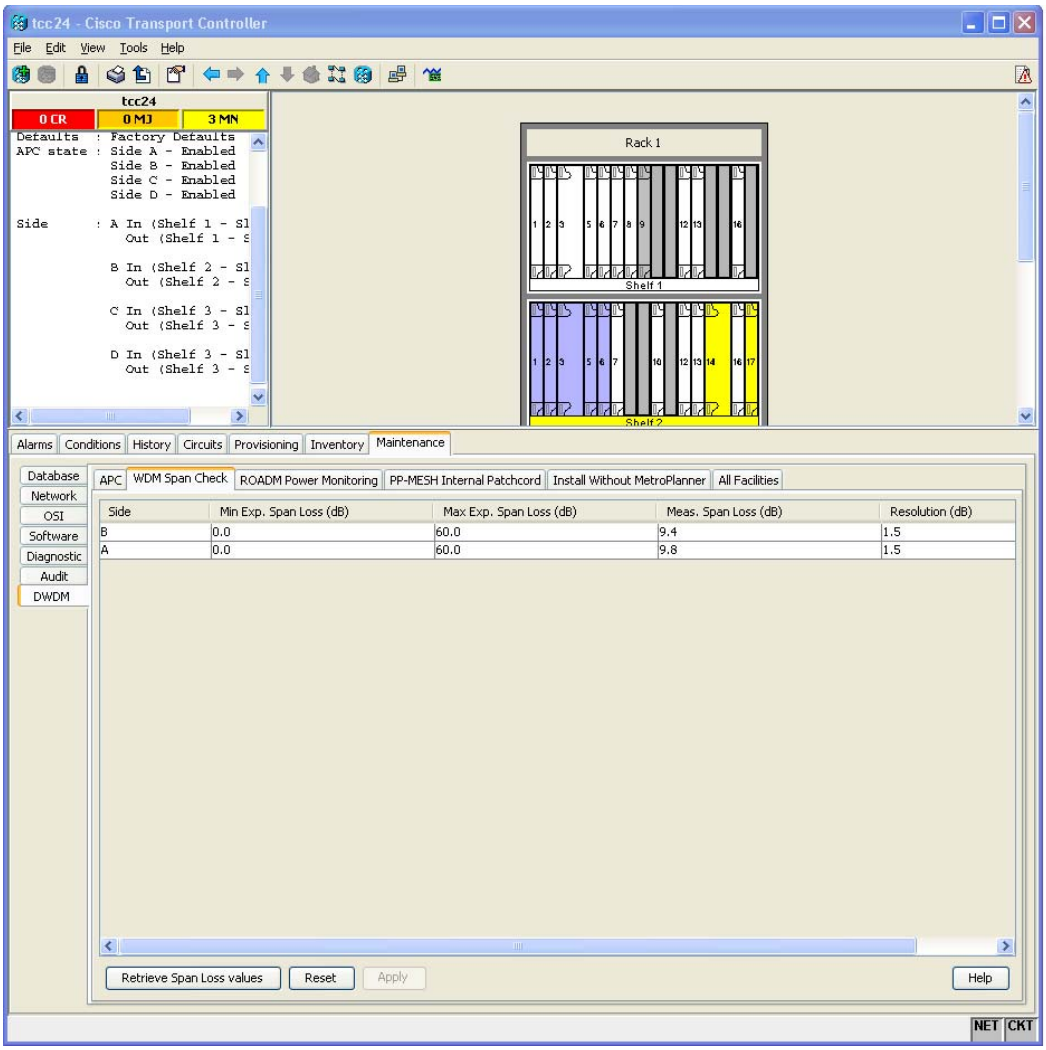
Span loss measurements can be performed from the Maintenance > DWDM > WDM Span Check tab (Figure 10-13). The CTC span check compares the far-end OSC power with the near-end OSC power. A Span Loss Out of Range condition is raised when the measured span loss is higher than the maximum expected span loss. It is also raised when the measured span loss is lower than the minimum expected span loss and the difference between the minimum and maximum span loss values is greater than 1 dB. The minimum and maximum expected span loss values are calculated by Cisco TransportPlanner for the network and imported into CTC. However, you can manually change the minimum and expected span loss values.

CTC span loss measurements provide a quick span loss check and are useful whenever changes to the network occur, for example after you install equipment or repair a broken fiber. CTC span loss measurement resolutions are:

- +/– 1.5 dB for measured span losses between 0 and 25 dB
- +/– 2.5 dB for measured span losses between 25 and 38 dB

For ONS 15454 span loss measurements with higher resolutions, an optical time domain reflectometer (OTDR) must be used.

Figure 10-13 Span Loss Verification



10.7 Network Optical Safety

If a fiber break occurs on the network, automatic laser shutdown (ALS) automatically shuts down the OSCM and OSC-CSM OSC laser output power and the optical amplifiers contained in the OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards. The Maintenance > ALS tabs in CTC card view provide the following ALS management options for OSCM, OSC-CSM, OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards:

- Disable—ALS is off. The OSC laser transmitter and optical amplifiers are not automatically shut down when a traffic outage loss of signal (LOS) occurs.
- Auto Restart—ALS is on. The OSC laser transmitter and optical amplifiers automatically shut down when traffic outages (LOS) occur. It automatically restarts when the conditions that caused the outage are resolved. Auto Restart is the default ALS provisioning for OSCM, OSC-CSM, OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards.

- Manual Restart—ALS is on. The OSC laser transmitter and optical amplifiers automatically shut down when traffic outages (LOS) occur. However, the laser must be manually restarted when conditions that caused the outage are resolved.
- Manual Restart for Test—Manually restarts the OSC laser transmitter and optical amplifiers for testing.

Warning **All ONS 15454 users must be properly trained on laser safety hazards in accordance with IEC 60825-2, or ANSI Z136.1.**

10.7.1 Automatic Laser Shutdown

When ALS is enabled on OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OSCM, and OSC-CSM cards, a network safety mechanism will occur in the event of a system failure. ALS provisioning is also provided on the transponder (TXP) and muxponder (MXP) cards. However, if a network uses ALS-enabled OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OSCM, and OSC-CSM cards, ALS does not need to be enabled on the TXP cards or MXP cards. ALS is disabled on TXP and MXP cards by default and the network optical safety is not impacted.

If TXP and MXP cards are connected directly to each other without passing through a DWDM layer, ALS should be enabled on them. The ALS protocol goes into effect when a fiber is cut, enabling some degree of network point-to-point bidirectional traffic management between the cards.

If ALS is disabled on the OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OSCM, and OSC-CSM cards (the DWDM network), ALS can be enabled on the TXP and MXP cards to provide laser management in the event of a fiber break in the network between the cards.

10.7.2 Automatic Power Reduction

Automatic power reduction (APR) is controlled by the software and is not user configurable. During amplifier restart after a system failure, the amplifier (OPT-BST, for example) operates in pulse mode and an APR level is activated so that the Hazard Level 1 power limit is not exceeded. This is done to ensure personnel safety.

When a system failure occurs (cut fiber or equipment failure, for example) and ALS Auto Restart is enabled, a sequence of events is placed in motion to shut down the amplifier laser power, then automatically restart the amplifier after the system problem is corrected. As soon as a loss of optical payload and OSC is detected at the far end, the far-end amplifier shuts down. The near-end amplifier then shuts down because it detects a loss of payload and OSC due to the far-end amplifier shutdown. At this point, the near end attempts to establish communication to the far end using the OSC laser transmitter. To do this, the OSC emits a two-second pulse at very low power (maximum of 0 dBm) and waits for a similar two-second pulse in response from the far-end OSC laser transmitter. If no response is received within 100 seconds, the near end tries again. This process continues until the near end receives a two-second response pulse from the far end, indicating the system failure is corrected and full continuity in the fiber between the two ends exists.

After the OSC communication is established, the near-end amplifier is configured by the software to operate in pulse mode at a reduced power level. It emits a nine-second laser pulse with an automatic power reduction to +8 dBm. This level assures that Hazard Level 1 is not exceeded, for personnel safety,

even though the establishment of successful OSC communication is assurance that any broken fiber is fixed. If the far-end amplifier responds with a nine-second pulse within 100 seconds, both amplifiers are changed from pulse mode at reduced power to normal operating power mode.

For a direct connection between TXP or MXP cards, when ALS Auto Restart is enabled and the connections do not pass through a DWDM layer, a similar process takes place. However, because the connections do not go through any amplifier or OSC cards, the TXP or MXP cards attempt to establish communication directly between themselves after a system failure. This is done using a two-second restart pulse, in a manner similar to that previously described between OSCs at the DWDM layer. The power emitted during the pulse is below Hazard Level 1.

Warning **In the event that ALS is disabled, a larger amount of invisible laser radiation might be emitted from the end of the unterminated fiber cable or connector. Do not view the end of the fiber 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.**

Note If you must disable ALS, verify that all fibers are installed in a restricted location. Enable ALS immediately after finishing the maintenance or installation process.

Note For the line amplifier to start up automatically, disable the ALS on the terminal node that is unidirectional.

10.7.3 Fiber Cut Scenarios

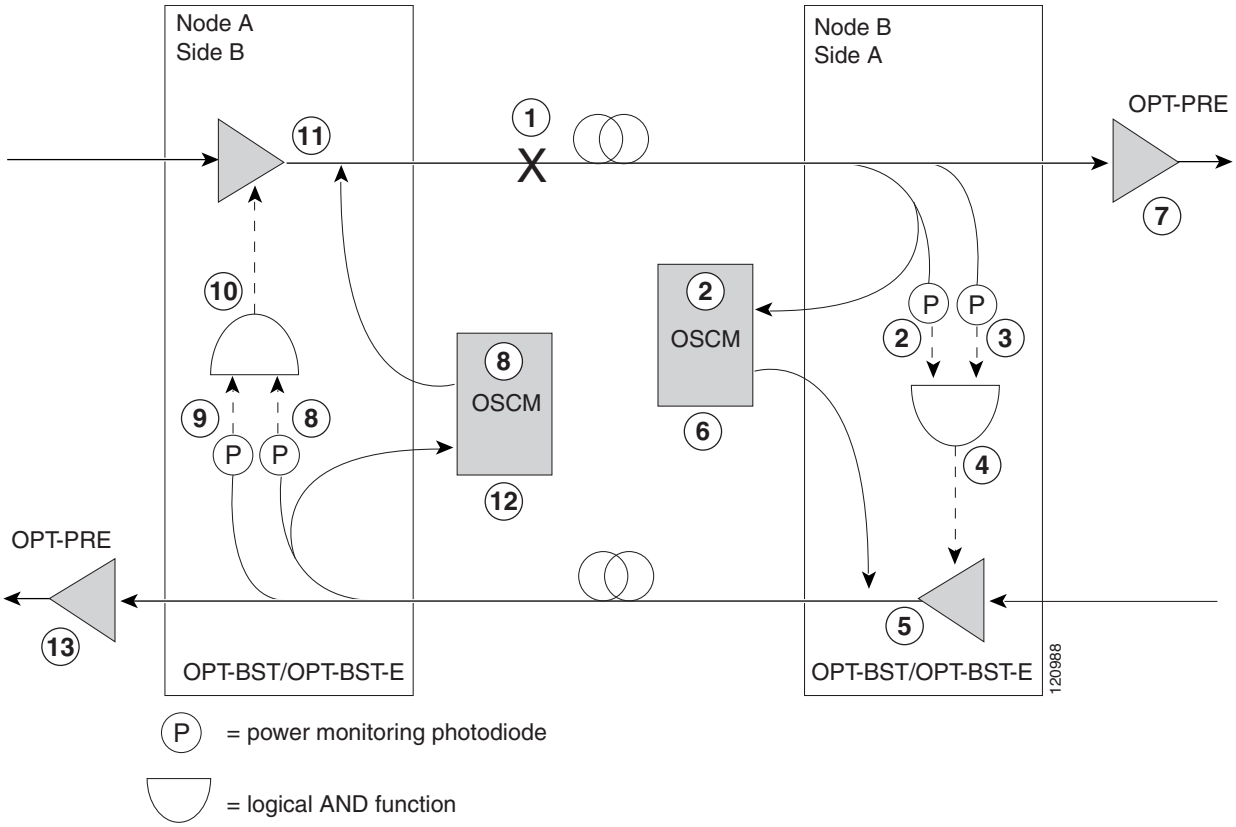
In the following paragraphs, four ALS scenarios are given:

- Nodes using OPT-BST/OPT-BST-E cards (amplified nodes)
- Nodes using OSC-CSM cards (passive nodes)
- Nodes using OPT-BST-L cards (amplified nodes)
- Nodes using OPT-AMP-L, OPT-AMP-C, or OPT-AMP-17-C cards (amplified nodes)
- Nodes using DCN extensions

10.7.3.1 Scenario 1: Fiber Cut in Nodes Using OPT-BST/OPT-BST-E Cards

Figure 10-14 shows nodes using OPT-BST/OPT-BST-E cards with a fiber cut between them.

Figure 10-14 Nodes Using OPT-BST/OPT-BST-E Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-BST/OPT-BST-E transmitter, OPT-PRE transmitter, and OSCM lasers to shut down. This in turn leads to an LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM, OPT-PRE transmitter, and OPT-BST/OPT-BST-E transmitter lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 10-14):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects a Loss of Incoming Payload (LOS-P) on the OPT-BST/OPT-BST-E card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OPT-BST/OPT-BST-E card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The OPT-BST/OPT-BST-E card amplifier is shut down within one second.
5. The OSCM laser is shut down.
6. The OPT-PRE card automatically shuts down due to a loss of incoming optical power.
7. The Node A power monitoring photodiode detects a LOS-O on the OPT-BST/OPT-BST-E card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
8. The Node A power monitoring photodiode detects a LOS-P on the OPT-BST/OPT-BST-E card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

9. On the OPT-BST/OPT-BST-E, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. The OPT-BST/OPT-BST-E card amplifier is shut down within one second.
11. The OSCM laser is shut down.
12. The Node A OPT-PRE card automatically shuts down due to a loss of incoming optical power.

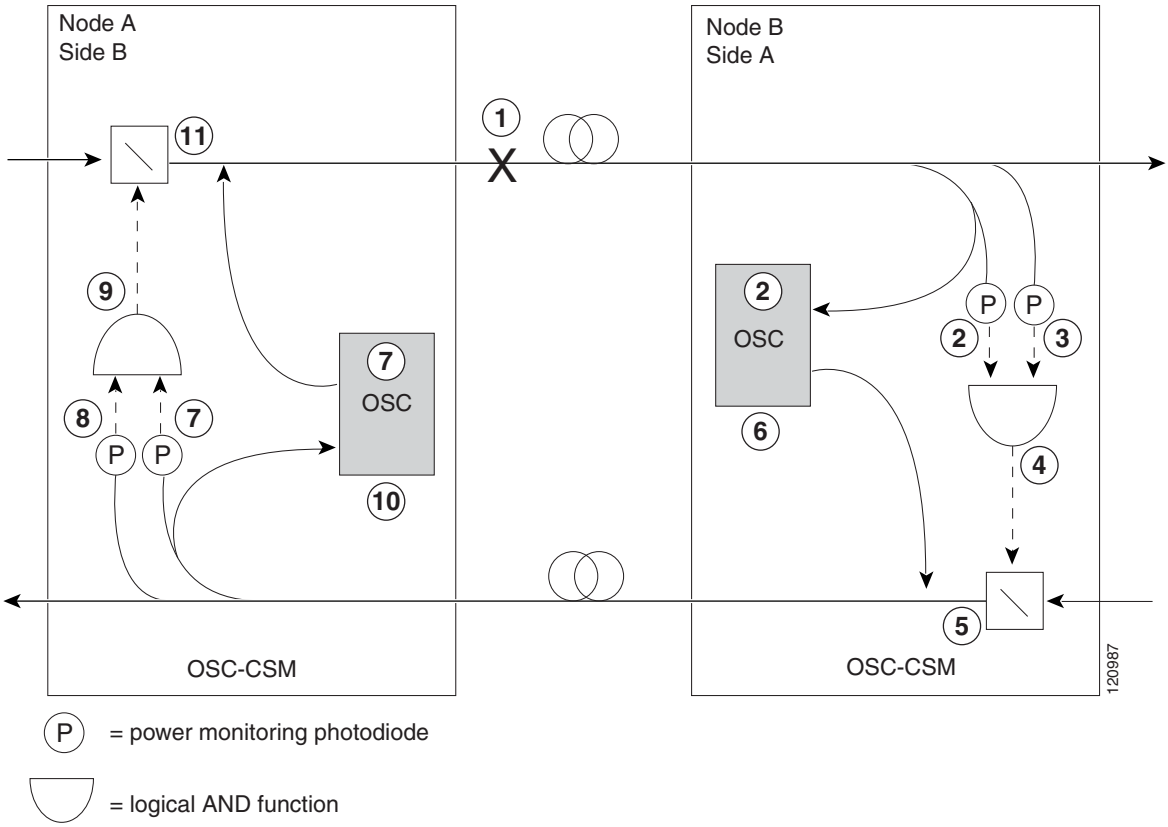
When the fiber is repaired, either an automatic or manual restart at the Node A OPT-BST/OPT-BST-E transmitter or at the Node B OPT-BST/OPT-BST-E transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse is used to signal that the optical path has been restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST/OPT-BST-E transmitter to begin transmitting an optical signal. The OPT-BST/OPT-BST-E receiver at Node A receives that signal and signals the Node A OPT-BST/OPT-BST-E transmitter to resume transmitting.

Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "10.7.2 Automatic Power Reduction" section on page 10-19 for more information about APR.

10.7.3.2 Scenario 2: Fiber Cut in Nodes Using OSC-CSM Cards

Figure 10-15 shows nodes using OSC-CSM cards with a fiber cut between them.

Figure 10-15 Nodes Using OSC-CSM Cards



Two photodiodes at the Node B OSC-CSM card monitor the received signal strength for the received optical payload and OSC signals. When the fiber is cut, LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the Node B OSC laser to shut down and the optical switch to block traffic. This in turn leads to LOS for both the optical payload and OSC signals at Node A, which causes Node A to turn off the OSC laser and the optical switch to block outgoing traffic. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 10-15):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects a LOS-P on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OSC-CSM, the simultaneous LOS-O and LOS-P detection triggers a change in the position of the optical switch. CTC reports a LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The optical switch blocks outgoing traffic.
5. The OSC laser is shut down.
6. The Node A power monitoring photodiode detects a LOS-O on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
7. The Node A power monitoring photodiode detects a LOS-P on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

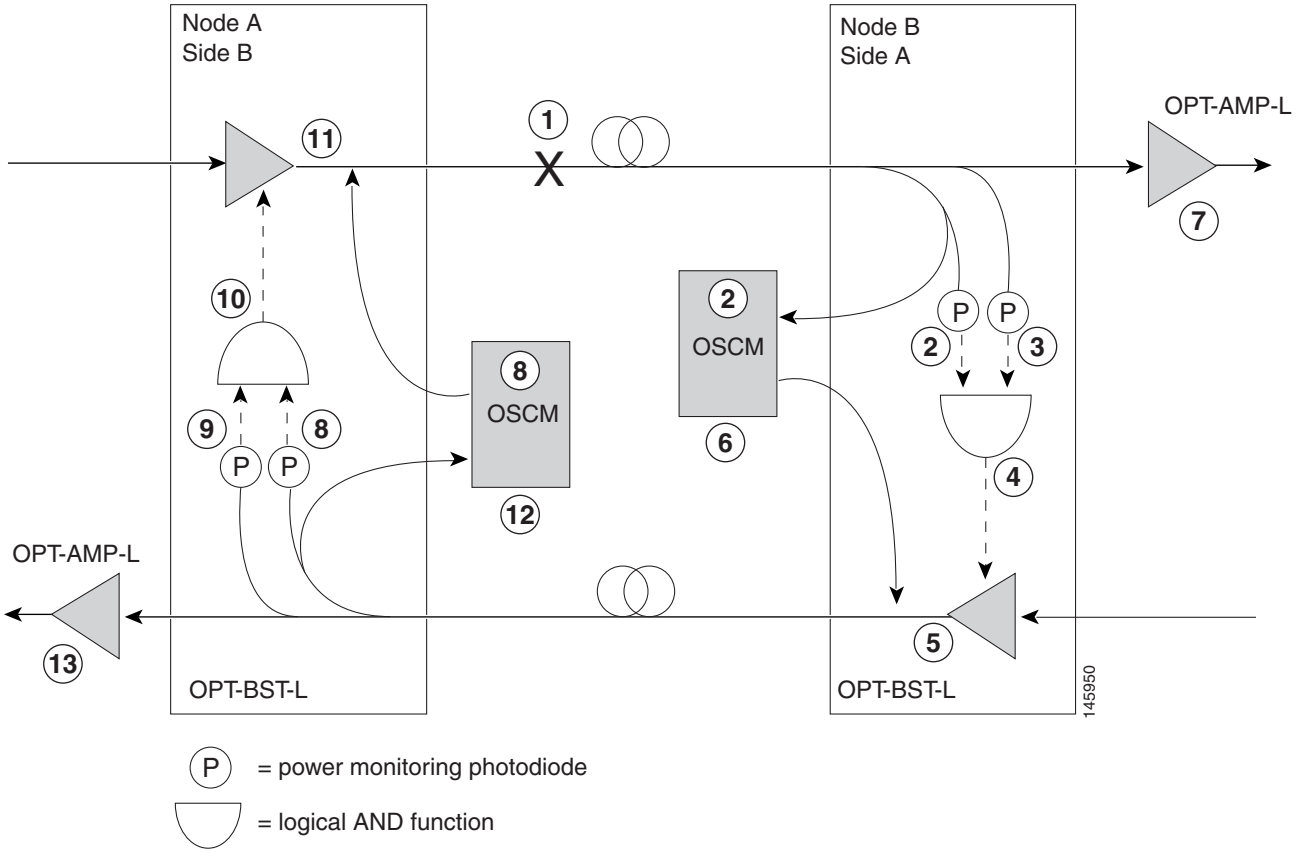
8. On the OSC-CSM, the simultaneous LOS-O and LOS-P detection triggers a change in the position of the optical switch. CTC reports a LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. The OSC laser is shut down.
10. The optical switch blocks outgoing traffic.

When the fiber is repaired, either an automatic or manual restart at the Node A OSC-CSM card OSC or at the Node B OSC-CSM card OSC is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse indicates the optical path is restored and transmission can begin. For example, when the far-end Node B receives a pulse, it signals to the Node B OSC to begin transmitting its optical signal and for the optical switch to pass incoming traffic. The OSC-CSM at Node A then receives the signal and tells the Node A OSC to resume transmitting and for the optical switch to pass incoming traffic.

10.7.3.3 Scenario 3: Fiber Cut in Nodes Using OPT-BST-L Cards

Figure 10-16 shows nodes using OPT-BST-L cards with a fiber cut between them.

Figure 10-16 Nodes Using OPT-BST-L Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-BST-L transmitter and OSCM lasers to shut down. This

in turn leads to an LOS for both the optical payload and the OSC at Node A, which causes Node A to turn off the OSCM OSC transmitter and OPT-BST-L amplifier lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 10-16):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-P on the OPT-BST-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OPT-BST-L card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The OPT-BST-L card amplifier is shut down within one second.
5. The OSCM laser is shut down.
6. The OPT-AMP-L, OPT-AMP-C, or OPT-AMP-17-C card automatically shuts down due to a loss of incoming optical power.
7. The Node A power monitoring photodiode detects an LOS-O on the OPT-BST-L card and the OSCM card detects an LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
8. The Node A power monitoring photodiode detects an LOS-P on the OPT-BST-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. On the OPT-BST-L, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while the LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. The OPT-BST-L card amplifier is shut down within one second.
11. The OSCM laser is shut down.
12. The Node A OPT-AMP-L, OPT-AMP-C, or OPT-AMP-17-C card automatically shuts down due to an LOS for the incoming optical power.

When the fiber is repaired, either an automatic or manual restart at the Node A OPT-BST-L transmitter or at the Node B OPT-BST-L transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse indicates the optical path is restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST-L transmitter to begin transmitting an optical signal. The OPT-BST-L receiver at Node A receives that signal and signals the Node A OPT-BST-L transmitter to resume transmitting.

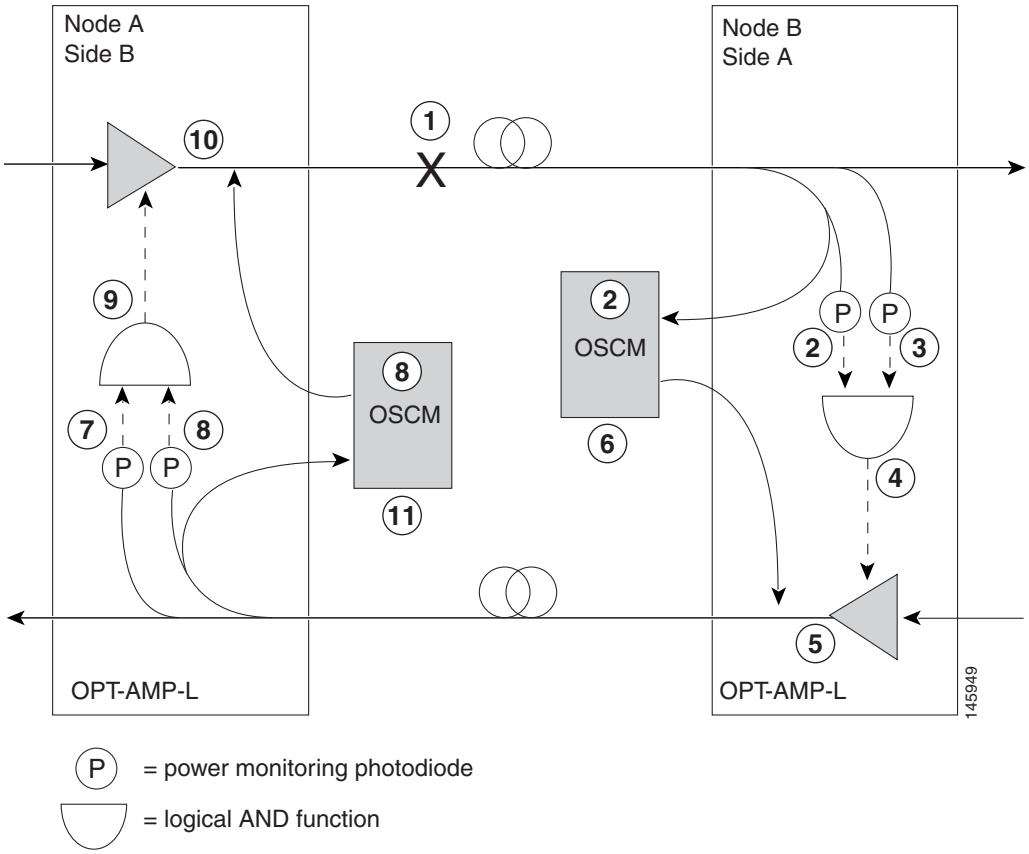
Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "10.7.2 Automatic Power Reduction" section on page 10-19 for more information about APR.

10.7.3.4 Scenario 4: Fiber Cut in Nodes Using OPT-AMP-L, OPT-AMP-C, or OPT-AMP-17-C (OPT-LINE Mode) Cards

Figure 10-17 shows nodes using OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C (in OPT-LINE mode) cards with a fiber cut between them.

Note A generic reference to the OPT-AMP card also refers to the OPT-AMP-L, OPT-AMP-17-C or OPT-AMP-C cards.

Figure 10-17 Nodes Using OPT-AMP Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-AMP-L card amplifier transmitter and OSCM card OSC lasers to shut down. This in turn leads to an LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM card OSC and OPT-AMP-L card amplifier lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 10-17):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-P on the OPT-AMP-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OPT-AMP-L card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The OPT-AMP-L card amplifier is shut down within one second.
5. The OSCM card laser is shut down.
6. The Node A power monitoring photodiode detects an LOS-O on the OPT-AMP-L card and the OSCM card detects an LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
7. The Node A power monitoring photodiode detects an LOS-P on the OPT-AMP-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

8. On the OPT-AMP-L card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. The OPT-AMP-L card amplifier is shut down within one second.
10. The OSCM card laser is shut down.

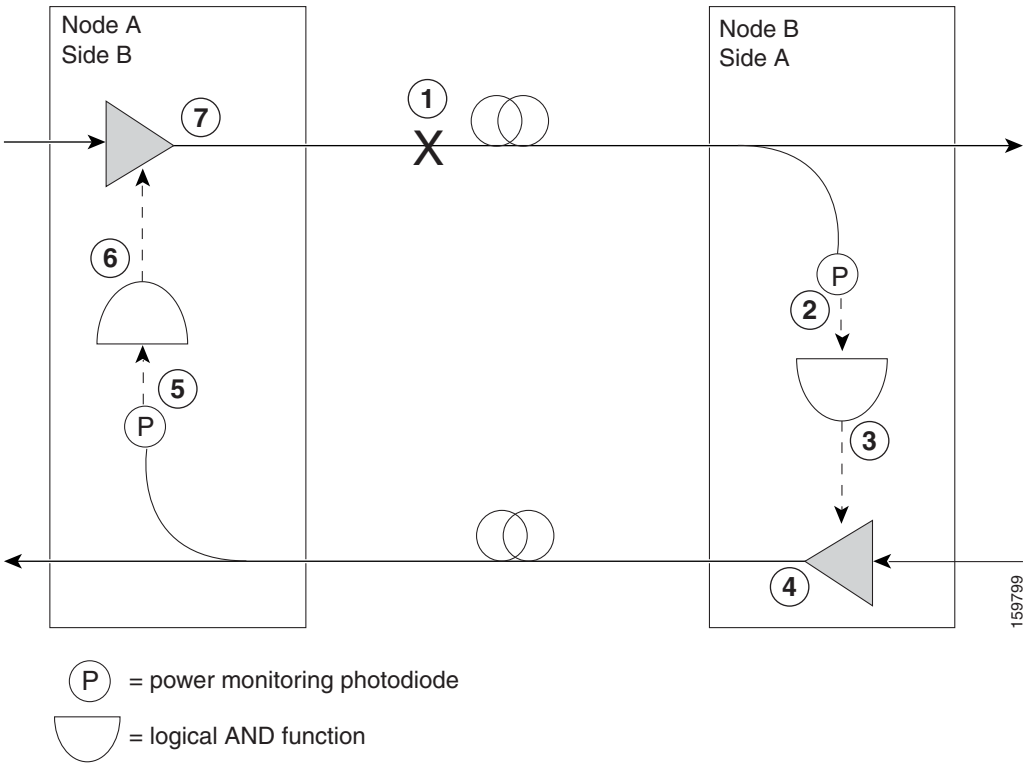
When the fiber is repaired, either an automatic or manual restart at the Node A OPT-AMP-L card transmitter or at the Node B OPT-AMP-L card transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse indicates the optical path is restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-AMP-L card transmitter to begin transmitting an optical signal. The OPT-AMP-L card receiver at Node A receives that signal and signals the Node A OPT-AMP-L card transmitter to resume transmitting.

Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "10.7.2 Automatic Power Reduction" section on page 10-19 for more information about APR.

10.7.3.5 Scenario 5: Fiber Cut in Nodes Using DCN Extension

Figure 10-18 shows a fiber cut scenario for nodes that do not have OSC connectivity. In the scenario, references to the OPT-BST cards refers to the OPT-BST, OPT-BST-L, OPT-BST-E, and the OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards when provisioned in OPT-LINE mode.

Figure 10-18 Fiber Cut With DCN Extension



Two photodiodes at Node B monitor the received signal strength for the optical payload. When the fiber is cut, an LOS is detected on the channel photodiode while the other one never gets a signal because the OSC is not present. The AND function then indicates an overall LOS condition, which causes the OPT-BST amplifier transmitter to shut down. This in turn leads to a LOS for the optical payload at Node A, which causes Node A to turn off the OPT-BST amplifier lasers.

The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 10-18):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-P on the OPT-BST card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for LOS-P troubleshooting procedures.
3. On the OPT-BST card, the LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-P is demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for alarm troubleshooting procedures.
4. The OPT-BST card amplifier is shut down within one second.
5. The Node A power monitoring photodiode detects a LOS-P on the OPT-BST card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for alarm troubleshooting procedures.
6. On the OPT-BST, the LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-P is demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
7. The OPT-BST card amplifier is shut down within one second.

When the fiber is repaired, a manual restart with 90 sec restart pulse time (MANUAL RESTART FOR TEST) is required at the Node A OPT-BST transmitter and at the Node B OPT-BST transmitter. A system that has been shut down is reactivated through the use of a 90 sec restart pulse. The pulse indicates that the optical path is restored and transmission can begin.

For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST transmitter to begin transmitting an optical signal. The OPT-BST receiver at Node A receives that signal and signals the Node A OPT-BST transmitter to resume transmitting.

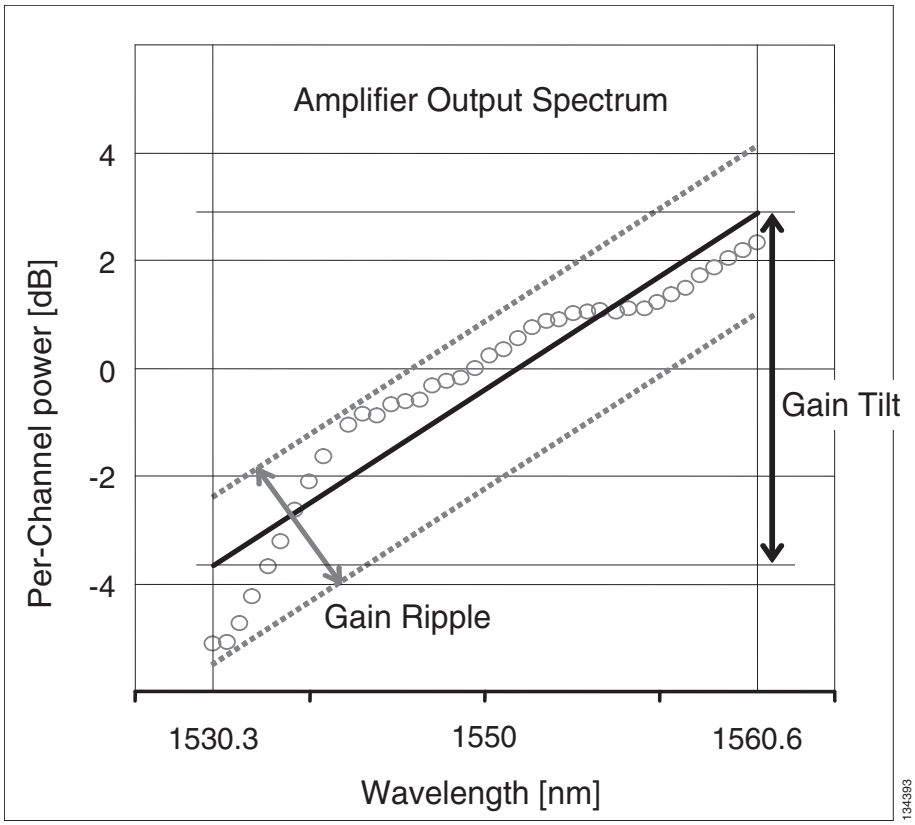
Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "10.7.2 Automatic Power Reduction" section on page 10-19 for more information about APR.

10.8 Network-Level Gain—Tilt Management of Optical Amplifiers

The ability to control and adjust per-channel optical power equalization is a principal feature of ONS 15454 DWDM metro core network applications. A critical parameter to assure optical spectrum equalization throughout the DWDM system is the gain flatness of erbium-doped fiber amplifiers (EDFAs).

Two items, gain tilt and gain ripple, are factors in the power equalization of optical amplifier cards such as the OPT-BST and OPT-PRE. Figure 10-19 shows a graph of the amplifier output power spectrum and how it is affected by gain tilt and gain ripple.

Figure 10-19 Effect of Gain Ripple and Gain Tilt on Amplifier Output Power



Gain ripple and gain tilt are defined as follows:

- Gain ripple is random and depends on the spectral shape of the amplifier optical components.
- Gain tilt is systematic and depends on the gain setpoint (Gstp) of the optical amplifier, which is a mathematical function F(Gstp) that relates to the internal amplifier design.

Gain tilt is the only contribution to the power spectrum disequalization that can be compensated at the card level. A VOA internal to the amplifier can be used to compensate for gain tilt.

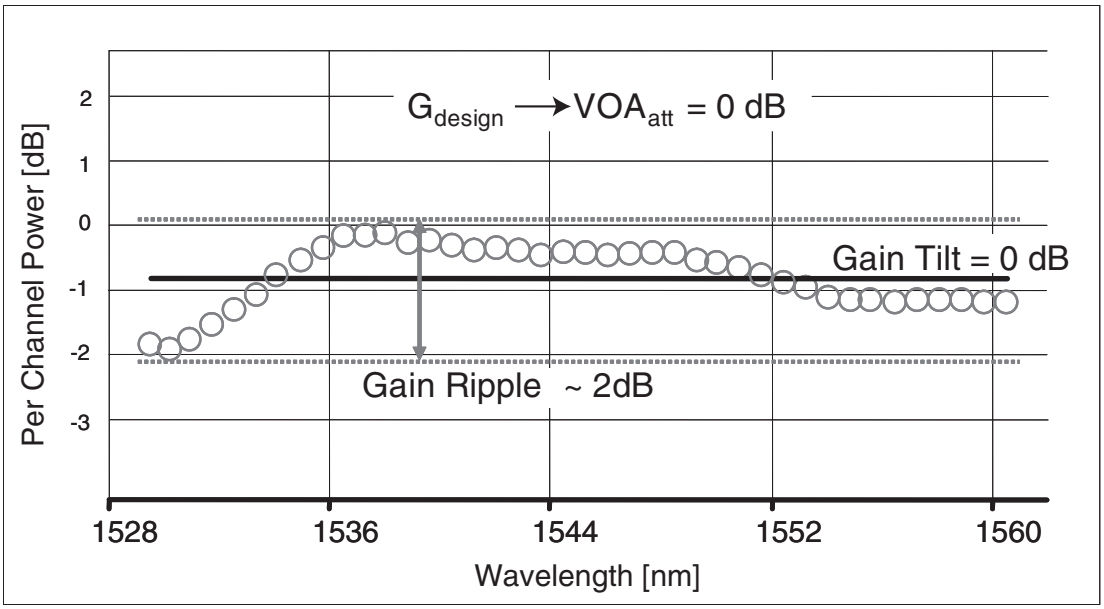
An optical spectrum analyzer (OSA) is used to acquire the output power spectrum of an amplifier. The OSA shows the peak-to-peak difference between the maximum and minimum power levels, and takes into account the contributions of both gain tilt and gain ripple.

Note Peak-to-peak power acquisition using an OSA cannot be used to measure the gain tilt, because gain ripple itself is a component of the actual measurement.

10.8.1 Gain Tilt Control at the Card Level

The OPT-BST and OPT-PRE amplifier cards have a flat output (gain tilt = 0 dB) for only a specific gain value (Gdesign), based on the internal optical design (see Figure 10-20).

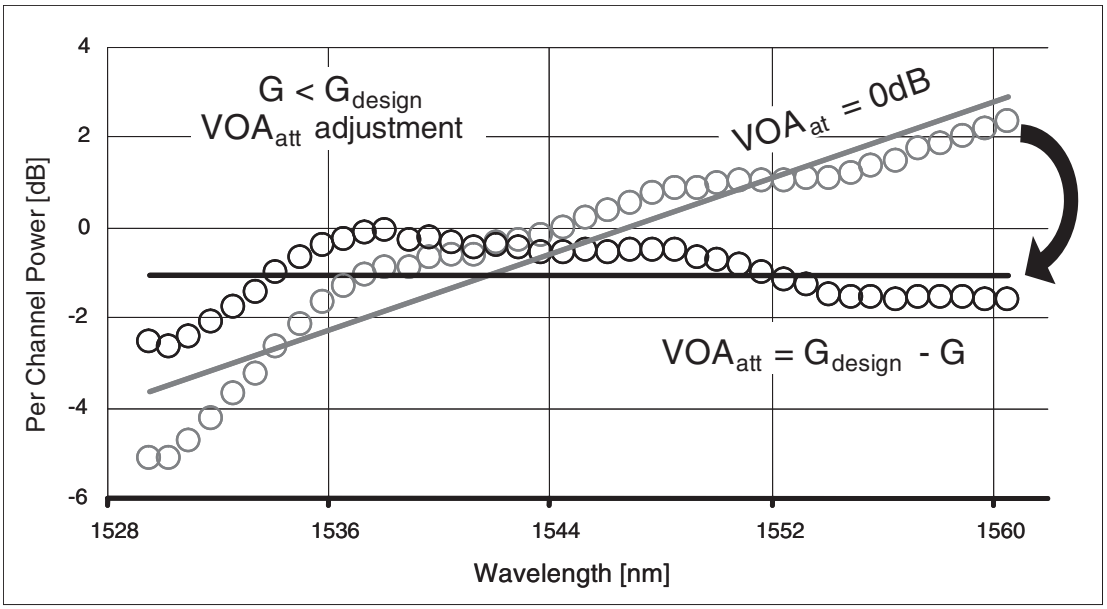
Figure 10-20 Flat Gain (Gain Tilt = 0 dB)



If the working gain setpoint of the amplifier is different from Gdesign, the output spectrum begins to suffer a gain tilt variation.

In order to compensate for the absolute value of the increase of the spectrum tilt, the OPT-BST and OPT-PRE cards automatically adjust the attenuation of the VOA to maintain a flat power profile at the output, as shown in Figure 10-21.

Figure 10-21 Effect of VOA Attenuation on Gain Tilt



The VOA attenuator automatic regulation guarantees (within limits) a zero tilt condition in the EDFA for a wide range of possible gain setpoint values.

Table 10-2 shows the flat output gain range limits for the OPT-BST and OPT-PRE cards, as well as the maximum (worst case) values of gain tilt and gain ripple expected in the specific gain range.

Table 10-2 Flat Output Gain Range Limits

Amplifier Card Type	Flat Output Gain Range	Gain Tilt (Maximum)	Gain Ripple (Maximum)
OPT-BST	G < 20 dB	0.5 dB	1.5 dB
OPT-PRE	G < 21 dB	0.5 dB	1.5 dB

If the operating gain value is outside of the range shown in Table 10-2, the EDFA introduces a tilt contribution for which the card itself cannot directly compensate. This condition is managed in different ways, depending the amplifier card type:

- OPT-BST—The OPT-BST amplifier is, by design, not allowed to work outside the zero tilt range. Cisco TransportPlanner network designs use the OPT-BST amplifier card only when the gain is less than or equal to 20 dB.
- OPT-PRE—Cisco TransportPlanner allows network designs even if the operating gain value is equal to or greater than 21 dB. In this case, a system-level tilt compensation strategy is adopted by the DWDM system. A more detailed explanation is given in 10.8.2 System Level Gain Tilt Control, page 10-31.

10.8.2 System Level Gain Tilt Control

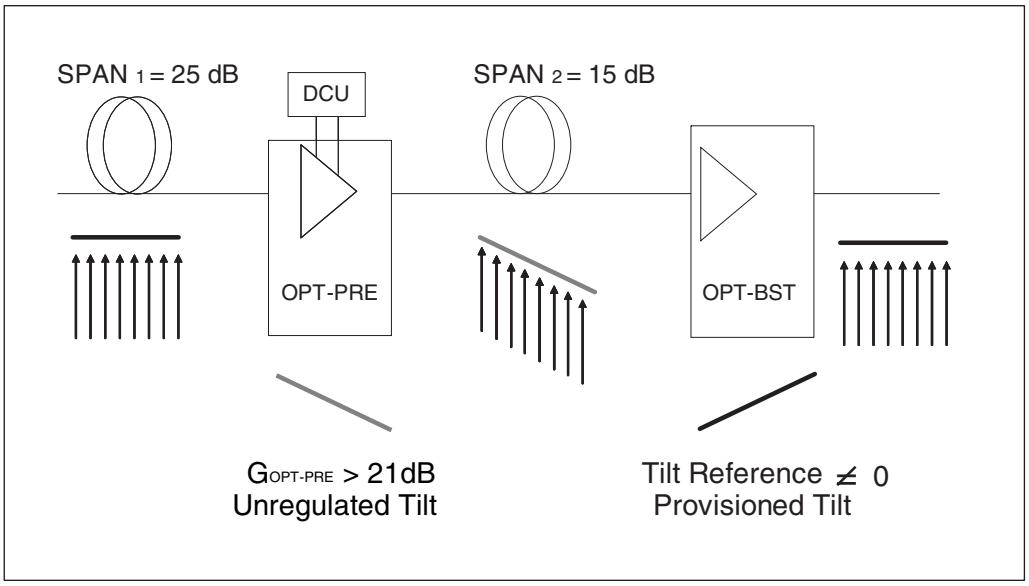
System level gain tilt control for OPT-PRE cards is achievable with two main scenarios:

- Without an ROADM node
- With an ROADM node

10.8.2.1 System Gain Tilt Compensation Without ROADM Nodes

When an OPT-PRE card along a specific line direction (Side A-to-Side B or Side B-to-Side A) is working outside the flat output gain range (G > 21 dB), the unregulated tilt is compensated for in spans that are not connected to ROADM nodes by configuring an equal but opposite tilt on one or more of the amplifiers in the downstream direction. The number of downstream amplifiers involved depends on the amount of tilt compensation needed and the gain setpoint of the amplifiers that are involved. See Figure 10-22.

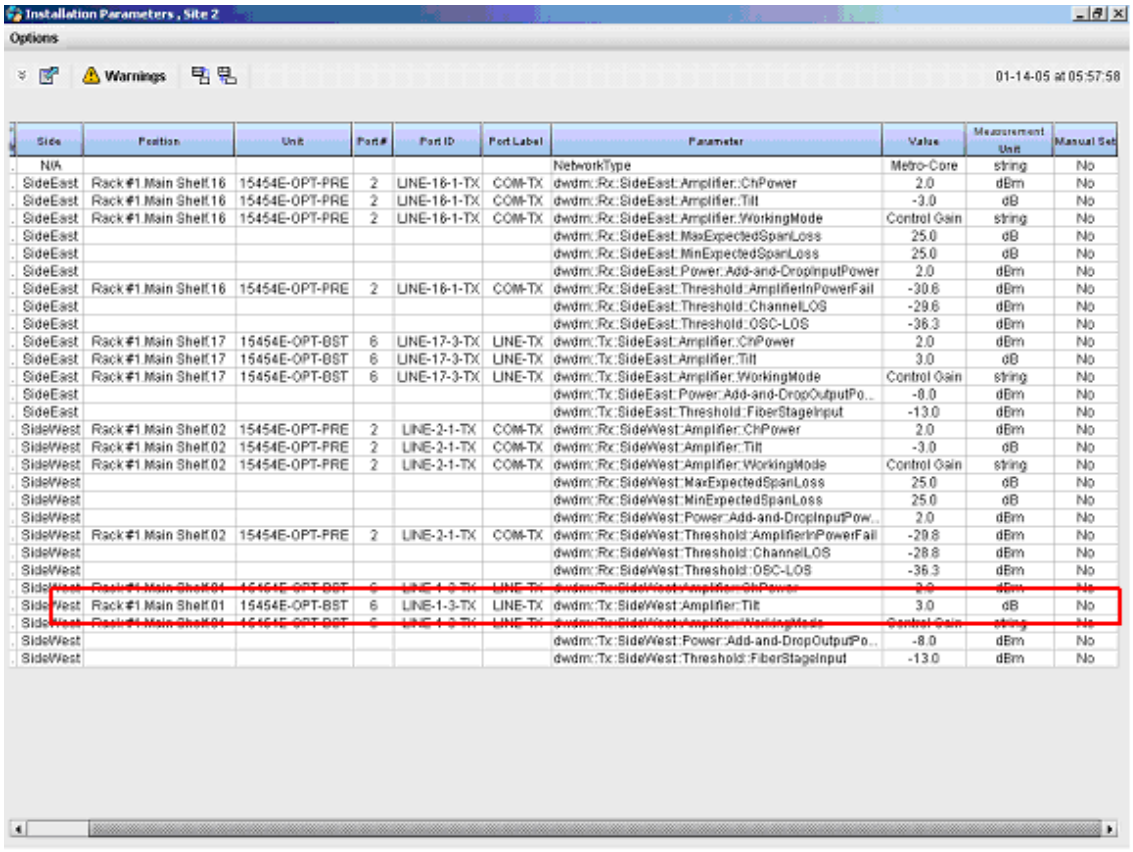
Figure 10-22 System Tilt Compensation Without an ROADM Node



The proper Tilt Reference value is calculated by Cisco TransportPlanner and inserted in the Installation Parameter List imported during the node turn-up process (see the "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*). For both OPT-PRE and OPT-BST cards, the provisionable Gain Tilt Reference range is between –3 dB and +3 dB.

During the ANS procedure, the Tilt value for the OPT-BST or OPT-PRE card is provisioned by the TCC2/TCC2P card (see Figure 10-23). The provisioned Tilt Reference Value is reported in the CTC OPT-PRE or OPT-BST card view (in the Provisioning > Opt. Ampli. Line > Parameters > Tilt Reference tab).

Figure 10-23 Cisco TransportPlanner Installation Parameters



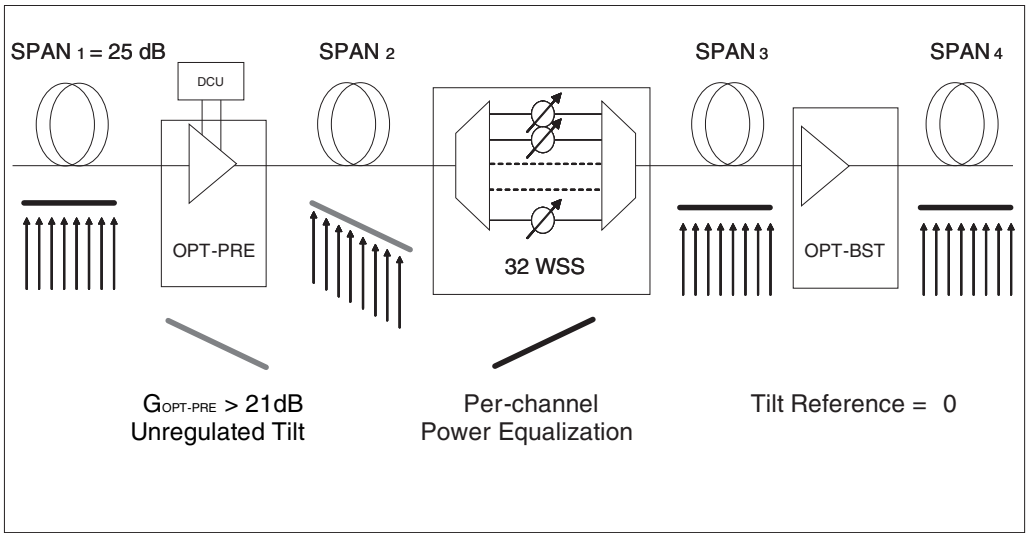
Side	Position	Unit	Port#	Port ID	Port Label	Parameter	Value	Measurement Unit	Manual Set
N/A						NetworkType	Metro-Core	string	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::ChPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::Tilt	-3.0	dB	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::WorkingMode	Control Gain	string	No
SideEast						dwdm::Rx::SideEast::MaxExpectedSpanLoss	25.0	dB	No
SideEast						dwdm::Rx::SideEast::MinExpectedSpanLoss	25.0	dB	No
SideEast						dwdm::Rx::SideEast::Power::Add-and-DropInputPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Threshold::AmplifierInPowerFail	-30.6	dBm	No
SideEast						dwdm::Rx::SideEast::Threshold::ChannelLOS	-29.6	dBm	No
SideEast						dwdm::Rx::SideEast::Threshold::OSC-LOS	-36.3	dBm	No
SideEast	Rack #1 Main Shelf.17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::ChPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf.17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::Tilt	3.0	dB	No
SideEast	Rack #1 Main Shelf.17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::WorkingMode	Control Gain	string	No
SideEast						dwdm::Tx::SideEast::Power::Add-and-DropOutputPo...	-8.0	dBm	No
SideEast						dwdm::Tx::SideEast::Threshold::FiberStageInput	-13.0	dBm	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::ChPower	2.0	dBm	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::Tilt	-3.0	dB	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::WorkingMode	Control Gain	string	No
SideWest						dwdm::Rx::SideWest::MaxExpectedSpanLoss	25.0	dB	No
SideWest						dwdm::Rx::SideWest::MinExpectedSpanLoss	25.0	dB	No
SideWest						dwdm::Rx::SideWest::Power::Add-and-DropInputPow...	2.0	dBm	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Threshold::AmplifierInPowerFail	-29.8	dBm	No
SideWest						dwdm::Rx::SideWest::Threshold::ChannelLOS	-28.8	dBm	No
SideWest						dwdm::Rx::SideWest::Threshold::OSC-LOS	-36.3	dBm	No
SideWest	Rack #1 Main Shelf.01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::ChPower	2.0	dBm	No
SideWest	Rack #1 Main Shelf.01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::Tilt	3.0	dB	No
SideWest	Rack #1 Main Shelf.01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::WorkingMode	Control Gain	string	No
SideWest						dwdm::Tx::SideWest::Power::Add-and-DropOutputPo...	-8.0	dBm	No
SideWest						dwdm::Tx::SideWest::Threshold::FiberStageInput	-13.0	dBm	No

10.8.2.2 System Gain Tilt Compensation With ROADM Nodes

When a ROADM node is present in the network, as shown in Figure 10-24, a per-channel dynamic gain equalization can be performed. Both gain tilt and gain ripple are completely compensated using the following techniques:

- Implementing the per-channel VOAs present inside the 32WSS card
- Operating in Power Control Mode with the specific power setpoint designed by Cisco TransportPlanner

Figure 10-24 System Tilt Compensation With an ROADM Node



10.9 Optical Data Rate Derivations

This section discusses the derivation of several data rates commonly used in optical networking.

10.9.1 OC-192/STM-64 Data Rate (9.95328 Gbps)

The SONET OC-1 rate is 51.84 Mbps. This rate results from a standard SONET frame, which consists of 9 rows of 90 columns of 8-bit bytes (810 bytes total). The transmission rate is 8000 frames per second (125 microseconds per frame). This works out to 51.84 Mbps, as follows:

(9) x (90 bytes/frame) x (8 bits/byte) x (8000 frames/sec) = 51.84 Mbps

OC-192 is 192 x 51.84 Mbps = 9953.28 Mbps = 9.95328 Gbps

STM-64 is an SDH rate that is equivalent to the SONET OC-192 data rate.

10.9.2 10GE Data Rate (10.3125 Gbps)

10.3125 Gbps is the standard 10 Gbps Ethernet LAN rate. The reason the rate is higher than 10.000 Gbps is due to the 64-bit to 66-bit data encoding. The result is 10 Gbps x 66/64 = 10.3125 Gbps. The reason for 64-bit to 66-bit encoding is to ensure that there are adequate data transitions to ensure proper operation of a clock and data recovery circuit at the far end. Additionally, the encoding assures a data stream that is DC balanced.

10.9.3 10G FC Data Rate (10.51875 Gbps)

The Fibre Channel rate is based on the OC-192 rate of 9.95328 Gbps, with the addition of 64-bit to 66-bit encoding and WAN Interconnect Sublayer (WIS) overhead bytes.

The rate is derived from the basic 9.95328 Gbps OC-192 rate. First, it has the 64-bit to 66-bit encoding added, which brings it to the 10.3125 Gbps rate (10 Gbps x 66/64 = 10.3125 Gbps). Beyond that, the WIS overhead is added, which is an additional two percent on top of the 10.3125 Gbps. This yields:

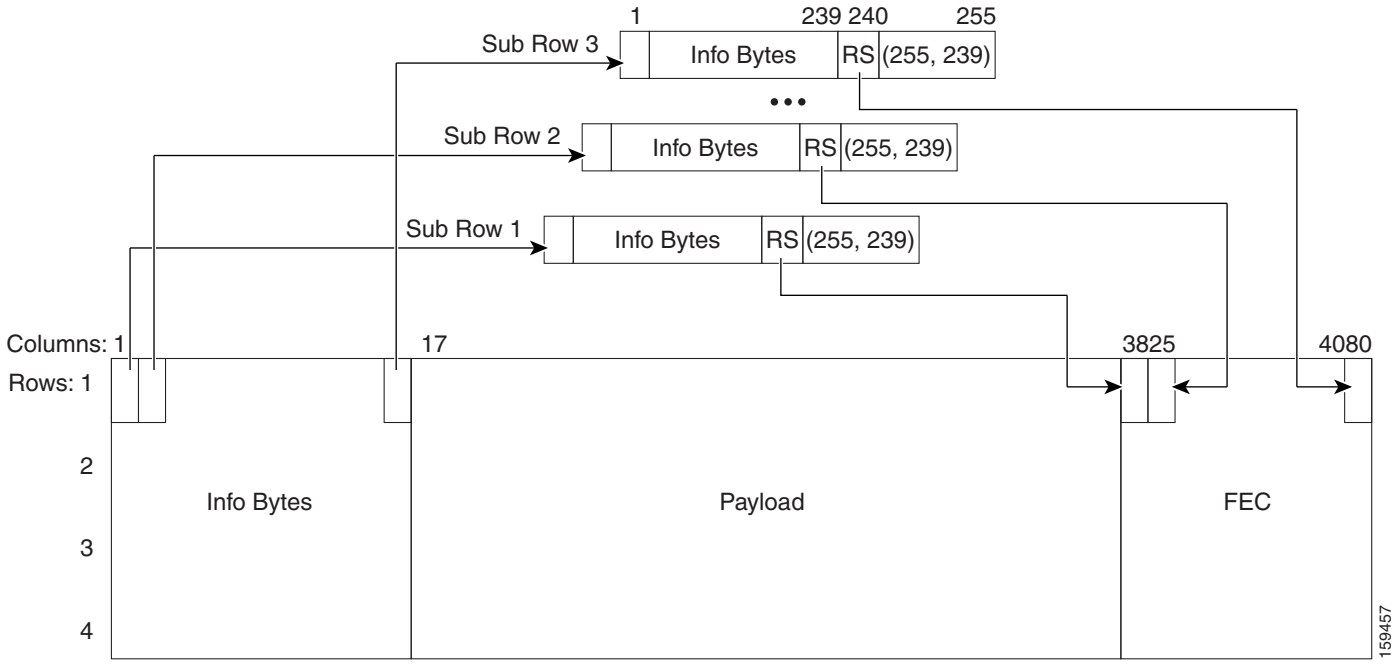
10.3125 Gbps x .02 = 0.20625 Gbps

10.3125 Gbps + 0.20625 Gbps = 10.51875 Gbps

10.9.4 ITU-T G.709 Optical Data Rates

To understand optical networking data rates, an understanding of the ITU-T G.709 frame structure, shown in Figure 10-25, is needed.

Figure 10-25 ITU-T G.709 Frame Structure



Each of the sub-rows in Figure 10-25 contains 255 bytes. Sixteen are interleaved horizontally (16 x 255 = 4080). This is repeated four times to make up the complete ITU-T G.709 frame.

The Reed Solomon (RS) (255,239) designation indicates the forward error correction (FEC) bytes. There are 16 FEC, or parity, bytes. The ITU-T G.709 protocol uses one overhead byte and 238 data bytes to compute 16 parity bytes to form 255 byte blocks—the RS (255,239) algorithm. Interleaving the information provides two key advantages. First, the encoding rate of each stream is reduced relative to the line transmission rate and, second, it reduces the sensitivity to bursts of error. The interleaving combined with the inherent correction strength of the RS (255,239) algorithm enables the correction of transmission bursts of up to 128 consecutive errored bytes. As a result, the ITU-T G.709 contiguous burst error correcting capability is enhanced 16 times above the capacity of the RS(255,239) algorithm by itself.

ITU-T G.709 defines the Optical Transport Unit 2 (OTU2) rate as 10.70923 Gbps. ITU-T G.709 defines three line rates:

1. 2,666,057.143 kbps—Optical Transport Unit 1 (OTU1)

2. 10,709,225.316 kbps—Optical Transport Unit 2 (OTU2)
3. 43,018,413.559 kbps—Optical Transport Unit 3 (OTU3)

The OTU2 rate is higher than OC-192 because the OTU2 has to carry overhead and FEC bytes in its frame; the bits must be sent faster to carry the payload information at the OC-192 rate.

The ITU-T G.709 frame has two parts. Two are similar to a SDH/SONET frame:

1. Overhead area for operation, administration, and maintenance functions
2. Payload area for customer data

In addition, the ITU-T G.709 frame also includes FEC bytes.

10.9.4.1 OC-192 Packaged Into OTU2 G.709 Frame Data Rate (10.70923 Gbps)

In this case, an OC-192 frame is being transported over a OTU2 G.709 frame, which adds the benefit of FEC. The OC-192 data rate (9.95328 Gbps) must increase in order to transport more bytes (OC-192 plus ITU-T G.709 overhead plus ITU-T G.709 FEC bytes) in the same amount of time. In an OTU2 transmission, 237 of the 255 bytes are OC-192 payload. This means the resultant data rate is:

9.95328 x 255/237 = 10.70923 Gbps

10.9.4.2 10GE Packaged Into OTU2 G.709 Frame Data Rate (Nonstandard 11.0957 Gbps)

Encapsulating Ethernet data into an OTU2 G.709 frame is considered nonstandard. The goal is to add the benefit of ITU-T G.709 encapsulation to achieve better burst error performance. However, this means adding overhead and FEC bytes, so more bytes must be transmitted in the same amount of time, so the data rate must increase. The new date rate is:

10.3215 x 255/237 = 11.0957 Gbps

10.9.4.3 10G FC Packaged Into OTU2 G.709 Frame Data Rate (Nonstandard 11.31764 Gbps)

Encapsulating Fibre Channel in an OTU2 frame is considered nonstandard. The rate is higher than the 10.51875 rate because OTU2 includes FEC bytes. The bits must run at a faster rate so that the payload is provided at the standard Fibre Channel rate. The rate is:

10.51875 x 255/237 = 11.31764 Gbps

10.10 Even Band Management

With the introduction of the following cards, it is now possible to transport 72, 80, 104, or 112 wavelength channels in the same network:

- 40-WSS-CE (40-channel Wavelength Selective Switch, C-band, even channels)
- 40-DMX-CE (40-channel Demultiplexer, C-band, even channels)

By using these new cards along with the 40-WSS-C and 40-DMX-C cards (which handle 40 C-band odd channels), the 32WSS and 32DMX cards (which handle 32 C-band odd channels), and the 32WSS-L and 32DMX-L (which handle 32 L-band odd channels), it is possible to cover 80 C-band channels (40 even and 40 odd channels) and 32 L-band odd channels, for a maximum of 112 channels. The following channel coverage combinations are possible:

- 72 C-band channels, using the 32WSS, 32DMX, 40-WSS-CE, and 40-DMX-CE cards

- 80 C-band channels, using the 40-WSS-C, 40-DMX-C, 40-WSS-CE, and 40-DMX-CE cards
- 104 channels (32 L-band odd channels and 72 C-band channels), using the 32WSS-L and 32DMX-L cards as a set to cover 32 L-band odd channels and the 32WSS, 32DMX, 40-WSS-CE, and 40-DMX-CE cards as a set to cover 72 C-band odd and even channels
- 112 channels (32 L-band odd channels and 80 C-band even channels), using the 32WSS-L and 32DMX-L cards as a set to cover 32 L-band odd channels and the 40-WSS-C, 40-DMX-C, 40-WSS-CE, and 40-DMX-CE, cards as a set to cover 80 C-band odd and even channels

The following node topologies are available for even channel management or odd-plus-even channel management:

- Terminal node
- Hub node
- ROADM node
- OSC regeneration and optical line amplification node

The external ONS 15216-ID-50 module is a 50 GHz/100GHz optical interleaver/deinterleaver that is required to combine or separate odd and even C-band channels. This module increases capacity by combining two optical data streams into a single, more densely spaced stream. The module can be used in multiplexer mode to combine two 100-GHz optical signal streams into one 50-GHz stream, and in demultiplexer mode to separate the 50-GHz stream into two 100-GHz streams.

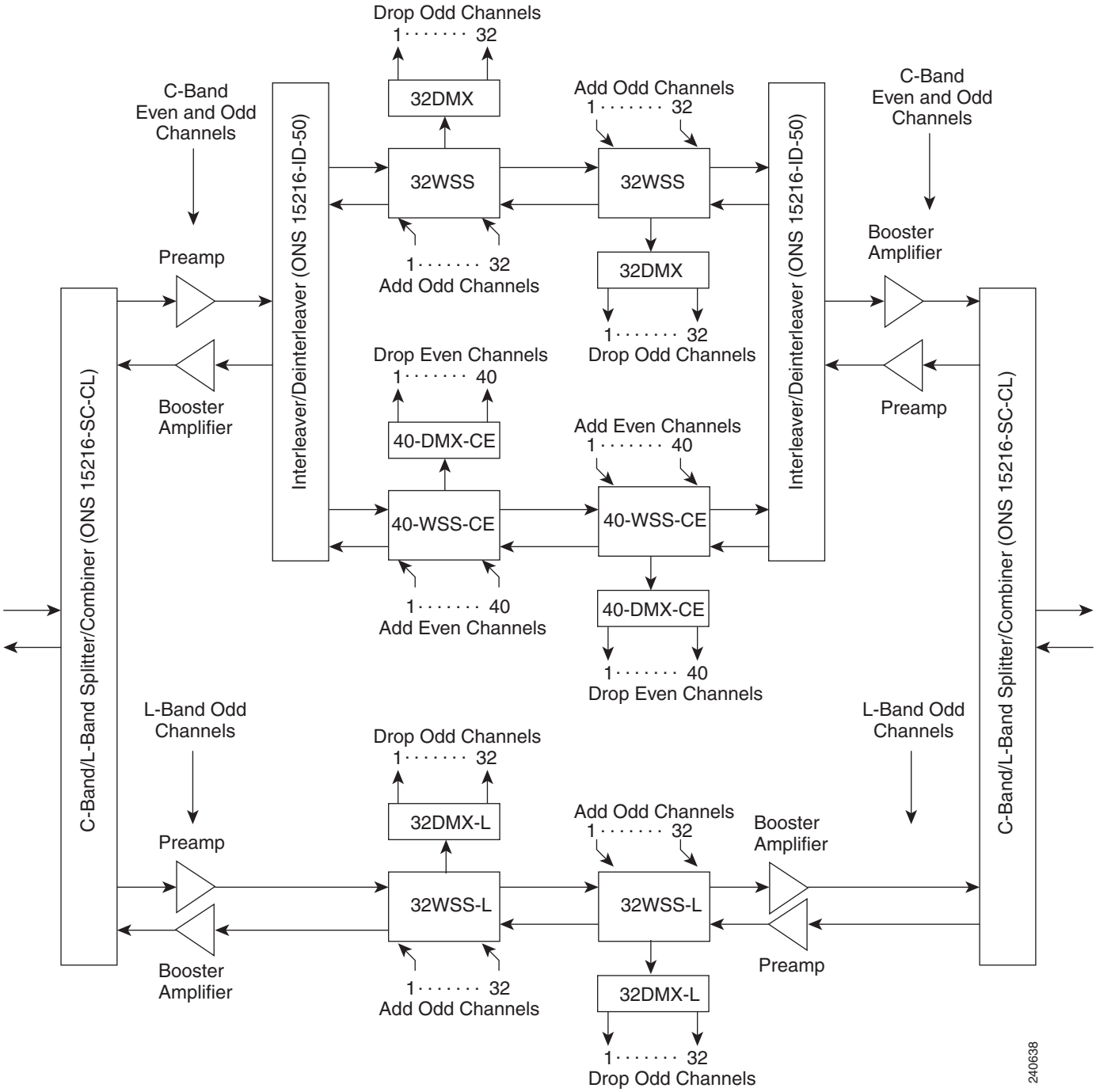
The ONS 15216-SC-CL module is an external C-band and L-band splitter/combiner module that combines and separates the C-band odd/even channels and the L-band odd channels.

An example of a 104-channel C-band plus L-band ROADM node is shown in Figure 10-26 on page 10-38. There are 72 C-band even channels and 32 L-band odd channels. The signal flow from the left side of the diagram to the right side is given in the following steps. The signal flow from the right side to the left is identical.

1. All the C-band and L-band signals enter the ONS 15216-SC-CL.
2. When the signals exit the ONS 15216-SC-CL, the 72 C-band even and odd channel signals are sent to the upper set of blocks and the 32 L-band odd channel signals are sent to the lower set of blocks.
3. The 72 C-band even and odd channel signals pass through a preamplifier, then through an ONS 15261-ID-50 and wavelength selective switch (WSS). Only the channels to be dropped are sent to the demultiplexer (DMX) block. There are two such sets of blocks, one set for the 32 odd C-band channels, and one set for the 40 even C-band channels.
4. The 32 L-band odd channel signals pass through a preamplifier, then through two 32-channel wavelength selective switch (32WSS-L) cards. Only the channels to be dropped are sent to the 32-channel demultiplexer (32DMX-L) card.
5. At the upper set of blocks, the ONS 15261-ID-50 deinterleaves the 32 C-band odd channels from the 40 C-band even channels. The 32 C-band odd channels are routed through the top blocks (two 32WSS cards and one 32DMX card), while the 40 C-band even channels are routed through the lower blocks (two 40-WSS-CE cards and one 40-DMX-CE card).
6. When a signal enters a 32WSS-L or 40-WSS-CE card, it is split. Part of the signal (the channels that are to be dropped) goes to the32 DMX-L card or 40-DMX-CE card so that channels can be dropped for use by the client equipment. The other part of the signal goes to the next 32WSS-L card or 40_DMX-CE card, where the channels can be passed through or blocked, and channels can be added to the stream from the client equipment.

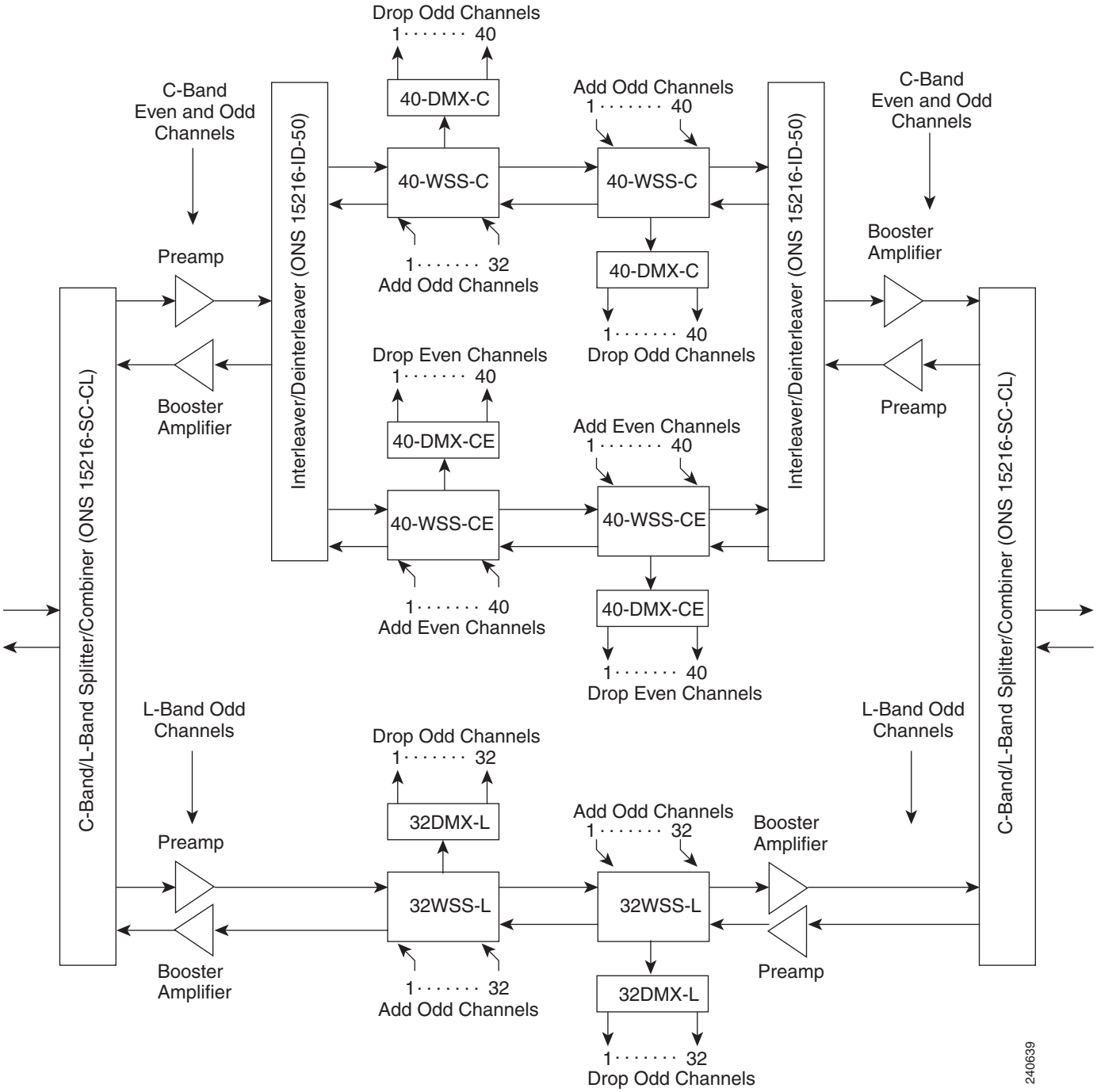
7. After the channels leave the last 32WSS-L card or 40-WSS-CE card, the C-band even and odd channels are interleaved back into a single stream by the ONS 15216-ID-50 module, sent through a booster amplifier, and then they enter the ONS 15216-SC-CL module, where they are combined with the L-band signals from the lower set of blocks and sent out onto the optical fiber.

Figure 10-26 104-Channel C-Band plus L-Band ROADM Node



An example of a 112-channel C-band plus L-band ROADM node is shown in Figure 10-27. It operates in a similar manner to the 104-channel ROADM node shown in Figure 10-26 on page 10-38, except that there are 40 odd C-band channels instead of 32.

Figure 10-27 112-Channel C-Band plus L-Band ROADM Node



CHAPTER 11

Optical Channel Circuits and Virtual Patchcords Reference

This chapter explains the Cisco ONS 15454 dense wavelength division multiplexing (DWDM) optical channel (OCH) circuit types and virtual patchcords that can be provisioned on the ONS 15454. Circuit types include the OCH client connection (OCHCC), the OCH trail, and the OCH network connection (OCHNC). Virtual patchcords include internal patchcords and provisionable (external) patchcords (PPCs).

Note Unless otherwise specified, “ONS 15454" refers to both ANSI and ETSI shelf assemblies.

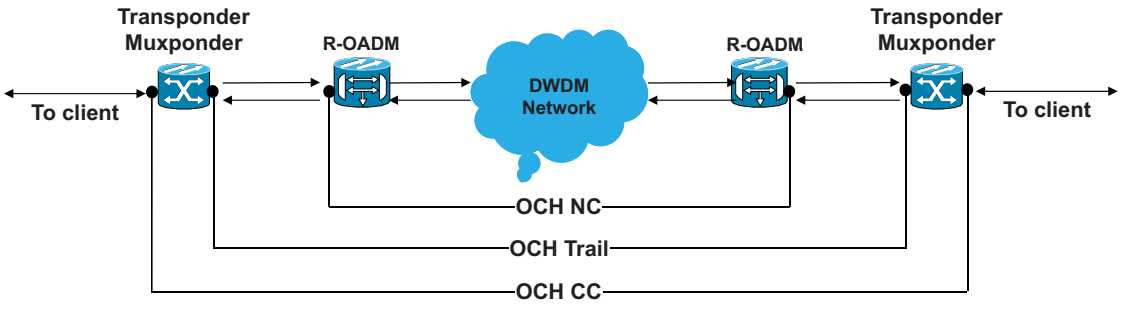
11.1 Optical Channel Circuits

The ONS 15454 DWDM optical circuits provide end-to-end connectivity using three OCH circuit types:

- Optical Channel Network Connections (OCHNC)
- Optical Channel Client Connections (OCHCC)
- Optical Channel Trails (OCH Trails)

A graphical representation of OCH circuits is shown in Figure 11-1.

Figure 11-1 Optical Channel Circuits



11.1.1 OCHNC Circuits

OCHNC circuits establish connectivity between two optical nodes on a specified C-band wavelength. The connection is made through the ports present on the wavelength selective switches, multiplexers, demultiplexer, and add/drop cards. In an OCHNC circuit, the wavelength from a source OCH port ingresses to a DWDM system and then egresses from the DWDM system to the destination OCH port. The source and destination OCH port details are listed in Table 11-1.

Table 11-1 OCHNC Ports

Card	Source Ports	Destination Ports
32WSS 32WSS-L 40-WSS-C 40-WSS-CE	ADD-RX	—
32MUX-O 40-MUX-C	CHAN-RX	—
32DMX-O 32DMX 32DMX-L 40-DMX-C 40-DMX-CE	—	CHAN-TX
4MD AD-1B-xx.x AD-4B-xx.x AD-1C-xx.x AD-4C-xx.x	CHAN-RX	CHAN-TX

11.1.2 OCHCC Circuits

OCHCC circuits extend the OCHNC to create an optical connection from the source client port to the destination client port of the TXP/MXP cards. An OCHCC circuit represents the actual end-to-end client service passing through the DWDM system.

Each OCHCC circuit is associated to a pair of client or trunk ports on the transponder (TXP), muxponder (MXP), GE_XP (in layer-1 DWDM mode), 10GE_XP (in layer-1 DWDM mode), or ITU-T line card.

The OCHCCs can manage splitter protection as a single protected circuit. However, for the Y-Cable protection, two OCHCC circuits and two protection groups are required.

11.1.3 OCH Trail Circuits

OCH trail circuits transport the OCHCCs. The OCH trail circuit creates an optical connection from the source trunk port to the destination trunk port of the Transponder (TXP), Muxponder (MXP), GE_XP, 10GE_XP, or ITU-T line card. The OCH trail represents the common connection between the two cards, over which all the client OCHCC circuits, SVLAN circuits or STS circuits are carried.

Once an OCHCC is created, a corresponding OCH Trail is automatically created. If the OCHCC is created between two TXP, MXP, GE_XP, or 10GE_XP cards, two circuits are created in the CTC. These are:

One OCHCC (at client port endpoints)

One OCH trail (at trunk port endpoints)

If the OCHCC is created between two TXPP or two MXPP cards, three circuits are created in the CTC. These are:

- One OCHCC (at client port endpoints)
- Two OCH Trails (at trunk port endpoints)
  One for the working and other for the protect trunk.

Note On a TXP, MXP, and GE_XP card (in layer 1 DWDM mode), additional OCHCC circuits are created over the same OCH trail.

Note On a TXP, MXP, GE_XP (in layer 1 DWDM mode), and 10GE_XP (in layer 1 DWDM mode) card, the OCH trail cannot be created independently, and is created along with the first OCHCC creation on the card. However, on a GE_XP card (in layer-2 DWDM mode), 10GE_XP card (in layer-2 DWDM mode), and ADM_10G card, an OCH trail can be created between the trunk ports for the upper layer circuits (SVLAN in GE_XP/10GE_XP and STS in ADM_10G). No OCHCC is supported in these cases.

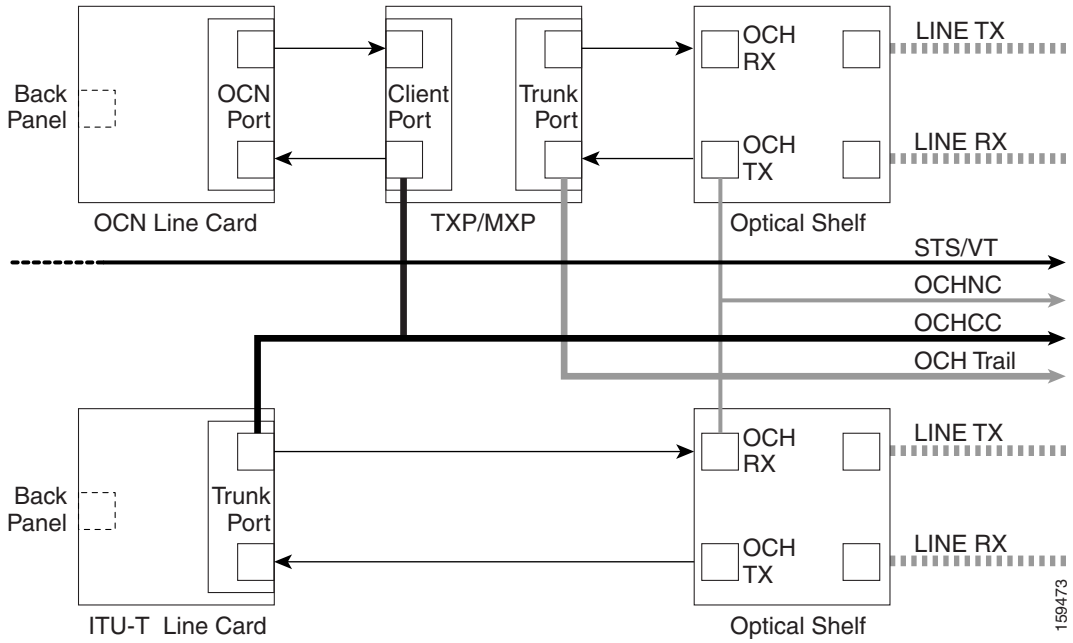
If the OCHCC is created between two ITU-T line cards, only one trunk port belongs to the OCHCC at each end of the circuit. Table 11-2 lists the ports that can be OCHCC and OCH trail endpoints.

Table 11-2 OCHCC and OCH Trail Ports

Card	OCHCC	OCH Trail
TXPs MXPs GE_XP 10GE_XP ADM-10G	Any client port	Any trunk port
ITU-T line cards: • OC48/STM64 EH • OC192 SR/STM64 • MRC-12 • MRC-2.5-12 • MRC-2.5G-4	Any trunk port	Any trunk port

Figure 11-2 shows the relationships and optical flow between the OCHCC, OCH trail, and OCHNC circuits.

Figure 11-2 Optical Channel Management



11.1.4 Administrative and Service States

OCHCCs, OCH trails, and OCHNCs occupy three different optical layers. Each OCH circuit has its own administrative and service states. The OCHCCs impose additional restrictions on changes that can be made to client card port administrative state.

The OCHCC service state is the sum of the OCHCC service state and the OCH trail service state. When creating an OCHCC circuit, you can specify an initial state for both the OCHCC and the OCH trail layers, including the source and destination port states. The ANSI/ETSI administrative states for the OCHCC circuits and connections are:

- IS/Unlocked
- IS,AINS/Unlocked,AutomaticInService
- OOS,DSBLD/Locked,disabled

OCHCC service states and source and destination port states can be changed independently. You can manually modify client card port states in all traffic conditions. Setting an OCHCC circuit to OOS,DSBLD/Locked,disabled state has no effect on OCHCC client card ports.

An OCH trail is created automatically when you create an OCHCC. OCH trails can be created independently between OCH-10G cards and GE_XP and 10GE_XP when they are provisioned in Layer 2 Over DWDM mode. The OCH trail ANSI/ETSI administrative states include:

- IS/Unlocked
- IS,AINS/Unlocked,automaticInService
- OOS,DSBLD/Locked,disabled

You can modify OCH trail circuit states from the Edit Circuit window. Placing an OCH trail OOS,DSBLD/Locked,disabled causes the following state changes:

- The state of the OCH trail ports changes to OOS,DSBLD/Locked,disabled.
- The OCHNC state changes to OOS,DSBLD/Locked,disabled.

Changing the OCH trail state to IS,AINS/Unlocked,automaticInService causes the following state changes:

- The state of the OCH trail trunk ports changes to IS/Unlocked.
- The OCHNC state changes to IS,AINS/Unlocked,automaticInService.

The OCH trail service state is the sum of the OCHCC trunk port state and the OCHNC (if applicable) state. Changing the client card trunk ports to OOS,DSBLD/Locked,disabled when the OCH trail state IS/Unlocked will cause the OCH trail state to change to OOS,DSBLD/Locked,disabled and its status to change to Partial.

The OCHNC circuit states are not linked to the OCHCC circuit states. The administrative states for the OCHNC circuit layer are:

- IS,AINS/Unlocked,AutomaticInService
- OOS,DSBLD/Locked,disabled

When you create an OCHNC, you can set the target OCHNC circuit state to IS/Unlocked or OOS,DSBLD/Locked,disabled. You can create an OCHNC even if OCHNC source and destination ports are OOS,MT/Locked,maintenance. The OCHNC circuit state will remain OOS-AU,AINS/Unlocked-disabled,automaticInService until the port maintenance state is removed. During maintenance or laser shutdown, the following behavior occurs:

- If OCHNCs or their end ports move into an AINS/AutomaticInService state because of user maintenance activity on an OCHCC circuit (for example, you change an optical transport section (OTS) port to OOS,DSBLD/Locked,disabled), Cisco Transport Controller (CTC) suppresses the loss of service (LOS) alarms on the TXP, MXP, GE_XP, 10GE_XP, or ITU-T line card trunk ports and raises a Trail Signal Fail condition. Line card trunk port alarms are not changed, however.
- If TXP client or trunk port are set to OOS,DSBLD/Locked,disabled state (for example, a laser is turned off) and the OCH trunk and OCH filter ports are located in the same node, the OCH filter LOS alarm is demoted by a Trail Signal Fail condition.

OCHCCs are associated with the client card end ports. Therefore, the following port parameters cannot be changed when they carry an OCHCC:

- Wavelength
- Service (or payload type)
- Splitter protection
- ITU-T G.709
- Forward error correction (FEC)
- Mapping

Certain OCHCC parameters, such as service type, service size, and OCHNC wavelength can only be modified by deleting and recreating the OCHCC. If the OCHCC has MXP end ports, you can modify services and parameters on client ports that are not allocated to the OCHCC. Some client port parameters, such as Ethernet frame size and distance extension, are not part of an OCHCC so they can be modified if not restricted by the port state. For addition information about administrative and service states, see Appendix B, “Administrative and Service States.”

11.1.5 Creating and Deleting OCHCCs

To create an OCHCC, you must know the client port states and their parameters. If the client port state is IS/Unlocked, OCHCC creation will fail if the OTN line parameters (ITU-T G.709, FEC, signal fail bit error rate (SF BER), and signal degrade bit error rate (SD BER) on the OCHCC differ from what is provisioned on the trunk port. The port state must be changed to OOS-DSLB/Locked,disabled in order to complete the OCHCC.

If you delete an OCHCC, you can specify the administrative state to apply to the client card ports. For example, you can have the ports placed in OOS,DSBLD/Locked,disabled state after an OCHCC is deleted. If you delete an OCHCC that originates and terminates on MXP cards, the MXP trunk port states can only be changed if the trunk ports do not carry other OCHCCs.

11.1.6 OCHCCs and Service and Communications Channels

Although optical service channels (OSCs), generic communications channels (GCCs), and data communications channels (DCCs) are not managed by OCHCCs, the following restrictions must be considered when creating or deleting OCHCCs on ports with service or communication channels:

- Creating an OCHCC when the port has a service or a communications channel is present—OCHCC creation will fail if the OCHCC parameters are incompatible with the GCC/DCC/GCC. For example, you cannot disable ITU-T G.709 on the OCHCC if a GCC carried by the port requires the parameter to be enabled.
- Creating a service or communications channel on ports with OCHCCs—OCHCC creation will fail if the GCC/DCC/GCC parameters are incompatible with the OCHCC.
- Deleting an OCHCC on ports with service or communications channels—If an OSC/GCC/DCC is present on a TXP, MXP, GE_XP, 20GE_XP, or ITU-T line card client or trunk port, you cannot set these ports to the OOS,DSBLD/Locked,disabled state after the OCHCC circuit is deleted.

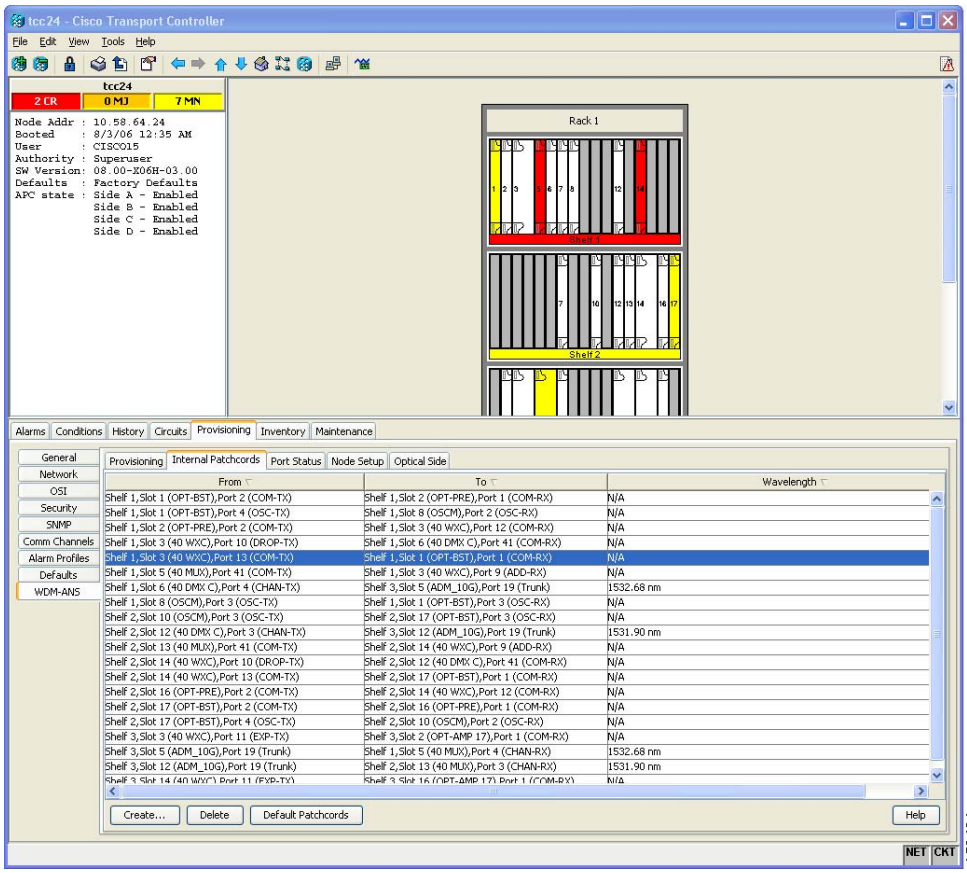
11.2 Virtual Patchcords

TXP, MXP, TXPP, MXPP, GE_XP, 10GE_XP, and ADM-10G client ports and DWDM filter ports can be located in different nodes or in the same single-shelf or multishelf node. ITU-T line card trunk ports and the corresponding DWDM filter ports are usually located in different nodes.

OCHCC provisioning requires a virtual patchcord between the client card trunk ports and the DWDM filter ports. Depending on the physical layout, this can be an internal patchcord or a provisionable (external) patchcord (PPC). Both patchcord types are bidirectional. However, each direction is managed as a separate patchcord.

Internal patchcords provide virtual links between the two sides of a DWDM shelf, either in single-shelf or multishelf mode. They are viewed and managed on the Provisioning > WDM-ANS > Internal Patchcords tab (Figure 11-3).

Figure 11-3 Internal Patchcords Tab



CTC calculates internal patchcords automatically after you click the Default Patchcords button on the Internal Patchcords tab. However, some internal patchcords cannot be calculated because of the card types that are installed and/or the card positions within a shelf. These internal patchcords must be created manually. For example, internal patchcords related to optical bypass circuits must be manually provisioned. When you create an internal patchcord manually, the Internal Patchcord Creation wizard asks you to choose one of the following internal patchcord types:

- OCH-Trunk to OCH-Filter—Creates an internal patchcord between the trunk port of a TXP, MXP, GE_XP, 10GE_XP, or ITU-T line card, and an OCH filter card (wavelength selective switch, multiplexer, or demultiplexer).
- OTS/OCH to OTS/OCH—Creates an internal patchcord between two OTS OCH ports.

Note If an OTS-to-OTS PPC is created between nodes, it will no longer function if the node Security Mode mode is enabled (see the "DLP-G264 Enable Node Security Mode" task in the *Cisco ONS 15454 DWDM Procedure Guide*). The reason for this is that if the Secure mode is enabled, it is no longer possible for the DCN extension feature to use the LAN interface to extend the internal network (due to the network isolation in this configuration mode). The result is that the topology discovery on the OTS-to-OTS PPC no longer operates.

Table 11-3 shows the internal patchcord OCH trunk, OCH filter, and OTS/OCH ports.

Table 11-3 Internal Patchcord Ports

Card	OCH Trunk Ports	OCH Filter Ports	OTS/OCH Ports
TXPs MXPs GE_XP 10GE_XP ADM-10G ITU-T line cards	Any trunk port	—	—
OPT-BST OPT-BST-E OPT-BST-L	—	—	COM-TX COM-RX OSC-TX OSC-RX
OPT-AMP-17-C OPT-AMP-L	—	—	COM-TX COM-RX OSC-TX[1] OSC-RX[1] DC-TX[1] DC-RX[1]
OPT-PRE	—	—	COM-TX COM-RX DC-TX DC-RX
OSCM OSC-CSM	—	—	COM-TX COM-RX OSC-TX OSC-RX
32MUX 32MUX-O 40-MUX-C	—	Any CHAN RX port	COM-TX
32DMX 32DMX-L 32DMX-O 40-DMX-C 40-DMX-CE	—	Any CHAN TX port	COM-RX

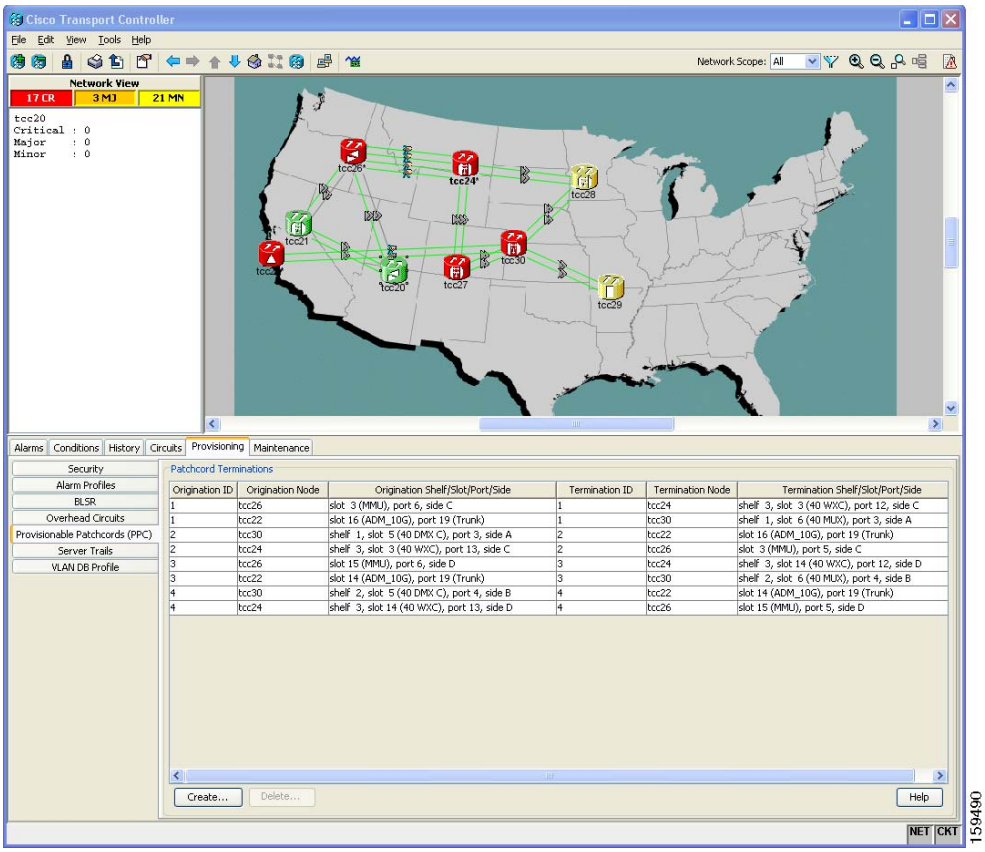
Table 11-3 Internal Patchcord Ports (continued)

Card	OCH Trunk Ports	OCH Filter Ports	OTS/OCH Ports
32WSS	—	Any ADD port	COM-TX
32WSS-L			COM-RX
40-WSS-C			EXP-TX
40-WSS-CE			EXP-RX
			DROP-TX
40-WXC-C	—	—	ADD-RX
			DROP-TX
			COM TX
			COM RX
MMU	—	—	EXP A TX
			EXP A RX

1. When provisioned in OPT-PRE mode.

PPCs are created and managed from the network view Provisioning > Provisionable Patchcord (PPC) tab (Figure 11-4), or from the node view (single-shelf mode) or multiself view (multishelf mode) Provisioning > Comm Channel > PPC tab.

Figure 11-4 Network View Provisionable Patchcords Tab



PPCs are required when the TXP, MXP, GE_XP, 10GE_XP, ADM-10G, or ITU-T line card is installed in a different node than the OCH filter ports. They can also be used to create OTS-to-OTS links between shelves that do not have OSC connectivity. PPCs are routable and can be used for network topology discovery by Open Shortest Path First (OSPF). GCCs and DCCs are not required for PPC creation. When you create a PPC, the PPC Creation wizard asks you to choose one of the following PPC types:

- OCH-Trunk to OCH-Trunk—Creates a PPC between two OCH trunk ports on TXP, MXP, GE_XP, 10GE_XP, ADM_10G, or ITU-T line cards.
- OTS to OTS—Creates a PPC between two OTS ports. This option establishes data communications network (DCN) connectivity between nodes that do not have OSCM or OSC-CSM cards installed and therefore do not have OSC connectivity. CTC selects the OTS ports after you choose the origination and termination sides.
- OCH-Trunk to OCH-Filter—Creates a PPC between a OCH trunk port on a TXP, MXP, GE_XP, 10GE_XP, ADM-10G, or ITU-T line card and an OCH filter port on a multiplexer, demultiplexer, or wavelength selective switch card.

Table 11-4 shows the PPC OCH trunk, OCH filter, and OTS ports.

Table 11-4 Provisionable Patchcord Ports

Card	OCH Trunk Port	OTS Port	OCH Filter Port
TXPs MXPs GE_XP 10GE_XP ADM-10G ITU-T line cards	Any trunk port	—	—
OPT-BST OPT-BST-E OPT-BST-L	—	COM RX[1] LINE RX LINE TX	—
OPT-AMP-17-C OPT-AMP-L	—	COM RX[2] COM TX[3] LINE RX[3] LINE TX[3]	—
OPT-PRE	—	COM RX[4] COM TX[4]	—
OSC-CSM	—	COM RX[1] LINE RX LINE TX	—
32MUX 32MUX-O 40-MUX-C	—	—	Any CHAN RX port
32DMX 32DMX-L 32DMX-O 40-DMX-C 40-DMX-CE	—	—	Any CHAN TX port
32WSS 32WSS-L 40-WSS-C 40-WSS-CE	—	—	Any ADD port
40-WXC-C	—	COM RX COM TX	—

Table 11-4 Provisionable Patchcord Ports (continued)

Card	OCH Trunk Port	OTS Port	OCH Filter Port
MMU	—	EXP A RX EXP A TX	—

1. Line nodes only.
2. When Card Mode is OPT-PRE.
3. When Card Mode is OPT-LINE.
4. Line nodes with two OPT-PRE cards and no BST cards installed.

For OCH trunk to OCH filter PPCs, the following rules and conditions apply:

- GCC and DCC links are not required to create a PPC.
- PPCs can be created for preprovisioned or physically installed cards.
- The OCH trunk and OCH filter ports must be on the same wavelength. CTC checks the ports for wavelength compatibility automatically during PPC provisioning.
- For OC-48/STM-16 and OC-192/STM-64 ITU-T line cards, the wavelength compatibility check is performed only when the cards are installed. The check is not performed for preprovisioned cards.
- For all other preprovisioned cards, a wavelength compatibility check is not performed if card is set to First Tunable Wavelength. The wavelength is automatically provisioned on the port, according to the add/drop port that you chose when you created the PPC.

For OCH-trunk to OCH-trunk PPCs, the following rules and conditions apply:

- Patchcords can be created on preprovisioned or physically installed cards.
- Trunk-to-trunk connections require compatible wavelengths if the port is equipped. A check is automatically performed during patchcord provisioning to ensure wavelength compatibility of ports.
- For connections involving one or more preprovisioned ports, no compatibility check is performed.

CHAPTER 12

Cisco Transport Controller Operation

This chapter describes Cisco Transport Controller (CTC), the software interface for the Cisco ONS 15454. For CTC setup and login information, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 12.1 CTC Software Delivery Methods, page 12-1
- 12.2 CTC Installation Overview, page 12-4
- 12.3 PC and UNIX Workstation Requirements, page 12-4
- 12.4 ONS 15454 Connections, page 12-7
- 12.5 CTC Window, page 12-8
- 12.6 Using the CTC Launcher Application to Manage Multiple ONS Nodes, page 12-20
- 12.7 TCC2/TCC2P Card Reset, page 12-23
- 12.8 TCC2/TCC2P Card Database, page 12-23
- 12.9 Software Revert, page 12-24

12.1 CTC Software Delivery Methods

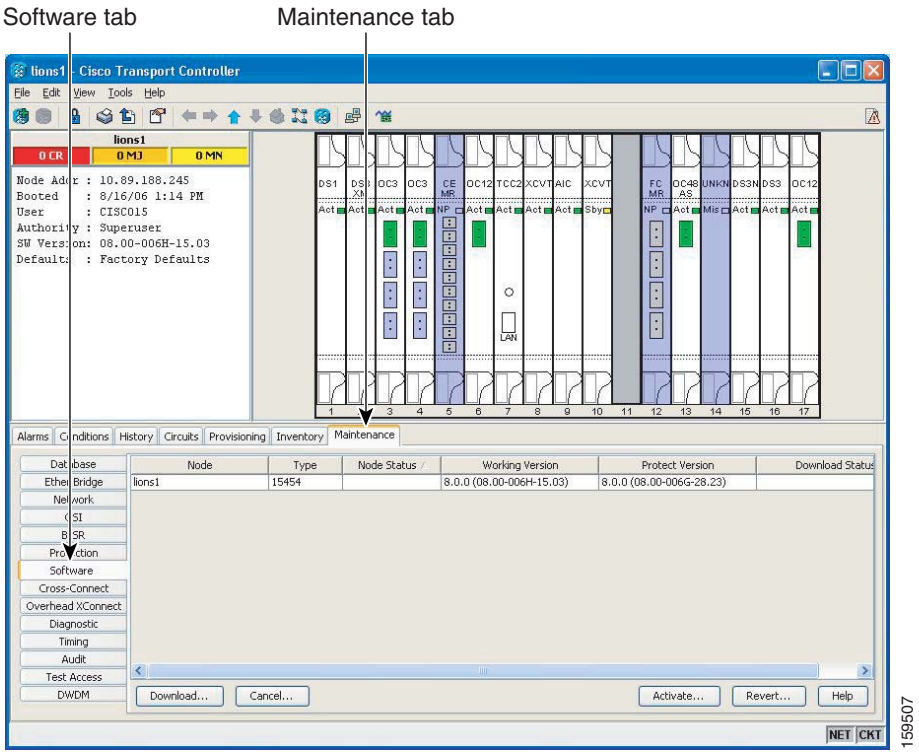
ONS 15454 provisioning and administration is performed using the CTC software. CTC is a Java application that is installed in two locations: it is stored on the TCC2 or TCC2P card and it is downloaded to your workstation the first time you log into the ONS 15454 with a new software release. You can also log into CTC using the CTC launcher application (StartCTC.exe). Refer to the "12.6 Using the CTC Launcher Application to Manage Multiple ONS Nodes" section on page 12-20 for more information.

12.1.1 CTC Software Installed on the TCC2/TCC2P Card

CTC software is preloaded on the ONS 15454 TCC2/TCC2P cards; therefore, you do not need to install software on the TCC2/TCC2P cards. When a new CTC software version is released, use the release-specific software upgrade document to upgrade the ONS 15454 software on the TCC2/TCC2P card.

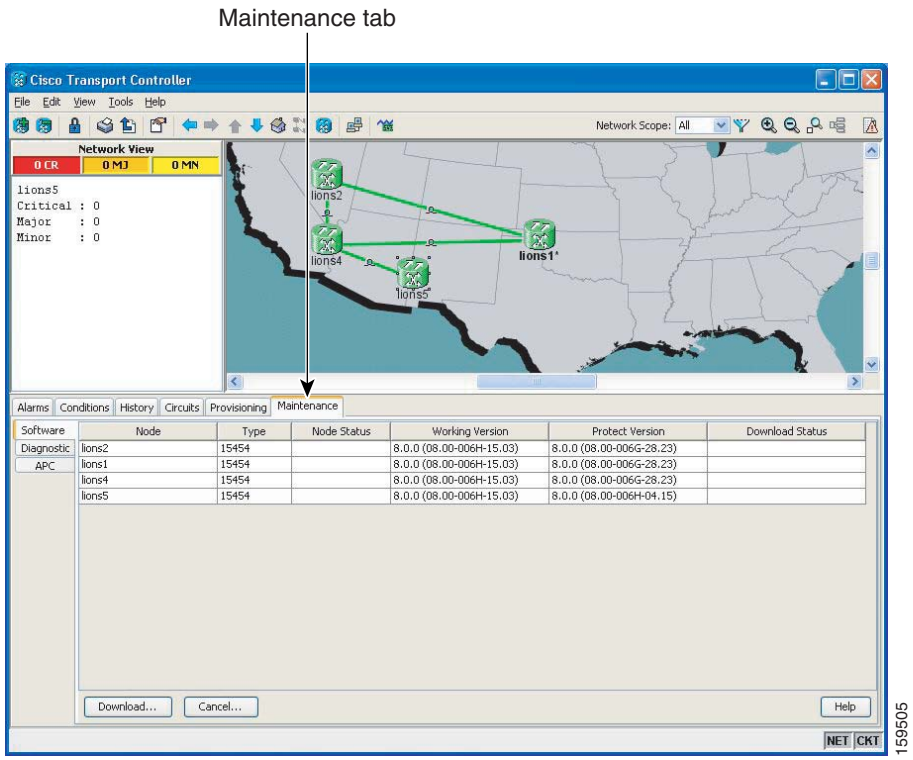
When you upgrade CTC software, the TCC2/TCC2P cards store the new CTC version as the protect CTC version. When you activate the new CTC software, the TCC2/TCC2P cards store the older CTC version as the protect CTC version, and the newer CTC release becomes the working version. You can view the software versions that are installed on an ONS 15454 by selecting the Maintenance > Software tabs in node view (single-shelf mode) or multishelf view (multishelf mode) (Figure 12-1).

Figure 12-1 CTC Software Versions, Node View (Single-Shelf Mode)



Select the Maintenance > Software tabs in network view to display the software versions installed on all the network nodes (Figure 12-2).

Figure 12-2 CTC Software Versions, Network View



12.1.2 CTC Software Installed on the PC or UNIX Workstation

CTC software is downloaded from the TCC2/TCC2P 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/TCC2P 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 (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 communications channel (DCC) network link require more time than JAR files downloaded over a LAN connection.

During network topology discovery, CTC polls each node in the network to determine which one contains the most recent version of the CTC software. If CTC discovers a node in the network that has a more recent version of the CTC software than the version you are currently running, CTC generates a message stating that a later version of the CTC has been found in the network and offers to install the CTC software upgrade. After the node view appears, you can upgrade CTC by using the **Tools > Update CTC** menu option. If you have network discovery disabled, CTC will not seek more recent versions of the software. Unreachable nodes are not included in the upgrade discovery.

Note Upgrading the CTC software will overwrite your existing software. You must restart CTC after the upgrade is complete.

12.2 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/TCC2P card to your computer.
2. The launcher determines whether your computer has a CTC release matching the release on the ONS 15454 TCC2/TCC2P card.
3. If the computer does not have CTC installed, or if the installed release is older than the TCC2/TCC2P card's version, the launcher downloads the CTC program files from the TCC2/TCC2P 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/TCC2P 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 SONET TL1 Command Guide* or *Cisco ONS 15454 SDH and Cisco ONS 15600 SDH TL1 Command Guide* for a comprehensive list of TL1 commands.

12.3 PC and UNIX Workstation Requirements

To use CTC for 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. 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.

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 12-1 shows JRE compatibility with ONS 15454 software releases.

Table 12-1 JRE Compatibility

ONS Software Release	JRE 1.2.2 Compatible	JRE 1.3 Compatible	JRE 1.4 Compatible	JRE 5.0 Compatible
ONS 15454 Release 4.5	No	Yes	No	No
ONS 15454 Release 4.6	No	Yes	Yes	No
ONS 15454 Release 4.7	No	No	Yes	No
ONS 15454 Release 5.0	No	No	Yes	No
ONS 15454 Release 6.0	No	No	Yes	No
ONS 15454 Release 7.0	No	No	Yes	Yes [1]

Table 12-1 JRE Compatibility (continued)

ONS Software Release	JRE 1.2.2 Compatible	JRE 1.3 Compatible	JRE 1.4 Compatible	JRE 5.0 Compatible
ONS 15454 Release 7.2	No	No	Yes	Yes[1]
ONS 15454 Release 8.0	No	No	No	Yes
ONS 15454 Release 8.5	No	No	No	Yes

1. JRE 1.4.2 is the preferred version which is included in the software CD

Note To avoid network performance issues, Cisco recommends managing a maximum of 50 nodes concurrently with CTC. The 50 nodes can be on a single DCC or split across multiple DCCs. Cisco does not recommend running multiple CTC sessions when managing two or more large networks. To manage more than 50 nodes, Cisco recommends using Cisco Transport Manager (CTM). If you do use CTC to manage more than 50 nodes, you can improve performance by adjusting the heap size; see the "General Troubleshooting" chapter of the *Cisco ONS 15454 DWDM Troubleshooting Guide*. You can also create login node groups; see the "Connect the PC and Log Into the GUI" chapter of the *Cisco ONS 15454 DWDM Procedure Guide*.

Table 12-2 lists the requirements for PCs and UNIX workstations. In addition to the JRE, the Java plug-in is also included on the ONS 15454 software CD.

Table 12-2 Computer Requirements for CTC

Area	Requirements	Notes
Processor (PC only)	Pentium 4 processor or equivalent	A faster CPU is recommended if your workstation runs multiple applications or if CTC manages a network with a large number of nodes and circuits.
RAM	512 MB RAM or more	A minimum of 1 GB is recommended if your workstation runs multiple applications or if CTC manages a network with a large number of nodes and circuits.
Hard drive	20 GB hard drive with 100MB of free space required	CTC application files are downloaded from the TCC2/TCC2P to your computer. These files occupy around 100MB (250MB to be safer) or more space depending on the number of versions in the network.
Operating System	• PC: Windows 98 (1st and 2nd editions), Windows ME, Windows NT 4.0 with Service Pack 6a, Windows 2000 with Service Pack 3, or Windows XP with Service Pack 1 • Workstation: Solaris versions 9 or 10	Check with the vendor for the latest patch/Service Pack level

Table 12-2 Computer Requirements for CTC (continued)

Area	Requirements	Notes
Java Runtime Environment	JRE 5.0	JRE 5.0 is installed by the CTC Installation Wizard included on the Cisco ONS 15454 software CD. JRE 5.0 provide enhancements to CTC performance, especially for large networks with numerous circuits. Cisco recommends that you use JRE 5.0 for networks with Software R8.5 nodes. If CTC must be launched directly from nodes running software R7.0 or R7.2, Cisco recommends JRE 1.4.2 or JRE 5.0. If CTC must be launched directly from nodes running software R5.0 or R6.0, Cisco recommends JRE 1.4.2.If CTC must be launched directly from nodes running software earlier than R5.0, Cisco recommends JRE 1.3.1_02.
Web browser	• PC:Internet Explorer 6.x or Netscape 7.x • UNIX Workstation: Mozilla 1.7, Netscape 4.76, Netscape 7.x	For the PC, use JRE 5.0 with any supported web browser. Cisco recommends Internet Explorer 6.x. For UNIX, use JRE 5.0 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
Cable	User-supplied CAT-5 straight-through cable with RJ-45 connectors on each end to connect the computer to the ONS 15454 directly or through a LAN. User-supplied cross-over CAT-5 cable to the DCN port on the ONS 15454 patch panel or to the Catalyst 2950 (multishelf mode).	—

12.4 ONS 15454 Connections

You can connect to the ONS 15454 in multiple ways. You can connect your PC directly to the ONS 15454 (local craft connection) using the RJ-45 port on the TCC2/TCC2P card or, for the ANSI shelf, using the LAN pins on the backplane (the ETSI shelf provides a LAN connection via the RJ-45 jack on the MIC-T/C/P Front Mount Electrical Connection [FMEC]). Alternatively, you can 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 12-3 lists the ONS 15454 connection methods and requirements.

Table 12-3 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/TCC2P card • The RJ-45 (LAN) port on the patch panel (multishelf mode) • Port 23 or 24 of the Catalyst 2950 (multishelf mode) • The LAN pins on the ONS 15454 backplane (ANSI) • The RJ-45 jack on the MIC-T/C/P FMEC (ETSI) • 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, and 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.

Table 12-3 ONS 15454 Connection Methods (continued)

Method	Description	Requirements
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 SONET TL1 Reference Guide* or the *Cisco ONS 15454 SDH and Cisco ONS 15600 SDH TL1 Reference 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.

12.5 CTC Window

When you log into a single-shelf ONS 15454, the CTC window appears in node view (Figure 12-3). When you log into a multishelf ONS 15454, meaning that two or more ONS 15454 shelves are configured to operate as one node, the multishelf view (Figure 12-4) appears in the CTC window. The window includes a menu bar, a 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 subtabs to view ONS 15454 information and perform ONS 15454 provisioning and maintenance tasks. From the CTC window, you can display the other ONS 15454 views. In single-shelf mode, these are the network, node, and card views. In multishelf mode, these are the network, multishelf, shelf, and card views.

Figure 12-3 Node View (Default Login View for Single-Shelf Mode)

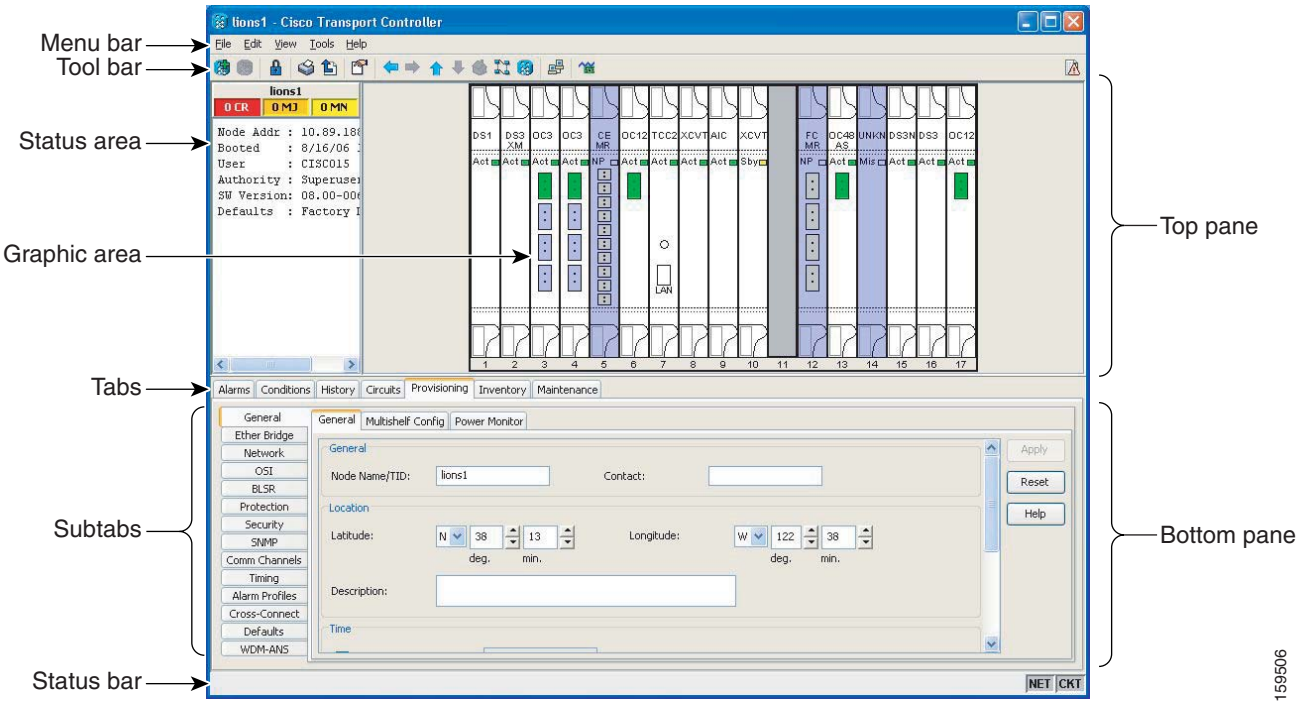
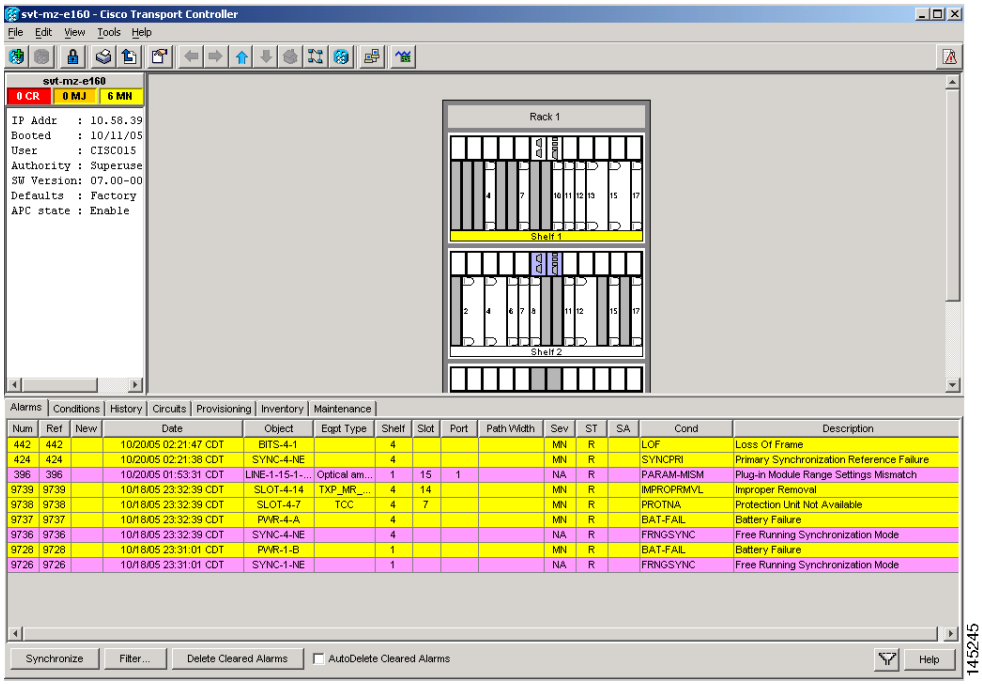


Figure 12-4 Multishelf View (Default Login View for Multishelf Mode)



12.5.1 Summary Pane

The Summary pane on the left has the following fields:

- Node Addr—IP address of the node.
- Booted—The Booted field indicates one of the following:
  - Date and time of the node reboot. The node reboot is caused by complete power cycle, software upgrade, or software downgrade.
  - Date and time of reset of the control cards one after the other.
- User—Login user name.
- Authority—Security level of users. The possible security levels are Retrieve, Maintanence, Provisioning, and Superuser.
- SW Version—CTC software version.
- Defaults—Name provided to identify the defaults list.

12.5.2 Node View (Multishelf Mode), Node View (Single-Shelf Mode), and Shelf View (Multishelf Mode)

Node view, shown in Figure 12-3, is the first view that appears after you log into a single-shelf ONS 15454. Multishelf view, shown in Figure 12-4, is the first view that appears after you log into a multishelf ONS 15454. The login node is the first node shown, and it is the "home view" for the session. Multishelf view and node view allow 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; name and security level of the current logged-in user; software version; and network element default setup.

In a multishelf mode, up to 12 shelves operate as a single node.

Note The reason for extending the number of subtending shelves from eight to 12 is to accommodate and manage the new optical and DWDM cards that operate in the even band frequency grid.

When you open a shelf from multishelf view, shelf view appears, which looks similar to node view but does not contain the tabs and subtabs that are used for node-level operations.

12.5.2.1 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 12-4).

Table 12-4 Multishelf View (Multishelf Mode), Node View (Single-Shelf Mode), and Shelf View (Multishelf Mode) 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.

Table 12-4 Multishelf View (Multishelf Mode), Node View (Single-Shelf Mode), and Shelf View (Multishelf Mode) Card Colors (continued)

Card Color	Status
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.

On the ONS 15454 ETSI, the colors of the FMEC cards reflect the real-time status of the physical FMEC cards. Table 12-5 lists the FMEC card colors. The FMEC ports shown in CTC do not change color.

Note You cannot preprovision FMECs.

Table 12-5 Multishelf View (Multishelf Mode) and Node View (Single-Shelf Mode) FMEC Color

Upper Shelf FMEC Color	Status
White	Functioning card is installed.
Yellow	Minor alarm condition exists.
Orange (Amber)	Major alarm condition exists.
Red	Critical alarm exists.

The wording on a card in node view (single-shelf mode) or shelf view (multishelf mode) shows the status of a card (Active, Standby, Loading, or Not Provisioned). Table 12-6 lists the card statuses.

Table 12-6 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Statuses

Card Status	Description
Act	Card is active.
Sty	Card is in standby mode.
Ldg	Card is resetting.
NP	Card is not present.

Port color in card view, node view (single-shelf mode), and shelf view (multishelf mode) indicates the port service state. Table 12-7 lists the port colors and their service states. For more information about port service states, see Appendix B, "Administrative and Service States."

Table 12-7 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Port Colors and Service States

Port Color	Service State	Description
Cyan (blue)	Out-of-Service and Management, Loopback (OOS-MA,LPBK) (ANSI) Locked-enabled,loopback (ETSI)	Port is in a loopback state. On the card in node or shelf view, a line between ports indicates that the port is in terminal or facility loopback (see Figure 12-5 and Figure 12-6). Traffic is carried 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.
Cyan (blue)	Out-of-Service and Management, Maintenance (OOS-MA,MT) (ANSI) Locked-enabled,maintenance (ETSI)	Port is out-of-service for maintenance. Traffic is carried and loopbacks are allowed. 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 this service state for testing or to suppress alarms temporarily. Change the state to IS-NR/Unlocked-enabled; OOS-MA,DSBLD/Locked-enabled,disabled; or OOS-AU,AINS/Unlocked-disabled,automaticInService when testing is complete.
Gray	Out-of-Service and Management, Disabled (OOS-MA,DSBLD) (ANSI) Locked-enabled,disabled (ETSI)	The port is out-of-service and unable to carry traffic. Loopbacks are not allowed in this service state.
Green	In-Service and Normal (IS-NR) (ANSI) Unlocked-enabled (ETSI)	The port is fully operational and performing as provisioned. The port transmits a signal and displays alarms; loopbacks are not allowed.
Violet	Out-of-Service and Autonomous, Automatic In-Service (OOS-AU,AINS) (ANSI) Unlocked-disabled,automaticInService (ETSI)	The port is out-of-service, but traffic is carried. Alarm reporting is suppressed. The node monitors the ports for an error-free signal. After an error-free signal is detected, the port stays in this service state for the duration of the soak period. After the soak period ends, the port service state changes to IS-NR/Unlocked-enabled. 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-NR/Unlocked-enabled when a signal is received for the length of time provisioned in the soak field.

Figure 12-5 Terminal Loopback Indicator

Figure 12-6 Facility Loopback Indicator

12.5.2.2 Multishelf View Card Shortcuts

If you move your mouse over cards in the multishelf view 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, or Minor (if any); the alarm profile used by the card; and for transponder (TXP) or muxponder (MXP) cards, the wavelength of the dense wavelength division multiplexing (DWDM) port.

12.5.2.3 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Shortcuts

If you move your mouse over cards in the node view (single-shelf mode) or shelf view (multishelf mode) 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, or 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).

12.5.2.4 Multishelf View Tabs

Table 12-8 lists the tabs and subtabs available in the multishelf view. The actions on these tabs apply to the multishelf node and its subtending shelves.

Table 12-8 Multishelf View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the multishelf node and updates them in real time.	—
Conditions	Displays a list of standing conditions on the multishelf node.	—
History	Provides a history of multishelf node alarms including the 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.	Circuits, Rolls
Provisioning	Provisions the ONS 15454 multishelf node.	General, Network, OSI, Security, SNMP, Comm Channels, Alarm Profiles, Defaults, WDM-ANS

Table 12-8 Multishelf View Tabs and Subtabs (continued)

Tab	Description	Subtabs
Inventory	Provides inventory information (part number, serial number, and Common Language Equipment Identification [CLEI] codes) for cards installed on all shelves in the multishelf node. Allows you to delete and reset cards and change the card service state.	—
Maintenance	Performs maintenance tasks for the multishelf node.	Database, Network, OSI, Software, Diagnostic, Audit, DWDM

12.5.2.5 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs

Table 12-9 lists the tabs and subtabs available in node view (single-shelf mode) or shelf view (multishelf mode).

Table 12-9 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the node or shelf and updates them in real time.	—
Conditions	Displays a list of standing conditions on the node or shelf.	—
History	Provides a history of node or shelf alarms including the 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.	Circuits, Rolls
Provisioning	Provisions the ONS 15454 single-shelf or multishelf node.	Single-shelf mode: General, Network, OSI, Security, SNMP, Comm Channels, Alarm Profiles, Defaults, WDM-ANS Multishelf mode: General, Protection, Timing, Alarm Profiles

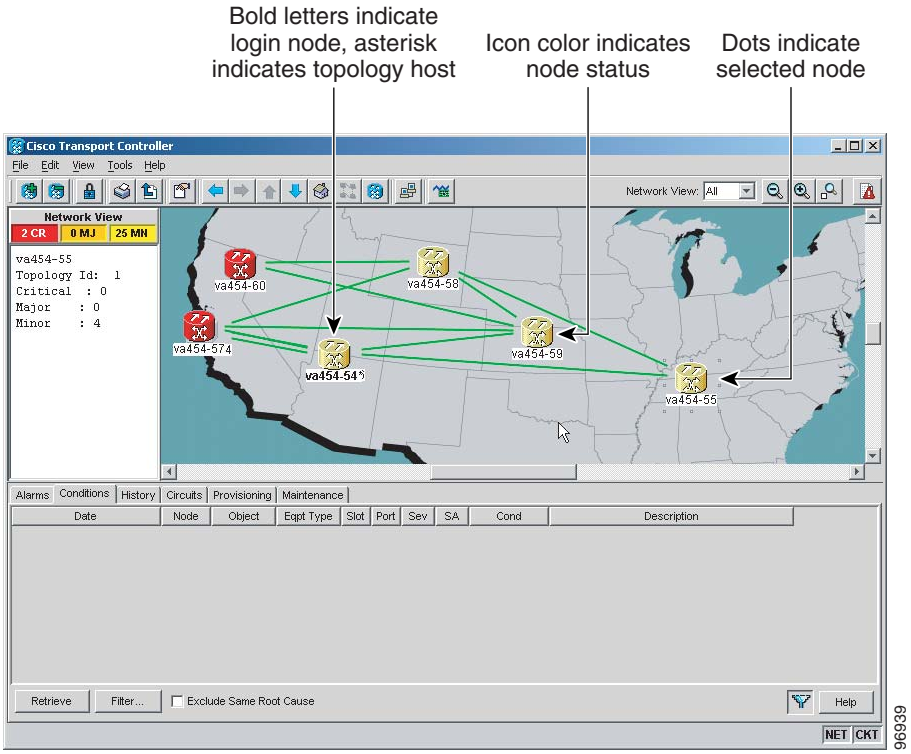
Table 12-9 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs and Subtabs

Tab	Description	Subtabs
Inventory	Provides inventory information (part number, serial number, and CLEI codes) for cards installed in the single-shelf or multishelf node. Allows you to delete and reset cards and change the card service state. **Note** Each card has bootstrap and boot code. After the card is upgraded using the boot code upgrade procedure, the bootstrap version is displayed in the Inventory tab in CTC; However, the boot code version is not displayed in the Inventory tab.	—
Maintenance	Performs maintenance tasks for the single-shelf or multishelf node.	Single-shelf mode: Database, Network, OSI, Software, Diagnostic, Audit, DWDM Multishelf mode: Protection, Overhead XConnect, Diagnostic, Timing

12.5.3 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 have selected (Figure 12-7).

Figure 12-7 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.

12.5.3.1 Network View Tabs

Table 12-10 lists the tabs and subtabs available in network view.

Table 12-10 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.	—

Table 12-10 Network View Tabs and Subtabs (continued)

Tab	Description	Subtabs
Provisioning	Provisions security, alarm profiles, bidirectional line switched rings (BLSRs) (ANSI), multiplex section-shared protection rings (MS-SPRing) (ETSI), and overhead circuits.	Security, Alarm Profiles, BLSR (ANSI), MS-SPRing (ETSI), Overhead Circuits, Provisionable Patchcords
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

12.5.3.2 CTC Node Colors

The color of a node in network view, shown in Table 12-11, indicates the node alarm status.

Table 12-11 Node Status Shown in Network View

Color	Alarm Status
Green	No alarms
Yellow	Minor alarms
Orange	Major alarms
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)

12.5.3.3 DCC Links

The lines show DCC connections between the nodes (Table 12-12). 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). 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.

Table 12-12 DCC Colors Indicating State in Network View

Color and Line Style	State
Green and solid	Active/Routable
Green and dashed	Active/Nonroutable
Gray and solid	Failed/Routable
Gray and dashed	Failed/Nonroutable

12.5.3.4 Link Consolidation

CTC provides the ability to consolidate the DCC, generic communications channel (GCC), optical transmission section (OTS), and PPC links shown in the network view into a more streamlined view. Link consolidation allows you to condense multiple inter-nodal links into a single link. The link

consolidation sorts links by class, meaning that all DCC links are consolidated together, for example.You can access individual links within consolidated links using the right-click shortcut menu.Each link has an associated icon (Table 12-13).

Table 12-13 Link Icons

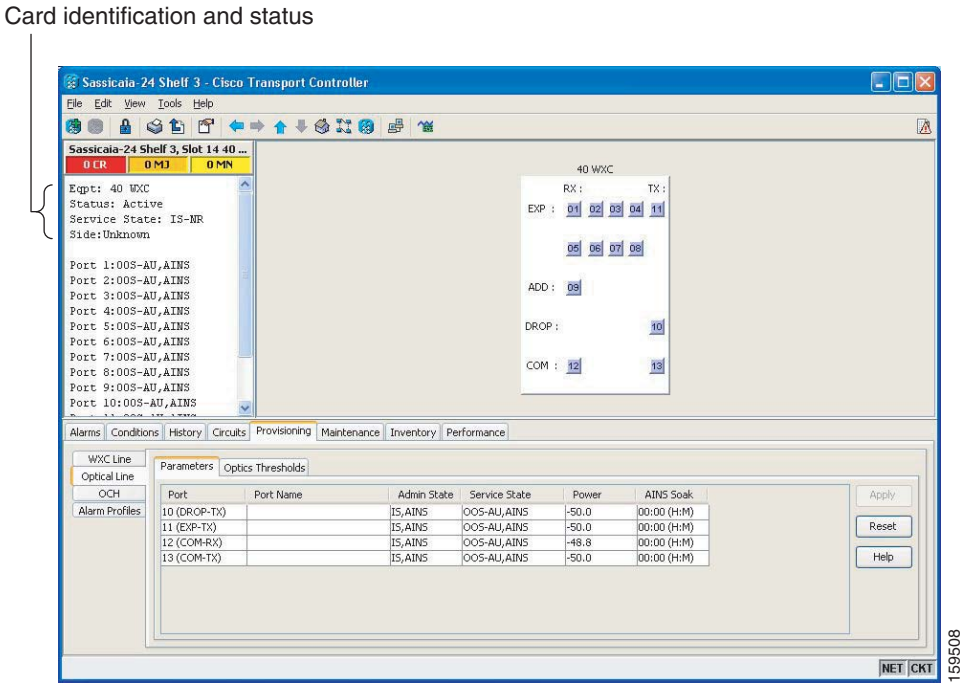
Icon	Description
	DCC icon
	GCC icon
	OTS icon
	PPC icon

Note Link consolidation is only available on non-detailed maps. Non-detailed maps display nodes in icon form instead of detailed form, meaning that the nodes appear as rectangles with ports on the sides. Refer to the *Cisco ONS 15454 DWDM Procedure Guide* for more information about consolidated links.

12.5.4 Card View

The card view provides information about individual ONS 15454 cards. Use this window to perform card-specific maintenance and provisioning (Figure 12-8). 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, card status (active or standby), card service state if the card is present, and port service state (described in Table 12-7 on page 12-12). The information that appears and the actions that you can perform depend on the card. For more information about card service states, refer to Appendix B, "Administrative and Service States."

Figure 12-8 CTC Card View Showing a 40-WXC-C Card



Note CTC provides a card view for all ONS 15454 cards except the TCC2/TCC2P card.

Use the card view tabs and subtabs shown in Table 12-14 to provision and manage the ONS 15454. The subtabs, fields, and information shown under each tab depend on the card type selected.

Table 12-14 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.	—

Table 12-14 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, SONET STS, Alarm Profiles TXP and MXP cards: Card, Line, Line Thresholds, Optics Thresholds, OTN, Alarm Profiles DWDM cards (subtabs depend on card type): Optical Line, Optical Chn, Optical Amplifier, Parameters, Optics Thresholds, Alarm Profiles
Maintenance	Performs maintenance tasks for the card.	Loopback, Info, Protection, J1 Path Trace, AINS Soak (options depend on the card type), Automatic Laser Shutdown
Performance (Not available for the AIC-I cards)	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 Line, OC3 Line, Parameters, Optics Thresholds
Inventory	(40-WSS, 40-WXC, OPT-PRE and OPT-BST cards) Displays an Inventory screen of the ports.	—

12.6 Using the CTC Launcher Application to Manage Multiple ONS Nodes

The CTC Launcher application is an executable file, StartCTC.exe, that is provided on Software Release 8.5 CDs for Cisco ONS products. You can use CTC Launcher to log into multiple ONS nodes that are running CTC Software Release 3.3 or higher, without using a web browser. The CTC launcher application provides an advantage particularly when you have more than one NE version on the network, because it allows you to pick from all available CTC software versions. It also starts more quickly than the browser version of CTC and has a dedicated node history list.

CTC Launcher provides two connection options. The first option is used to connect to ONS NEs that have an IP connection to the CTC computer. The second option is used to connect to ONS NEs that reside behind third party, OSI-based GNEs. For this option, CTC Launcher creates a TL1 tunnel to transport the TCP traffic through the OSI-based GNE.

The TL1 tunnel transports the TCP traffic to and from ONS ENEs through the OSI-based GNE. TL1 tunnels are similar to the existing static IP-over-CLNS tunnels, GRE, and Cisco IP, that can be created at ONS NEs using CTC. (Refer to the Cisco ONS product documentation for information about static IP-over-CLNS tunnels.) However, unlike the static IP-over-CLNS tunnels, TL1 tunnels require no provisioning at the ONS ENE, the third-party GNE, or DCN routers. All provisioning occurs at the CTC computer when the CTC Launcher is started.

Figure 12-9 shows examples of two static IP-over-CLNS tunnels. A static Cisco IP tunnel is created from ENE 1 through other vendor GNE 1 to a DCN router, and a static GRE tunnel is created from ONS ENE 2 to the other vender, GNE 2. For both static tunnels, provisioning is required on the ONS ENEs. In addition, a Cisco IP tunnel must be provisioned on the DCN router and a GRE tunnel provisioned on GNE 2.

Figure 12-9 Static IP-Over-CLNS Tunnels

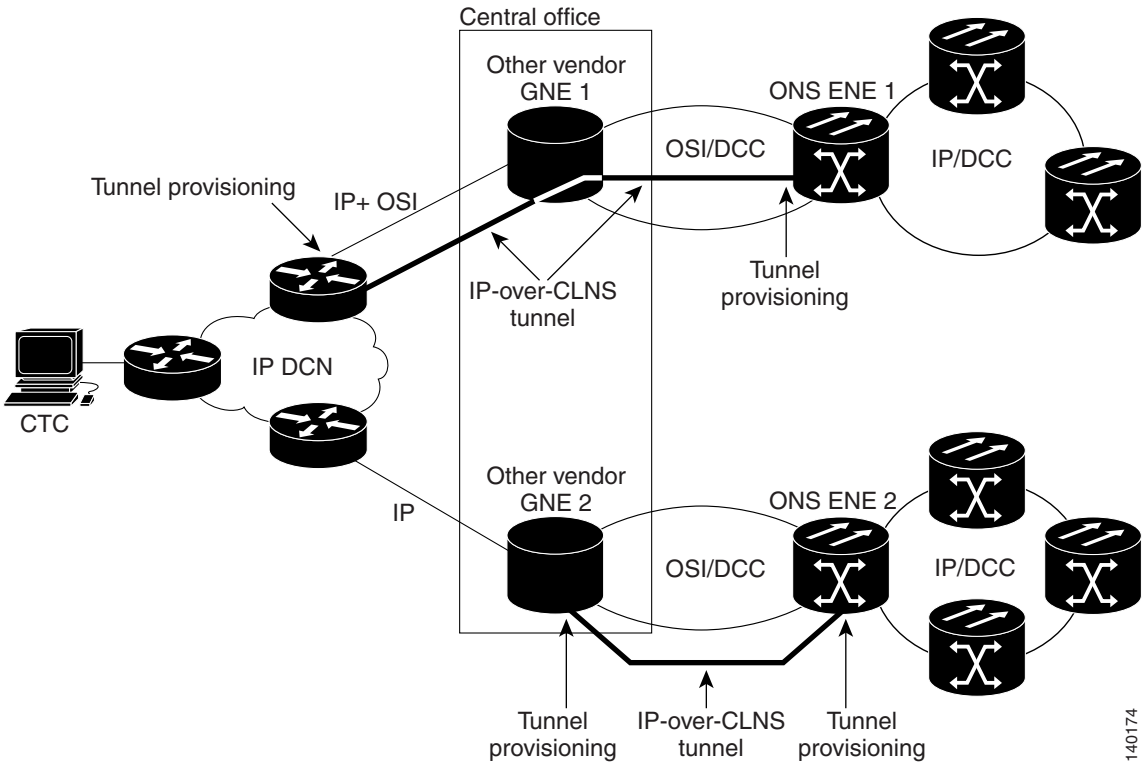
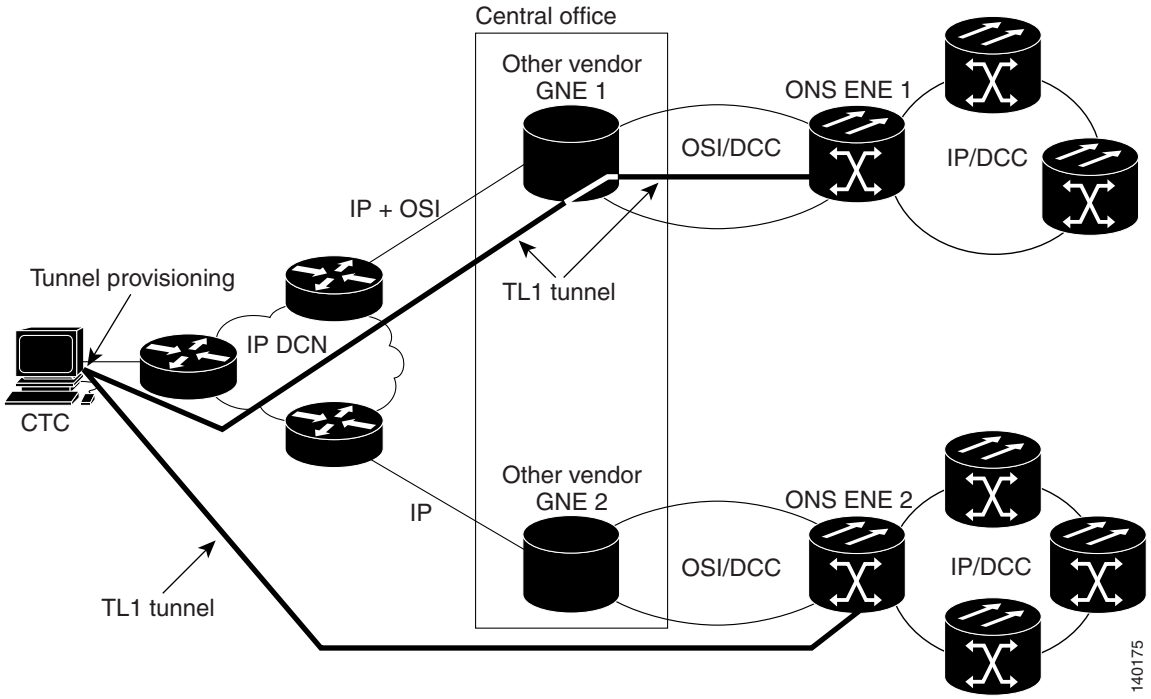


Figure 12-10 shows the same network using TL1 tunnels. Tunnel provisioning occurs at the CTC computer when the tunnel is created with the CTC Launcher. No provisioning is needed at ONS NEs, GNEs, or routers.

Figure 12-10 TL1 Tunnels



TL1 tunnels provide several advantages over static IP-over-CLNS tunnels. Because tunnel provisioning is needed only at the CTC computer, they are faster to set up. Because they use TL1 for TCP transport, they are more secure. TL1 tunnels also provide better flow control. On the other hand, IP over CLNS tunnels require less overhead and usually provide a slight performance edge over TL1 Tunnels (depending on network conditions). TL1 tunnels do not support all IP applications such as SNMP and RADIUS Authentication. Table 12-15 shows a comparison between the two types of tunnels.

Table 12-15 TL1 and Static IP-Over-CLNS Tunnels Comparison

Category	Static IP-Over-CLNS	TL1 Tunnel	Comments
Setup	Complex	Simple	Requires provisioning at ONS NE, GNE, and DCN routers. For TL1 tunnels, provisioning is needed at CTC computer.
Performance	Best	Average to good	Static tunnels generally provide better performance than TL1 tunnels, depending on TL1 encoding used. LV+Binary provides the best performance. Other encoding will produce slightly slower TL1 tunnel performance.
Support all IP applications	Yes	No	TL1 tunnels do not support SNMP or RADIUS Server IP applications.
ITU Standard	Yes	No	Only the static IP-over-CLNS tunnels meet ITU standards. TL1 tunnels are new.
Tunnel traffic control	Good	Very good	Both tunnel types provide good traffic control
Security setup	Complex	No setup needed	Static IP-over-CLNS tunnels require careful planning. Because TL1 tunnels are carried by TL1, no security provisioning is needed.

Table 12-15 TL1 and Static IP-Over-CLNS Tunnels Comparison (continued)

Category	Static IP-Over-CLNS	TL1 Tunnel	Comments
Potential to breach DCN from DCC using IP.	Possible	Not possible	A potential exists to breach a DCN from a DCC using IP. This potential does not exist for TL1 tunnels.
IP route management	Expensive	Automatic	For static IP-over-CLNS tunnels, route changes require manual provisioning at network routers, GNEs, and ENEs. For TL1 tunnels, route changes are automatic.
Flow control	Weak	Strong	TL1 tunnels provide the best flow control.
Bandwidth sharing among multiple applications	Weak	Best	—
Tunnel lifecycle	Fixed	CTC session	TL1 tunnels are terminated when the CTC session ends. Static IP-over-CLNS tunnels exist until they are deleted in CTC.

TL1 tunnel specifications and general capabilities include:

- Each tunnel generally supports between six to eight ENEs, depending on the number of tunnels at the ENE.
- Each CTC session can support up to 32 tunnels.
- The TL1 tunnel database is stored locally in the CTC Preferences file.
- Automatic tunnel reconnection when the tunnel goes down.
- Each ONS NE can support at least 16 concurrent tunnels.

12.7 TCC2/TCC2P Card Reset

You can reset the ONS 15454 TCC2/TCC2P card by using CTC (a soft reset) or by physically reseating the card (a hard reset). A soft reset reboots the TCC2/TCC2P card and reloads the operating system and the application software. Additionally, a hard reset temporarily removes power from the TCC2/TCC2P card and clears all buffer memory.

You can apply a soft reset from CTC to either an active or standby TCC2/TCC2P card without affecting traffic. If you need to perform a hard reset on an active TCC2/TCC2P card, put the TCC2/TCC2P card into standby mode first by performing a soft reset.

Note When a CTC reset is performed on an active TCC2/TCC2P card, the AIC-I card goes through an initialization process and also resets because it is controlled by the active TCC2/TCC2P card.

12.8 TCC2/TCC2P Card Database

When dual TCC2/TCC2P cards are installed in the ONS 15454, each TCC2/TCC2P card hosts a separate database; therefore, the protect card database is available if the database on the working TCC2/TCC2P 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.

12.9 Software Revert

When you click the Activate button after a software upgrade, the TCC2/TCC2P card copies the current working database and saves it in a reserved location in the TCC2/TCC2P card flash memory. If later during the upgrade you 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.

The revert feature is useful if the maintenance window in which you were performing an upgrade closes while you are still upgrading CTC software. You can revert to the protect software load without losing traffic. During the next maintenance window, you can complete the upgrade and activate the new software load.

Circuits created or provisioning done after you activate a new software load (upgrade to a higher release) will be lost with a revert. The database configuration at the time of activation is reinstated after a revert. (This does not apply to maintenance reverts, such as Software R5.0.1 to Software R5.0.2, because maintenance releases retain the database during activation.)

Caution Cisco does not recommend reverting after changing provisioning on the node. Depending upon the particular provisioning, reverting in this case can be traffic affecting.

To perform a supported (non-service-affecting) revert from a software release that you have just activated, the release you revert to must have been working at the time you first activated the new software on that node. Because a supported revert automatically restores the node configuration at the time of the previous activation, any configuration changes made after activation will be lost when you revert the software. Downloading the software release that you are upgrading to a second time after you have activated the new load ensures that no actual revert to a previous load can take place (the TCC2/TCC2P will reset, but will not be traffic affecting and will not change your database).

Note To perform a supported software upgrade or revert, you must consult the specific upgrade document and release notes for the release you are upgrading to (or reverting from).

CHAPTER 13

Security Reference

This chapter provides information about Cisco ONS 15454 users and security.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 13.1 User IDs and Security Levels, page 13-1
- 13.2 User Privileges and Policies, page 13-2
- 13.3 Audit Trail, page 13-8
- 13.4 RADIUS Security, page 13-9

13.1 User IDs and Security Levels

The Cisco Transport Controller (CTC) ID is provided with the ONS 15454 system, but the system does not display the user ID when you sign into CTC. This ID can be used to set up other ONS 15454 users.

You can have up to 500 user IDs on one ONS 15454. Each 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.

See Table 13-3 on page 13-7 for idle user timeout information for each security level.

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.

Note Maintenance, Provisioning, and Superusers must be properly trained on the hazards of laser safety and be aware of safety-related instructions, labels, and warnings. Refer to the *Cisco Optical Products Safety and Compliance Information* document for a current list of safety labels and warnings, including laser warnings. Refer to IEC 60825-2 for international laser safety standards, or to ANSI Z136.1 for U.S. laser safety standards. The *Cisco ONS 15454 DWDM Procedure Guide* explains how users can disable laser safety during maintenance or installation; when following these procedures, adhere to all posted warnings and cautions to avoid unsafe conditions or abnormal exposure to optical radiation.

13.2 User Privileges and Policies

This section lists user privileges for each CTC task and describes the security policies available to Superusers for provisioning.

13.2.1 User Privileges by CTC Task

Table 13-1 shows the actions that each user privilege level can perform in node view.

Table 13-1 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	Circuits	Create/Edit/Delete	—	—	X	X
		Filter/Search	X	X	X	X
	Rolls	Complete/ Force Valid Signal/ Finish	—	—	X	X

Table 13-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Provisioning	General	General: Edit	—	—	Partial[1]	X
		Multishelf Config: Edit	—	—	—	X
	Network	General: Edit	—	—	—	X
		Static Routing: Create/Edit/ Delete	—	—	X	X
		OSPF: Create/Edit/Delete	—	—	X	X
		RIP: Create/Edit/Delete	—	—	X	X
		Proxy: Create/Edit/Delete	—	—	—	X
		Firewall: Create/Edit/Delete	—	—	—	X
	OSI	Main Setup:Edit	—	—	—	X
		TARP: Config: Edit	—	—	—	X
		TARP: Static TDC: Add/Edit/Delete	—	—	X	X
		TARP: MAT: Add/Edit/Remove	—	—	X	X
		Routers: Setup: Edit	—	—	—	X
		Routers: Subnets: Edit/Enable/Disable	—	—	X	X
		Tunnels: Create/Edit/Delete	—	—	X	X

Table 13-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
	Security	Users: Create/Delete/Clear Security Intrusion Alarm	—	—	—	X
		Users: Change	Same user	Same user	Same user	All users
		Active Logins: View/Logout/ Retrieve Last Activity Time	—	—	—	X
		Policy: Edit/View	—	—	—	X
		Access: Edit/View	—	—	—	X
		RADIUS Server: Create/Edit/Delete/Move Up/M ove Down/View	—	—	—	X
		Legal Disclaimer: Edit	—	—	—	X
	SNMP	Create/Edit/Delete	—	—	X	X
		Browse trap destinations	X	X	X	X
	Comm Channels	SDCC: Create/Edit/Delete	—	—	X	X
		LDCC: Create/Edit/Delete	—	—	X	X
		GCC: Create/Edit/Delete	—	—	X	X
		OSC: Create/Edit/Delete	—	—	X	X
		PPC: Create/Edit/Delete	—	—	X	X
		LMP: General: Edit	X	X	X	X
		LMP: Control Channels: Create/Edit/Delete	—	—	—	X
		LMP: TE Links: Create/Edit/Delete	—	—	—	X
		LMP: Data Links: Create/Edit/Delete	—	—	—	X
	Alarm Profiles	Load/Store/Delete[2]	—	—	X	X
		New/Compare/Available/Usage	X	X	X	X
	Defaults	Edit/Import	—	—	—	X
		Reset/Export	X	X	X	X
	WDM-ANS	Provisioning: Edit	—	—	—	X
		Provisioning: Reset	X	X	X	X
		Internal Patchcords: Create/Edit/Delete/Commit/ Default Patchcords	—	—	X	X
		Port Status: Launch ANS	—	—	—	X
		Node Setup: Setup/Edit	X	X	X	X
		Optical Side: Create/Edit/Delete	X	X	X	X
Inventory	—	Delete	—	—	X	X
		Reset	—	X	X	X

Table 13-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Maintenance	Database	Backup	—	X	X	X
		Restore	—	—	—	X
	Network	Routing Table: Retrieve	X	X	X	X
		RIP Routing Table: Retrieve	X	X	X	X
	OSI	IS-IS RIB: Refresh	X	X	X	X
		ES-IS RIB: Refresh	X	X	X	X
		TDC: TID to NSAP/Flush Dynamic Entries	—	X	X	X
		TDC: Refresh	X	X	X	X
	Software	Download/Cancel	—	X	X	X
		Activate/Revert	—	—	—	X
	Diagnostic	Retrieve Tech Support Log	—	—	X	X
	Audit	Retrieve	—	—	—	X
		Archive	—	—	X	X
	DWDM	APC: Run/Disable/Refresh	—	X	X	X
		WDM Span Check: Retrieve Span Loss values/ Edit/Reset	X	X	X	X
		ROADM Power Monitoring: Refresh	X	X	X	X
		PP-MESH Internal Patchcord: Refresh	X	X	X	X
		Install Without Metro Planner: Retrieve Installation values	X	X	X	X
		All Facilities: Mark/Refresh	X	X	X	X

1. A Provisioning user cannot change node name, contact, location and AIS-V insertion on STS-1 signal degrade (SD) parameters.
2. The action buttons in the subtab are active for all users, but the actions can be completely performed only by the users assigned with the required security levels.

Table 13-2 shows the actions that each user privilege level can perform in network view.

Table 13-2 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

Table 13-2 ONS 15454 Security Levels—Network View (continued)

CTC Tab	Subtab	[Subtab]: Actions	Retrieve	Maintenance	Provisioning	Superuser
Circuits	Circuits	Create/Edit/Delete	—	—	X	X
		Filter/Search	X	X	X	X
	Rolls	Complete/ Force Valid Signal/ Finish	—	—	X	X
Provisioning	Security	Users: Create/Delete/Clear Security Intrusion Alarm	—	—	—	X
		Users: Change	Same User	Same User	Same User	All Users
		Active logins: Logout/Retrieve Last Activity Time	—	—	—	X
		Policy: Change	—	—	—	X
	Alarm Profiles	New/Load/Store/Delete[1]	—	—	X	X
		Compare/Available/Usage	X	X	X	X
	BLSR (ANSI) MS-SPRing (ETSI)	Create/Edit/Delete/Upgrade	—	—	X	X
	Overhead Circuits	Create/Delete/Edit/Merge	—	—	X	X
		Search	X	X	X	X
	Provisionable Patchcords (PPC)	Create/Edit/Delete	—	—	X	X
	Server Trails	Create/Edit/Delete	—	—	X	X
	VLAN DB Profile	Load/Store/Merge/Circuits	X	X	X	X
		Add/Remove Rows	—	—	X	X
Maintenance	Software	Download/Cancel	—	X	X	X
	Diagnostic	OSPF Node Information: Retrieve/Clear	X	X	X	X
	APC	Run APC/Disable APC	—	—	—	X
		Refresh	X	X	X	X

1. The action buttons in the subtab are active for all users, but the actions can be completely performed only by the users assigned with the required security levels.

13.2.2 Security Policies

Superusers 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, Superusers can access the ONS 15454 through the TCC2/TCC2P RJ-45 port, the backplane LAN connection, or both.

13.2.2.1 Superuser Privileges for Provisioning Users

Superusers can grant permission to Provisioning users to perform a set of tasks. The tasks include retrieving audit logs, restoring databases, clearing PMs, and activating and reverting software loads. These privileges can be set only through CTC network element (NE) defaults, except the PM clearing privilege, which can be granted to Provisioning users using CTC Provisioning> Security > Access tabs. For more information on setting up Superuser privileges, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

13.2.2.2 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 13-3.

Table 13-3 ONS 15454 Default User Idle Times

Security Level	Idle Time
Superuser	15 minutes
Provisioning	30 minutes
Maintenance	60 minutes
Retrieve	Unlimited

13.2.2.3 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 length, expiration and reuse—Superusers can configure the password length by using NE defaults. The password length, by default, is set to a minimum of six and a maximum of 20 characters. You can configure the default values in CTC node view with the Provisioning > NE Defaults > Node > security > password Complexity tabs. The minimum length can be set to eight, ten or twelve characters, and the maximum length to 80 characters. The password must be a combination of alphanumeric (a-z, A-Z, 0-9) and special (+, #,%) characters, where at least two characters are nonalphabetic and at least one character is a special character. Superusers can specify when users must change their passwords and when they can reuse them.
- 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. The number of allowed lockout attempts is set to the number of allowed login attempts.
- 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/TCC2P 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.

13.3 Audit Trail

The Cisco ONS 15454 maintains a Telcordia GR-839-CORE-compliant audit trail log that resides on the TCC2/TCC2P card. Audit trails are useful for maintaining security, recovering lost transactions and enforcing accountability. Accountability refers to tracing user activities; that is, associating a process or action with a specific user. This record shows who has accessed the system and what operations were performed during a given period of time. The log includes authorized Cisco logins and logouts using the operating system command line interface, CTC, and TL1; the log also includes FTP actions, circuit creation/deletion, and user/system generated actions.

Event monitoring is also recorded in the audit log. An event is defined as the change in status of an element within the network. External events, internal events, attribute changes, and software upload/download activities are recorded in the audit trail.

The audit trail is stored in persistent memory and is not corrupted by processor switches, resets or upgrades. However, if a user pulls both TCC2/TCC2P cards, the audit trail log is lost.

13.3.1 Audit Trail Log Entries

Table 13-4 contains the columns listed in Audit Trail window.

Table 13-4 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 (whether or not the action was executed)
Operation	Action that was taken

Audit trail records capture the following activities:

- User—Name of the user performing the action
- Host—Host from where the activity is logged
- Device ID—IP address of the device involved in the activity
- Application—Name of the application involved in the activity
- Task—Name of the task involved in the activity (view a dialog box, apply configuration, and so on)
- Connection Mode—Telnet, Console, Simple Network Management Protocol (SNMP)
- Category—Type of change: Hardware, Software, Configuration
- Status—Status of the user action: Read, Initial, Successful, Timeout, Failed
- Time—Time of change
- Message Type—Denotes whether the event is Success/Failure type
- Message Details—Description of the change

13.3.2 Audit Trail Capacities

The system is able to store 640 log entries.When this limit is reached, the oldest entries are overwritten with new events. When the log server is 80 percent full, an AUD-LOG-LOW condition is raised and logged (by way of Common Object Request Broker Architecture [CORBA]/CTC).

When the log server reaches a maximum capacity of 640 entries and begins overwriting records that were not archived, an AUD-LOG-LOSS condition is raised and logged. This event indicates that audit trail records have been lost. Until the user off-loads the file, this event occurs only once regardless of the amount of entries that are overwritten by the system.

13.4 RADIUS Security

Superusers can configure nodes to use Remote Authentication Dial In User Service (RADIUS) authentication. RADIUS uses a strategy known as authentication, authorization, and accounting (AAA) for verifying the identity of, granting access to, and tracking the actions of remote users. To configure RADIUS authentication, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

13.4.1 RADIUS Authentication

RADIUS is a system of distributed security that secures remote access to networks and network services against unauthorized access. RADIUS comprises three components:

- A protocol with a frame format that utilizes User Datagram Protocol (UDP)/IP
- A server
- A client

The server runs on a central computer typically at the customer's site, while the clients reside in the dial-up access servers and can be distributed throughout the network.

An ONS 15454 node operates as a client of RADIUS. The client is responsible for passing user information to designated RADIUS servers, and then acting on the response that is returned. RADIUS servers are responsible for receiving user connection requests, authenticating the user, and returning all configuration information necessary for the client to deliver service to the user. The RADIUS servers can act as proxy clients to other kinds of authentication servers. Transactions between the client and RADIUS server are authenticated through the use of a shared secret, which is never sent over the network. In addition, any user passwords are sent encrypted between the client and RADIUS server. This eliminates the possibility that someone snooping on an unsecured network could determine a user's password.

13.4.2 Shared Secrets

A shared secret is a text string that serves as a password between:

- A RADIUS client and RADIUS server
- A RADIUS client and a RADIUS proxy
- A RADIUS proxy and a RADIUS server

For a configuration that uses a RADIUS client, a RADIUS proxy, and a RADIUS server, the shared secret that is used between the RADIUS client and the RADIUS proxy can be different than the shared secret used between the RADIUS proxy and the RADIUS server.

Shared secrets are used to verify that RADIUS messages, with the exception of the Access-Request message, are sent by a RADIUS-enabled device that is configured with the same shared secret. Shared secrets also verify that the RADIUS message has not been modified in transit (message integrity). The shared secret is also used to encrypt some RADIUS attributes, such as User-Password and Tunnel-Password.

When creating and using a shared secret:

- Use the same case-sensitive shared secret on both RADIUS devices.
- Use a different shared secret for each RADIUS server-RADIUS client pair.
- To ensure a random shared secret, generate a random sequence at least 22 characters long.
- You can use any standard alphanumeric and special characters.
- You can use a shared secret of up to 128 characters in length. To protect your server and your RADIUS clients from brute force attacks, use long shared secrets (more than 22 characters).
- Make the shared secret a random sequence of letters, numbers, and punctuation and change it often to protect your server and your RADIUS clients from dictionary attacks. Shared secrets should contain characters from each of the three groups listed in Table 13-5.

Table 13-5 Shared Secret Character Groups

Group	Examples
Letters (uppercase and lowercase)	A, B, C, D and a, b, c, d
Numerals	0, 1, 2, 3
Symbols (all characters not defined as letters or numerals)	Exclamation point (!), asterisk (*), colon (:)

The stronger your shared secret, the more secure the attributes (for example, those used for passwords and encryption keys) that are encrypted with it. An example of a strong shared secret is 8d#>9fq4bV)H7%a3-zE13sW$hIa32M#m<PqAa72(.

CHAPTER 14

Timing Reference

This chapter provides information about Cisco ONS 15454 users and node timing. To provision timing, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 14.1 Node Timing Parameters, page 14-1
- 14.2 Network Timing, page 14-2
- 14.3 Synchronization Status Messaging, page 14-3

14.1 Node Timing Parameters

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 (ANSI) or MIC-C/T/P coaxial connectors (ETSI).
- An OC-N/STM-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/TCC2P 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/STM-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/STM-N trunk (span) cards. The DWDM node normally derives timing from the line using the OSCM or OSC-CSM card that are inside an OC-3/STM-1 channel.

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/TCC2P 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 tab show current timing information for an ONS 15454, including the timing mode, clock state and status, switch type, and reference data.

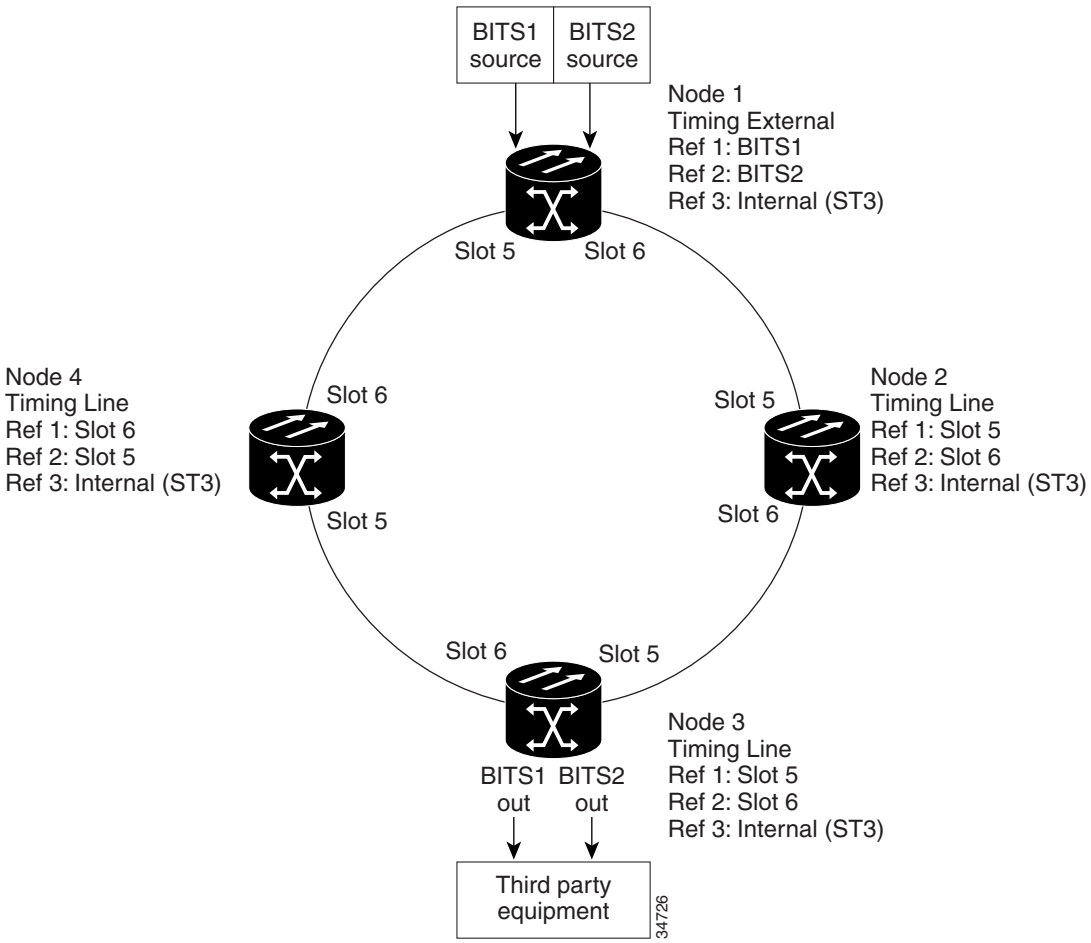
Caution Mixed timing allows you to select both external and line timing sources. However, Cisco does not recommend its use because it can create timing loops. Use this mode with caution.

14.2 Network Timing

Figure 14-1 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 set to 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 at an equal distance from Node 1.

Figure 14-1 ONS 15454 Timing Example



14.3 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 14-1 and Table 14-2 on page 14-4 show the Generation 1 and Generation 2 message sets.

Table 14-1 SSM Generation 1 Message Set

Message	Quality	Description
PRS	1	Primary reference source—Stratum 1
STU	2	Synchronization traceability unknown

Table 14-1 SSM Generation 1 Message Set (continued)

Message	Quality	Description
ST2	3	Stratum 2
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 14-2 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 15

Management Network Connectivity

This chapter provides an overview of ONS 15454 data communications network (DCN) connectivity. Cisco Optical Networking System (ONS) network communication is based on IP, including communication between Cisco Transport Controller (CTC) computers and ONS 15454 nodes, and communication among networked ONS 15454 nodes. The chapter shows common Cisco ONS 15454 IP network configurations and includes detailed data communications network (DCN) case studies that are based on actual ONS 15454 installations. The chapter provides information about the ONS 15454 IP routing table, external firewalls, and open gateway network element (GNE) networks.

Although ONS 15454 DCN communication is based on IP, ONS 15454 nodes can be networked to equipment that is based on the Open System Interconnection (OSI) protocol suites. This chapter also describes the ONS 15454 OSI implementation and provides scenarios that show how the ONS 15454 can be networked within a mixed IP and OSI environment.

This chapter does not provide a comprehensive explanation of IP networking concepts and procedures, nor does it provide IP addressing examples to meet all networked scenarios. For ONS 15454 networking setup instructions, refer to the "Turn Up a Node" chapter of the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, in this chapter "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 15.1 IP Networking Overview, page 15-2
- 15.2 IP Addressing Scenarios, page 15-2
- 15.3 DCN Case Studies, page 15-23
- 15.4 DCN Extension, page 15-37
- 15.5 Routing Table, page 15-39
- 15.6 External Firewalls, page 15-41
- 15.7 Open GNE, page 15-42
- 15.8 TCP/IP and OSI Networking, page 15-45
- 15.9 Link Management Protocol, page 15-49
- 15.10 IPv6 Network Compatibility, page 15-54

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.

15.1 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 nodes in a network that are not connected with a data communications channel (DCC).
- 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 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.

15.2 IP Addressing Scenarios

ONS 15454 IP addressing generally has nine common scenarios or configurations. Use the scenarios as building blocks for more complex network configurations. Table 15-1 provides a general list of items to check when setting up ONS 15454s in IP networks.

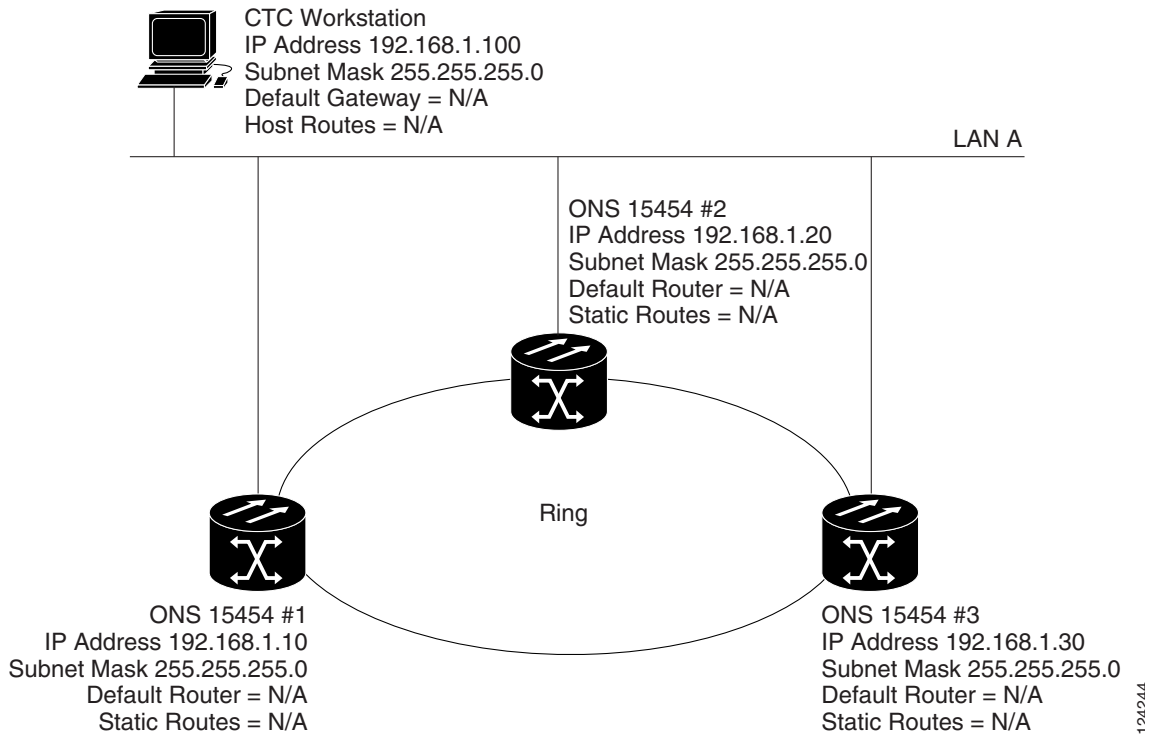
Table 15-1 General ONS 15454 IP Troubleshooting Checklist

Item	What to Check
Link integrity	Verify that link integrity exists between: • CTC computer and network hub/switch • ONS 15454s (backplane [ANSI] or MIC-C/T/P [ETSI] 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.

15.2.1 Scenario 1: CTC and ONS 15454s on Same Subnet

Scenario 1 shows a basic ONS 15454 LAN configuration (Figure 15-1). 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 15-1 Scenario 1: CTC and ONS 15454s on Same Subnet (ANSI and ETSI)

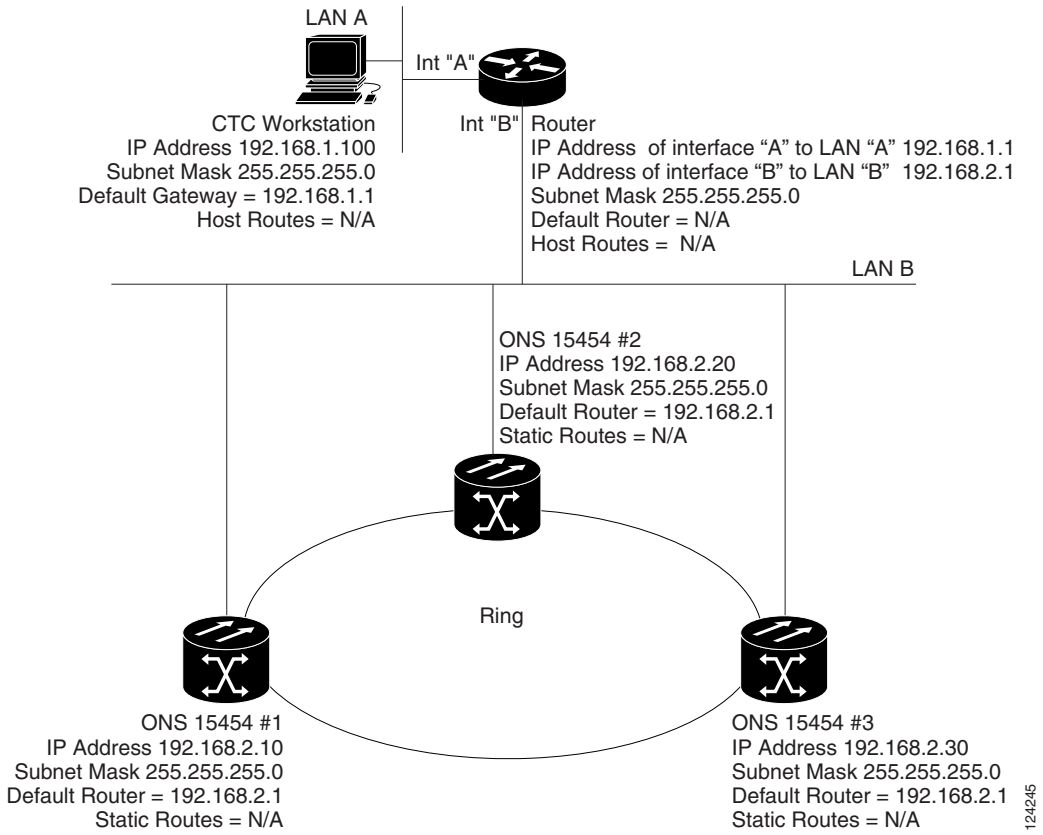


15.2.2 Scenario 2: CTC and ONS 15454s Connected to a Router

In Scenario 2, the CTC computer resides on a subnet (192.168.1.0) and attaches to LAN A (Figure 15-2). 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). The routers each have a subnet mask of 255.255.255.0.

On the CTC computer, the default gateway is set to router interface A. If the LAN uses Dynamic Host Configuration Protocol (DHCP), the default gateway and IP address are assigned automatically. In the Figure 15-2 example, a DHCP server is not available.

Figure 15-2 Scenario 2: CTC and ONS 15454s Connected to Router (ANSI and ETSI)



15.2.3 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 as the LAN-connected (gateway) ONS 15454. When a LAN device sends an ARP request to an ONS 15454 that is not connected to the LAN, the gateway ONS 15454 (the one connected to the LAN) 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.

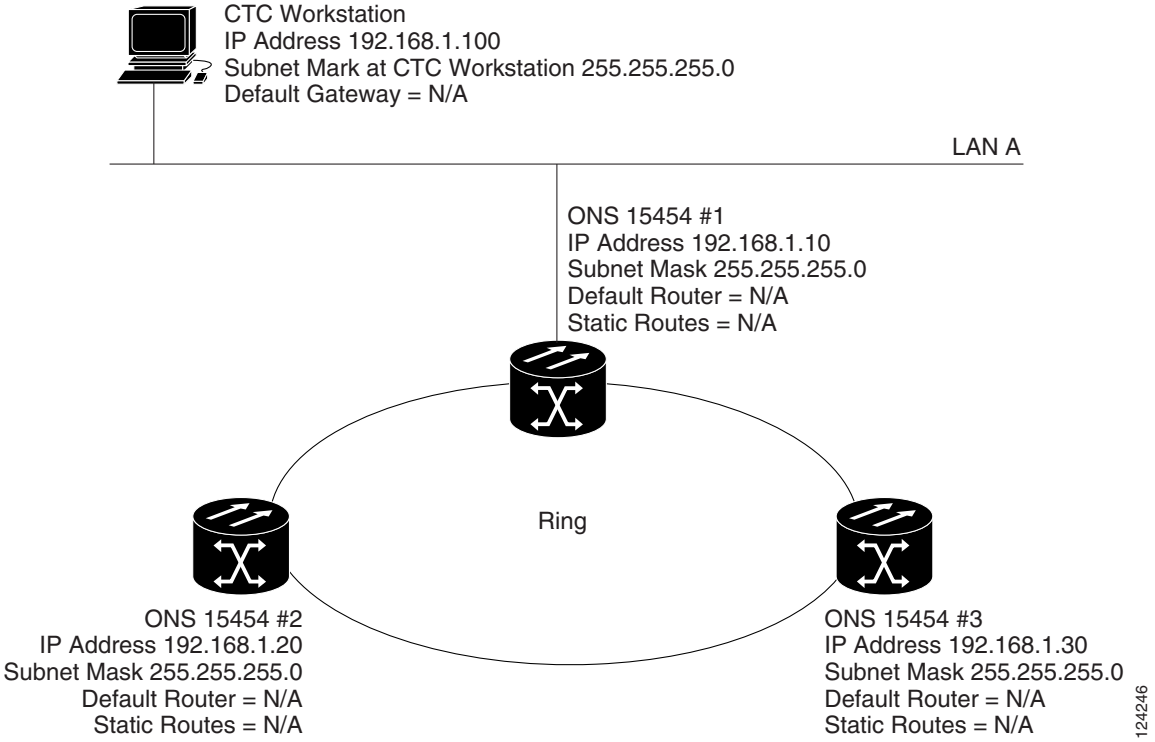
Scenario 3 is similar to Scenario 1, but only one ONS 15454 (Node 1) connects to the LAN (Figure 15-3). Two ONS 15454s (Node 2 and Node 3) connect to ONS 15454 Node 1 through the section DCC. Because all three ONS 15454s are on the same subnet, proxy ARP enables ONS 15454 Node 1 to serve as a gateway for ONS 15345 Node 2 and Node 3.

Note This scenario assumes all CTC connections are to Node 1. If you connect a laptop to either ONS 15454 Node 2 or Node 3, network partitioning occurs; neither the laptop or the CTC computer can see all nodes. If you want laptops to connect directly to end network elements (ENEs), you must create static routes (see the "15.2.5 Scenario 5: Using Static Routes to Connect to LANs" section on page 15-8) or enable the ONS 15454 proxy server (see "15.2.7 Scenario 7: Provisioning the ONS 15454 Proxy Server" section on page 15-12).

Be aware that:

- GNE and ENE 15454 proxy ARP is disabled.
- There is exactly one proxy ARP server on any given Ethernet segment; however, there might be more than one server in an ANSI or ETSI topology.
- The proxy ARP server does not perform the proxy ARP function for any node or host that is on the same Ethernet segment.
- It is important in Figure 15-3 that the CTC workstation be located within the same subnet and on the same Ethernet segment as the proxy ARP server.

Figure 15-3 Scenario 3: Using Proxy ARP (ANSI and ETSI)

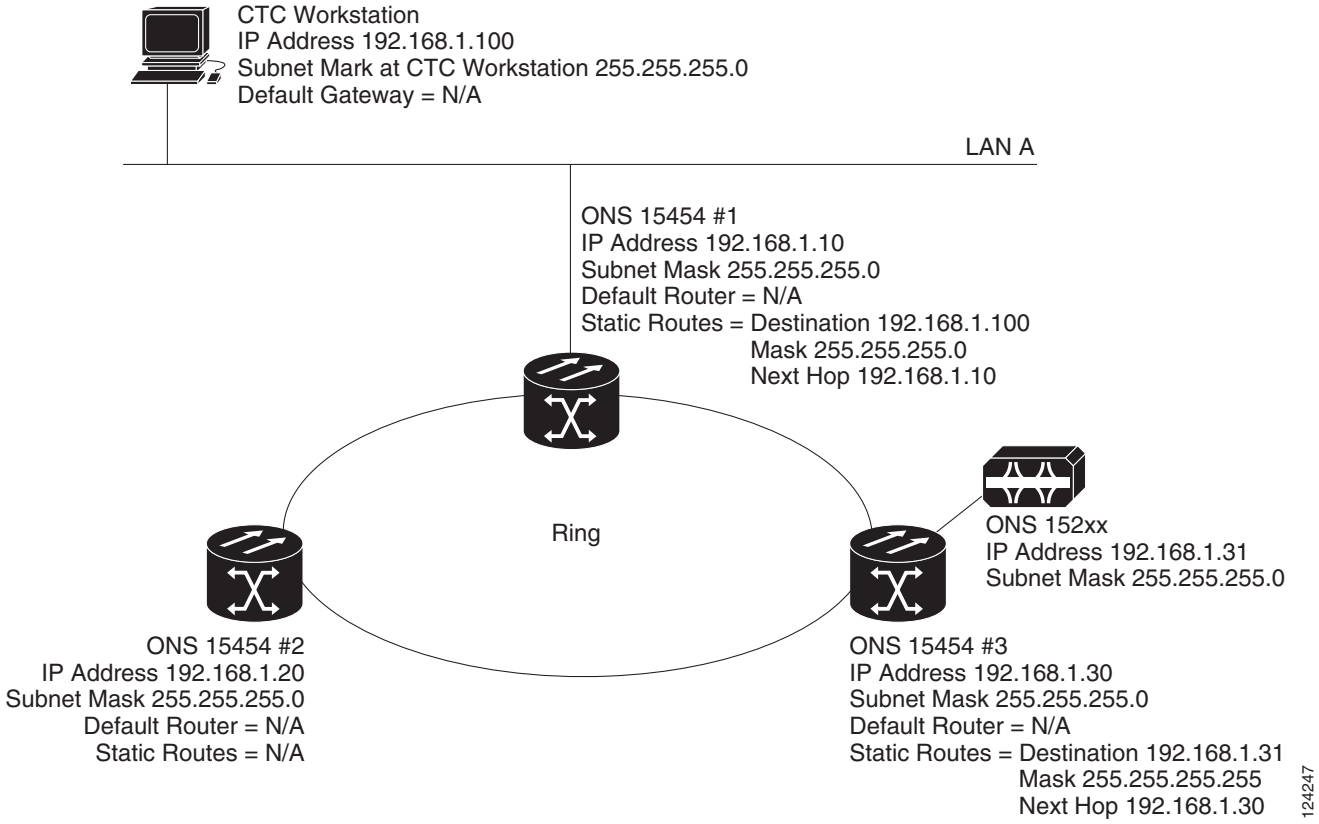


You can also use proxy ARP to communicate with hosts attached to the craft Ethernet ports of DCC-connected nodes (Figure 15-4). The node with an attached host must have a static route to the host. Static routes are propagated to all DCC peers using OSPF. The existing proxy ARP node is the gateway for 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 15-4, 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.

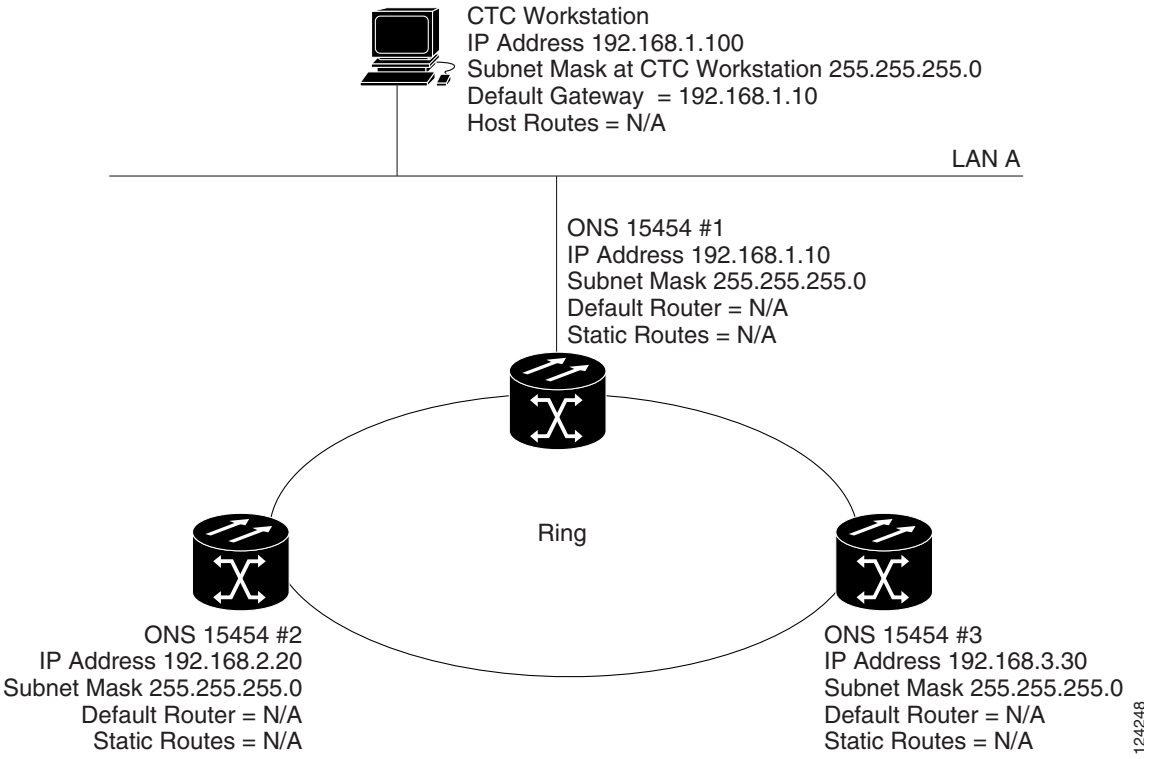
Figure 15-4 Scenario 3: Using Proxy ARP with Static Routing (ANSI and ETSI)



15.2.4 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 15-5). 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 15-5 Scenario 4: Default Gateway on a CTC Computer (ANSI and ETSI)



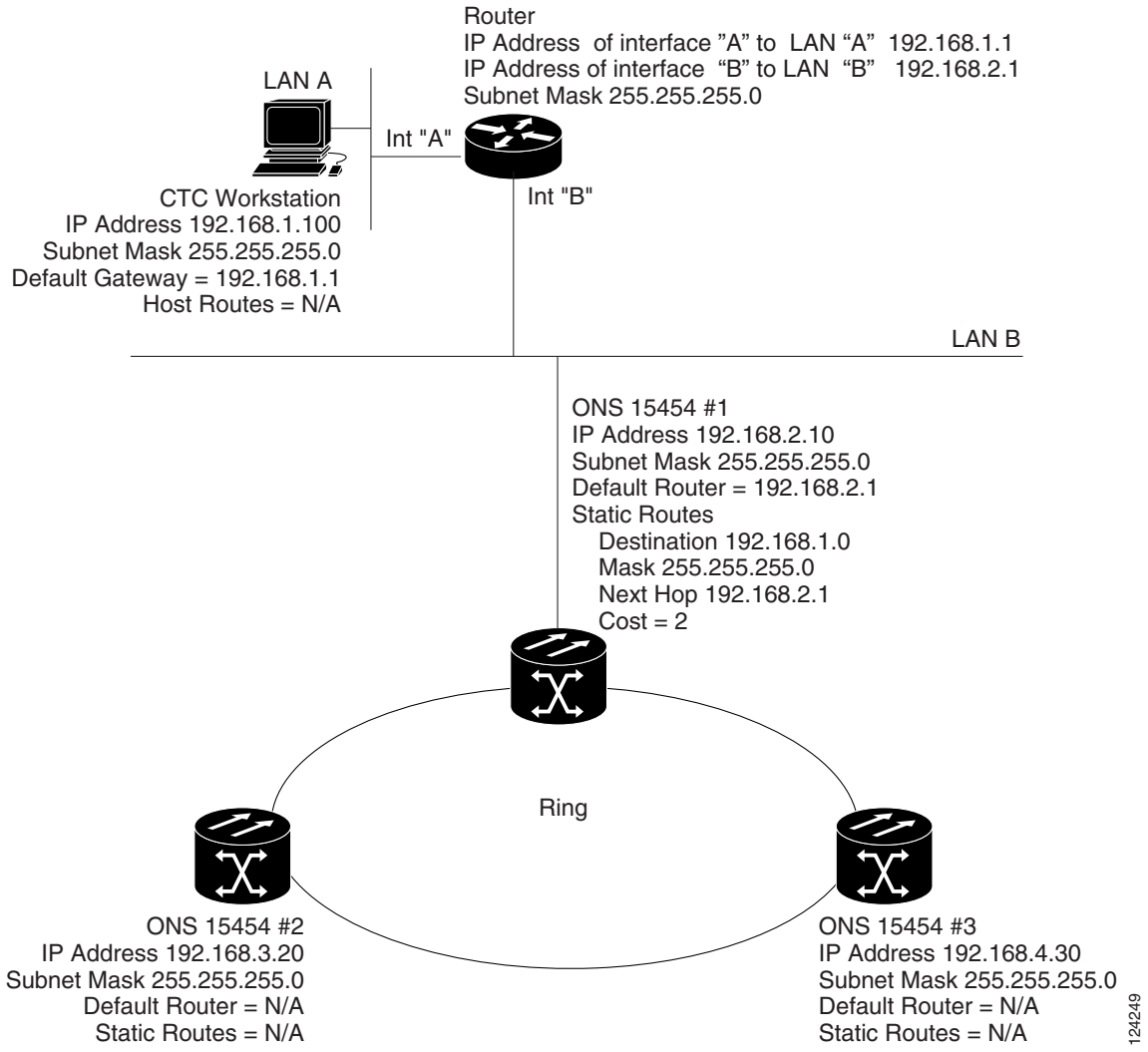
15.2.5 Scenario 5: Using Static Routes to Connect to LANs

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 15-6, 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 CTC computers on LAN A, a static route is created on Node 1.

Figure 15-6 Scenario 5: Static Route With One CTC Computer Used as a Destination (ANSI and ETSI)

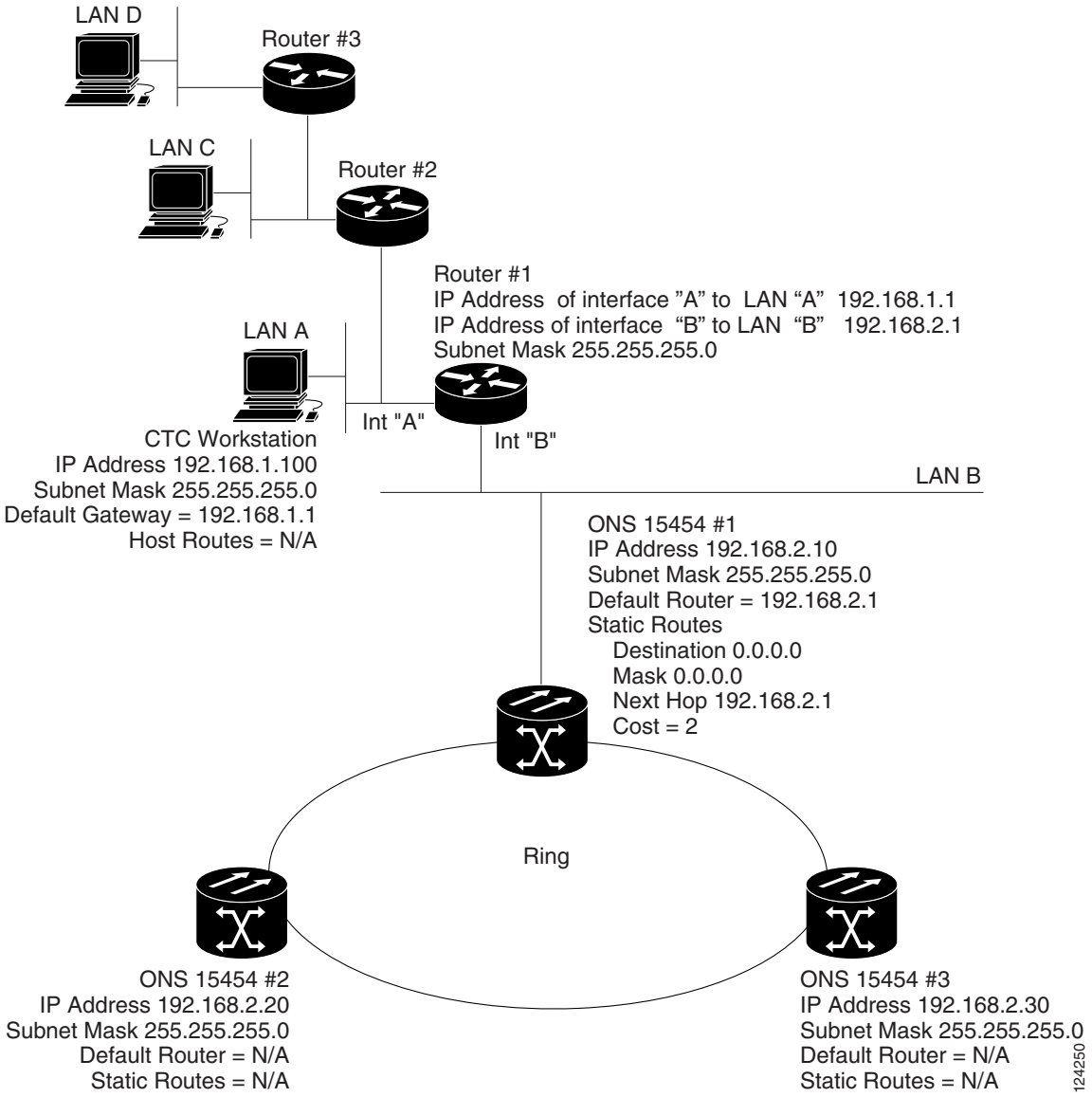


The destination and subnet mask entries control access to the ONS 15454s:

- 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 15-7 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.

Figure 15-7 Scenario 5: Static Route With Multiple LAN Destinations (ANSI and ETSI)



15.2.6 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 15-8 shows a network enabled for OSPF. Figure 15-9 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. An area ID is a “dotted quad” value that appears similar to an IP address. Coordinate the area ID number assignment with your LAN administrator. All DCC-connected ONS 15454s should be assigned the same OSPF area ID.

Note It is recommended that the number of ONS 15454s in an OSPF area be limited, because this allows faster loading into a CTC an is less likely to incur any problems.

Figure 15-8 Scenario 6: OSPF Enabled (ANSI and ETSI)

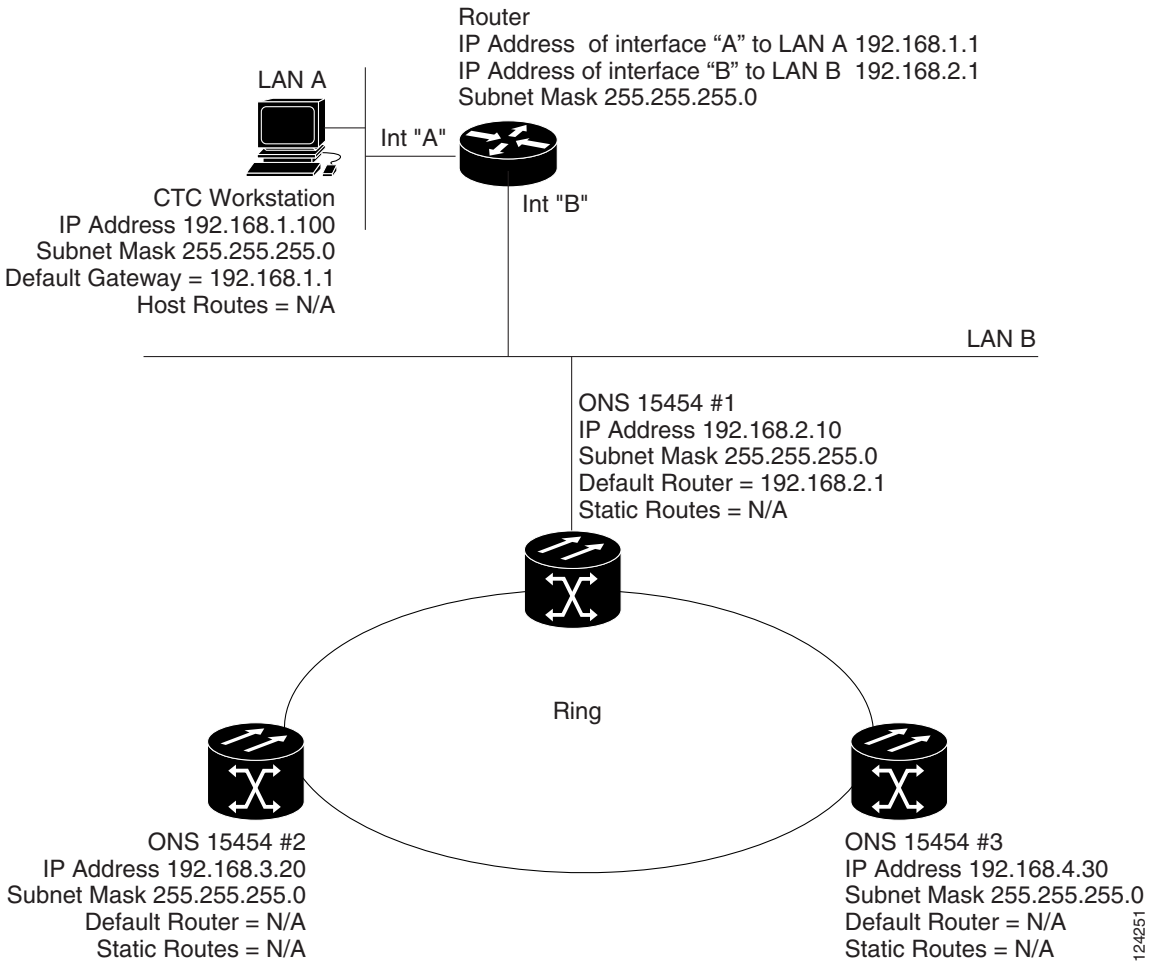
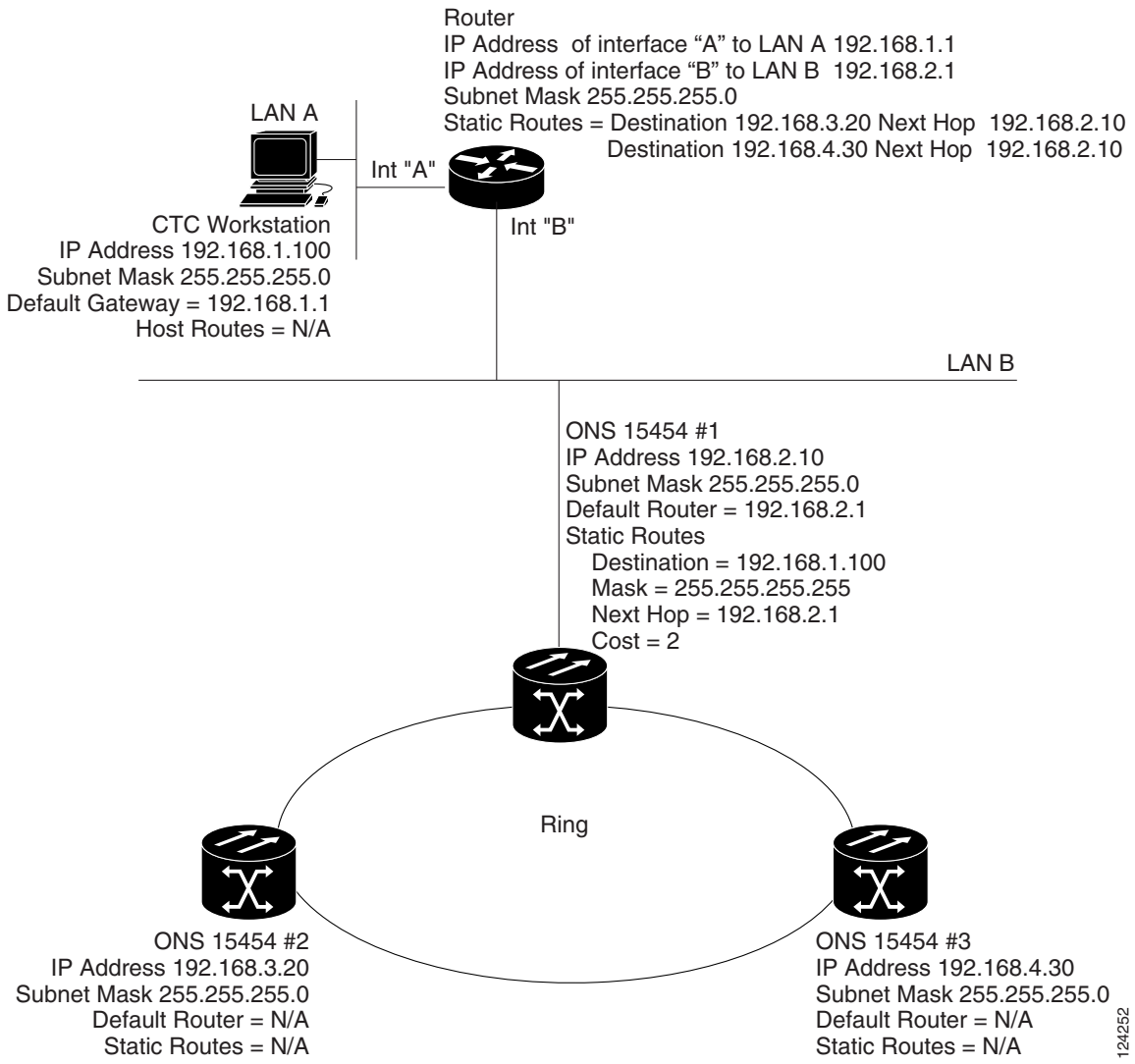


Figure 15-9 Scenario 6: OSPF Not Enabled (ANSI and ETSI)



15.2.7 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 operations 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 GNE and the other ONS 15454s are provisioned as end 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 15-3 on page 15-17 and Table 15-4 on page 15-17) depend on whether the packet arrives at the ONS 15454 DCC or TCC2/TCC2P Ethernet interface.
- Processes Simple Network Time Protocol (SNTP) and Network Time Protocol (NTP) requests. ONS 15454 ENEs can derive time-of-day from an SNTP/NTP LAN server through the GNE ONS 15454.
- Processes Simple Network Management Protocol version 1 (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. 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:

- External Network Element (ENE)—If set as an ENE, the ONS 15454 neither installs nor advertises default or static routes that go through its Ethernet port. However, an ENE does install and advertise routes that go through the DCC. CTC computers can communicate with the ONS 15454 using the TCC2/TCC2P 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.
- SOCKS Proxy-only—If Proxy-only is selected, firewall is not enabled. CTC can communicate with any other DCC-connected ONS 15454s.

Note If you launch CTC against a node through a Network Address Translation (NAT) or Port Address Translation (PAT) 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.

Note ENEs that belong to different private subnetworks do not need to have unique IP addresses. Two ENEs that are connected to different GNEs can have the same IP address. However, ENEs that connect to the same GNE must always have unique IP addresses.

Figure 15-10 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 15-10 Scenario 7: ONS 15454 Proxy Server with GNE and ENEs on the Same Subnet (ANSI and ETSI)

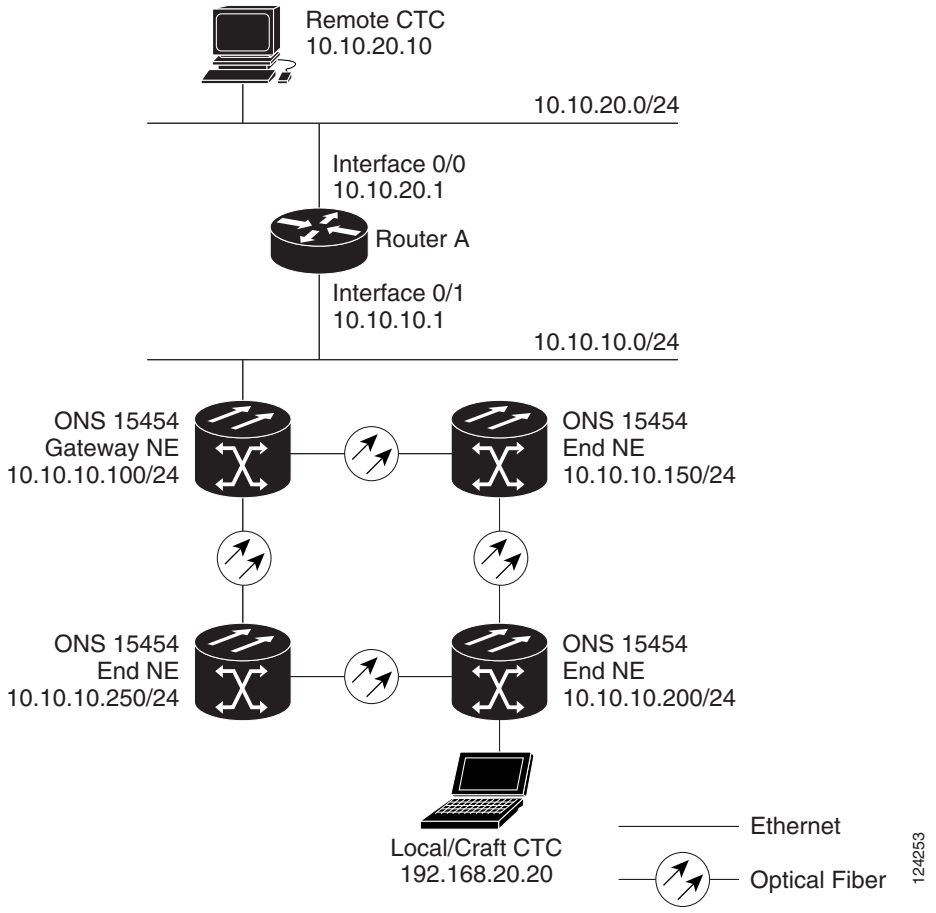


Table 15-2 shows recommended settings for ONS 15454 GNEs and ENEs in the configuration shown in Figure 15-10.

Table 15-2 ONS 15454 Gateway and End NE Settings

Setting	ONS 15454 Gateway NE	ONS 15454 End NE
OSPF	Off	Off

Table 15-2 ONS 15454 Gateway and End NE Settings (continued)

Setting	ONS 15454 Gateway NE	ONS 15454 End NE
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 15-11 shows the same proxy server implementation with ONS 15454 ENEs on different subnets. The ONS 15454 GNEs and ENEs are provisioned with the settings shown in Table 15-2.

Figure 15-11 Scenario 7: ONS 15454 Proxy Server with GNE and ENEs on Different Subnets (ANSI and ETSI)

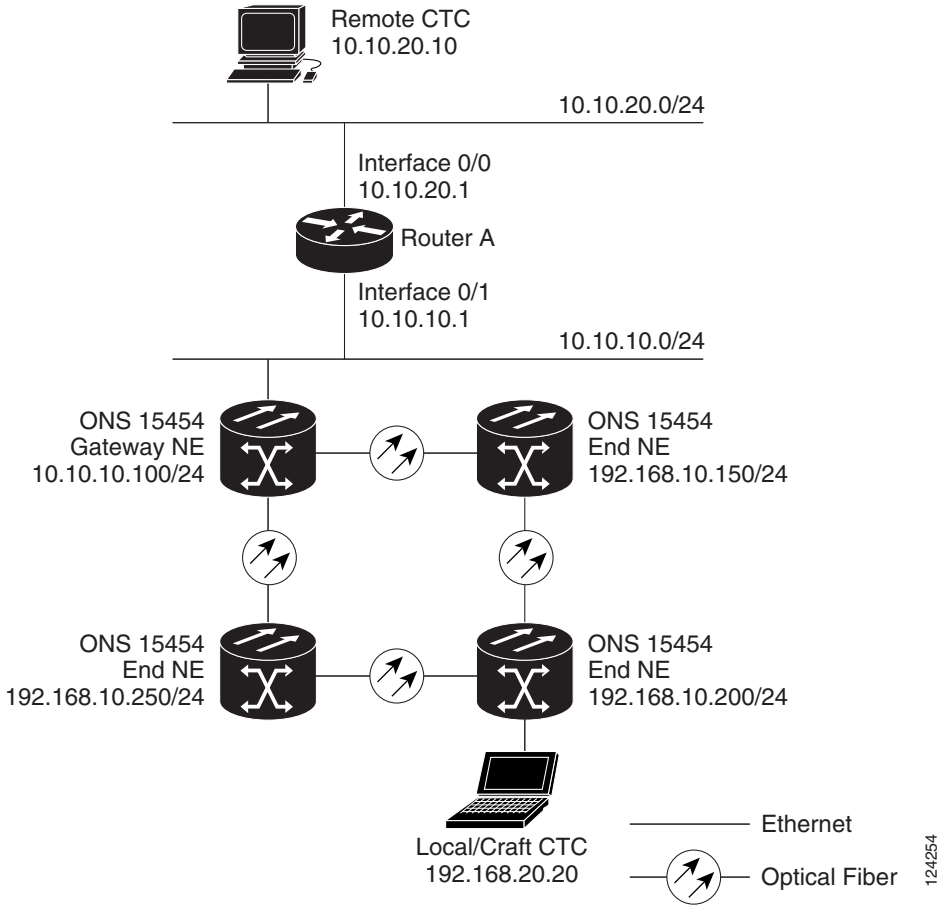


Figure 15-12 shows the same proxy server implementation with ONS 15454 ENEs in multiple rings.

Figure 15-12 Scenario 7: ONS 15454 Proxy Server With ENEs on Multiple Rings (ANSI and ETSI)

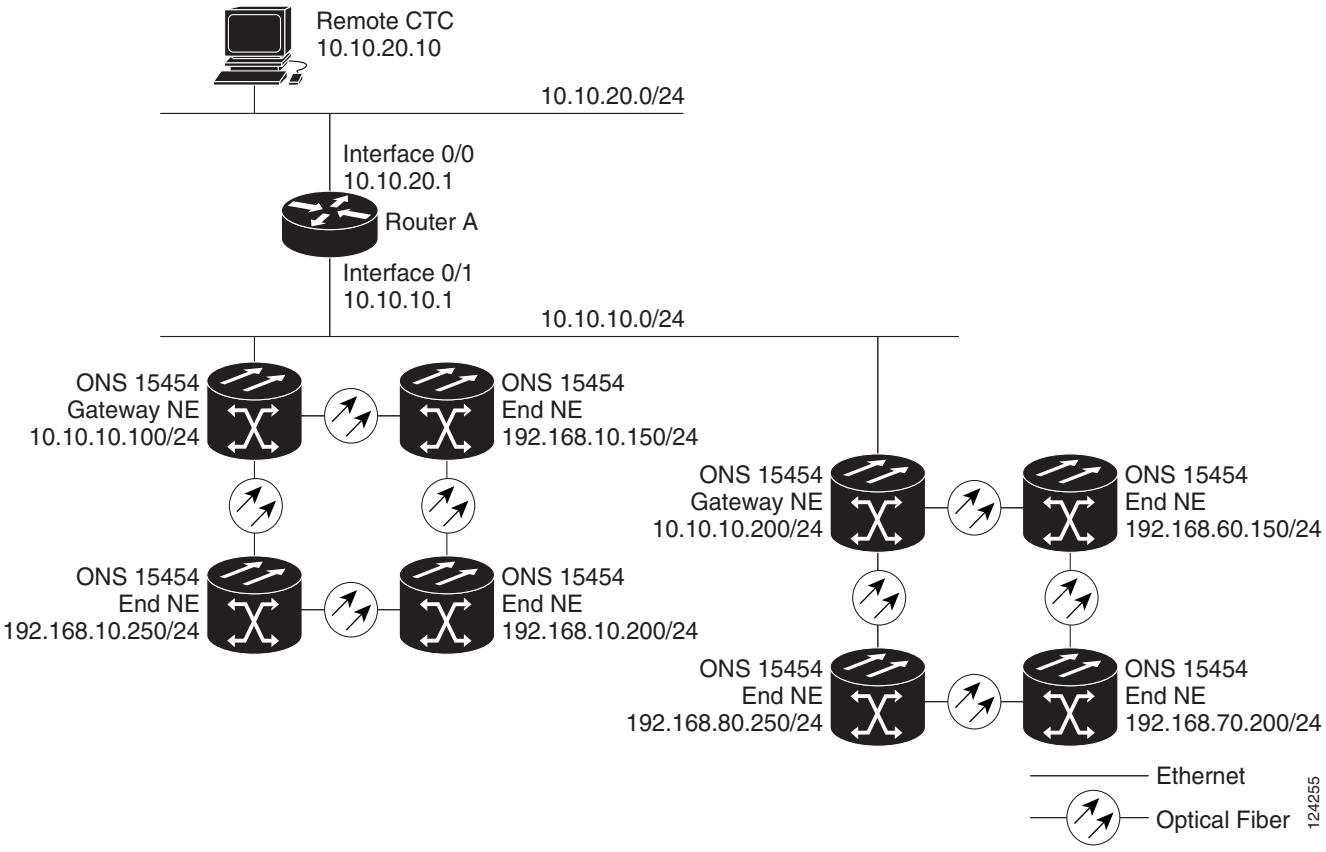


Table 15-3 shows the rules the ONS 15454 follows to filter packets for the firewall when nodes are configured as ENEs and GNEs. If the packet is addressed to the ONS 15454, additional rules (shown in Table 15-4) are applied. Rejected packets are silently discarded.

Table 15-3 Proxy Server Firewall Filtering Rules

Packets Arriving At:	Are Accepted if the Destination IP Address is:
TCC2/TCC2P 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 15-4 Proxy Server Firewall Filtering Rules

Packets Arriving At:	Are Rejected If:
TCC2/TCC2P Ethernet interface	• User Datagram Protocol (UDP) packets addressed to the SNMP trap relay port (391)
DCC interface	• Transmission Control Protocol (TCP) packets addressed to the proxy server port (1080)

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.

15.2.8 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. GNE load balancing reduces the dependency on the launch GNE and DCC bandwidth, both of which enhance CTC performance.

Note Dual GNEs do not need special provisioning

Figure 15-13 shows a network with dual GNEs on the same subnet.

Figure 15-13 Scenario 8: Dual GNEs on the Same Subnet (ANSI and ETSI)

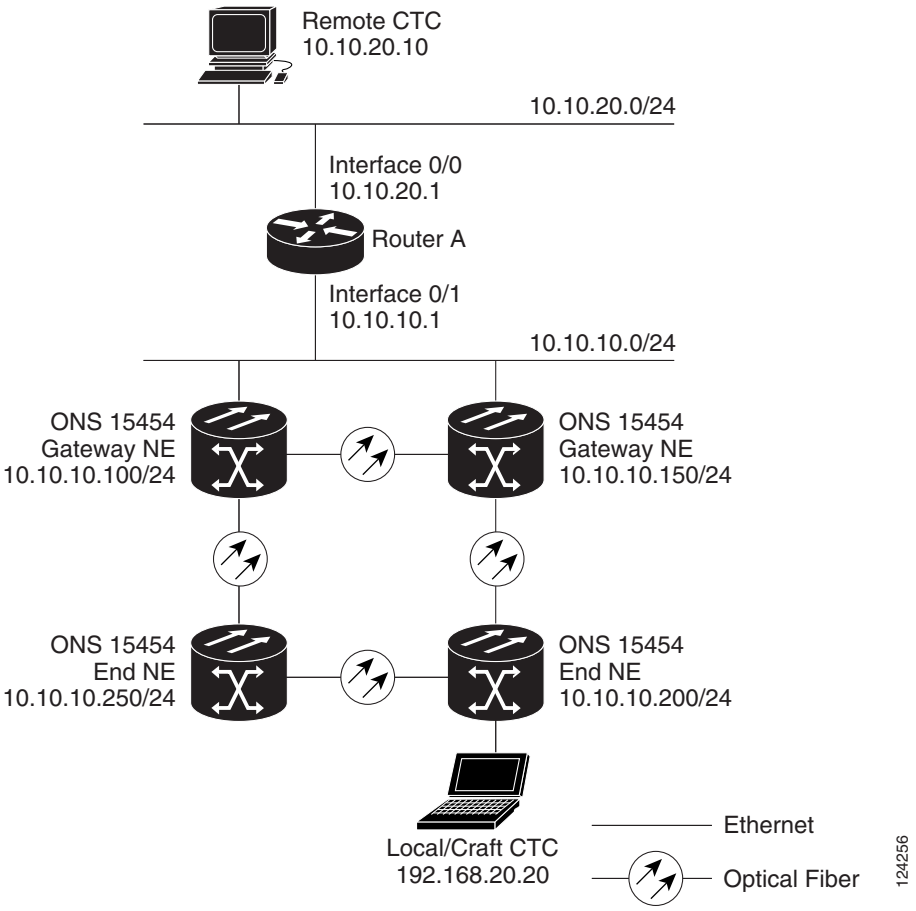
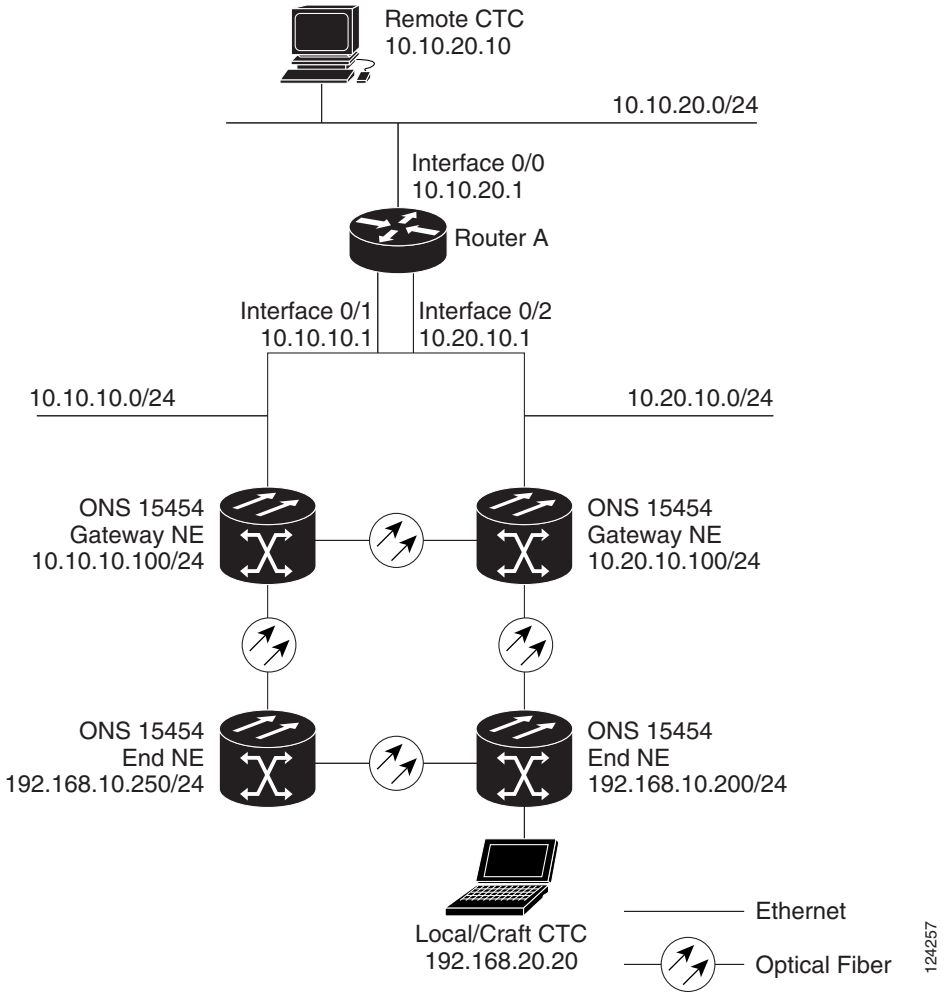


Figure 15-14 shows a network with dual GNEs on different subnets.

Figure 15-14 Scenario 8: Dual GNEs on Different Subnets (ANSI and ETSI)



15.2.9 Scenario 9: IP Addressing with Secure Mode Enabled

The TCC2 card and TCC2P card both default to repeater mode. In this mode, the front and back Ethernet (LAN) ports share a single MAC address and IP address. TCC2P cards allow you to place a node in secure mode, which prevents a front-access craft port user from accessing the LAN through the backplane port. Secure mode can be locked, which prevents the mode from being altered. To place a node in secure mode or to lock secure node, refer to the "Manage the Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

15.2.9.1 Secure Mode Behavior

Changing a TCC2P node from repeater mode to secure mode allows you to provision two IP addresses for the ONS 15454 and causes the node to assign the ports different MAC addresses. In secure mode, one IP address is provisioned for the ONS 15454 backplane LAN port, and the other IP address is

provisioned for the TCC2P Ethernet port. Both addresses reside on different subnets, providing an additional layer of separation between the craft access port and the ONS 15454 LAN. If secure mode is enabled, the IP addresses provisioned for the backplane LAN port and TCC2P Ethernet port must follow general IP addressing guidelines and must reside on different subnets from each other.

In secure mode, the IP address assigned to the backplane LAN port becomes a private address, which connects the node to an operations support system (OSS) through a central office LAN or private enterprise network. A Superuser can configure the node to hide or reveal the backplane's LAN IP address in CTC, the routing table, or TL1 autonomous message reports.

In repeater mode, a node can be a GNE or ENE. Placing the node into secure mode automatically turns on SOCKS proxy and defaults the node to GNE status. However, the node can be changed back to an ENE. In repeater mode, an ENE's SOCKS proxy can be disabled—effectively isolating the node beyond the LAN firewall—but it cannot be disabled in secure mode. To change a node's GNE or ENE status and disable the SOCKS proxy, refer to the "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

Caution Enabling secure mode causes the TCC2P card to reboot; a TCC2P card reboot affects traffic.

Note The secure mode option does not appear in CTC if TCC2 cards are installed. If one TCC2 and one TCC2P card are installed in a node, secure mode will appear in CTC but it cannot be modified.

Note If both front and backplane access ports are disabled in an ENE and the node is isolated from DCC communication (due to user provisioning or network faults), the front and backplane ports are automatically reenabled.

Figure 15-15 shows an example of secure mode ONS 15454 nodes with front-access Ethernet port addresses that reside on the same subnet.

Figure 15-15 Scenario 9: ONS 15454 GNE and ENEs on the Same Subnet with Secure Mode Enabled

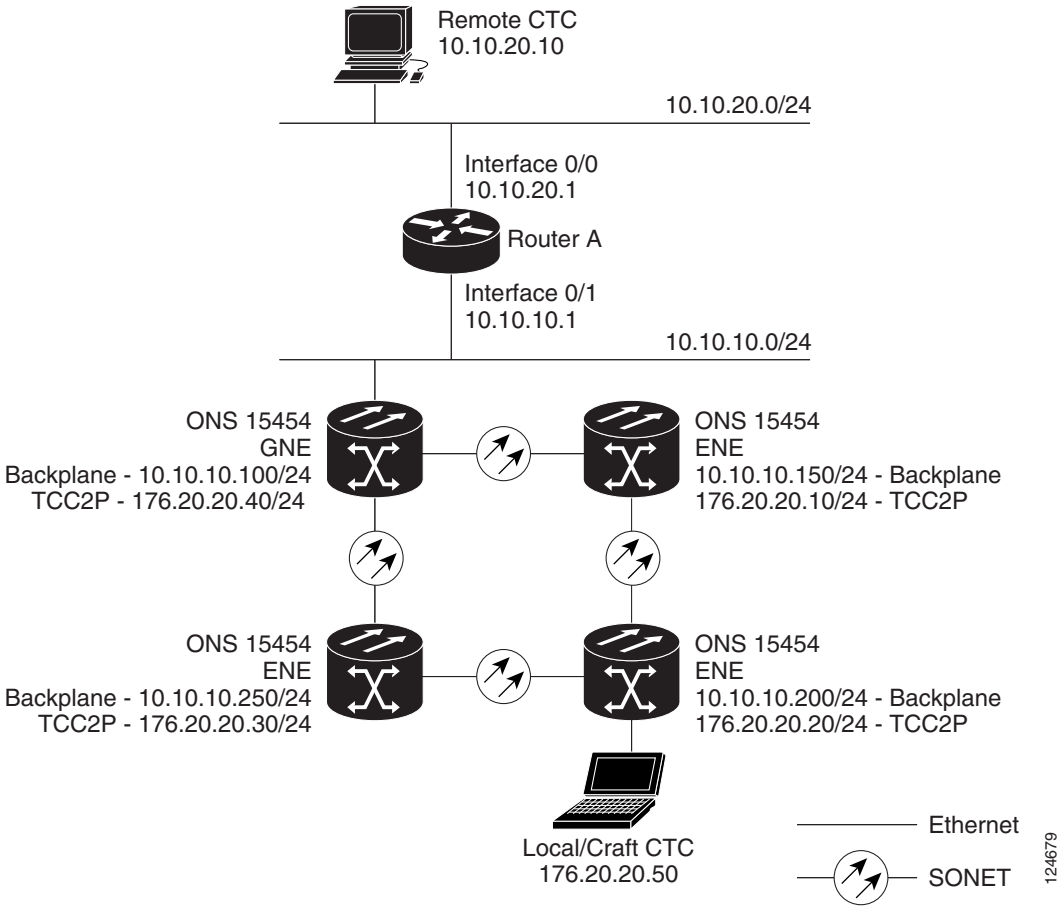
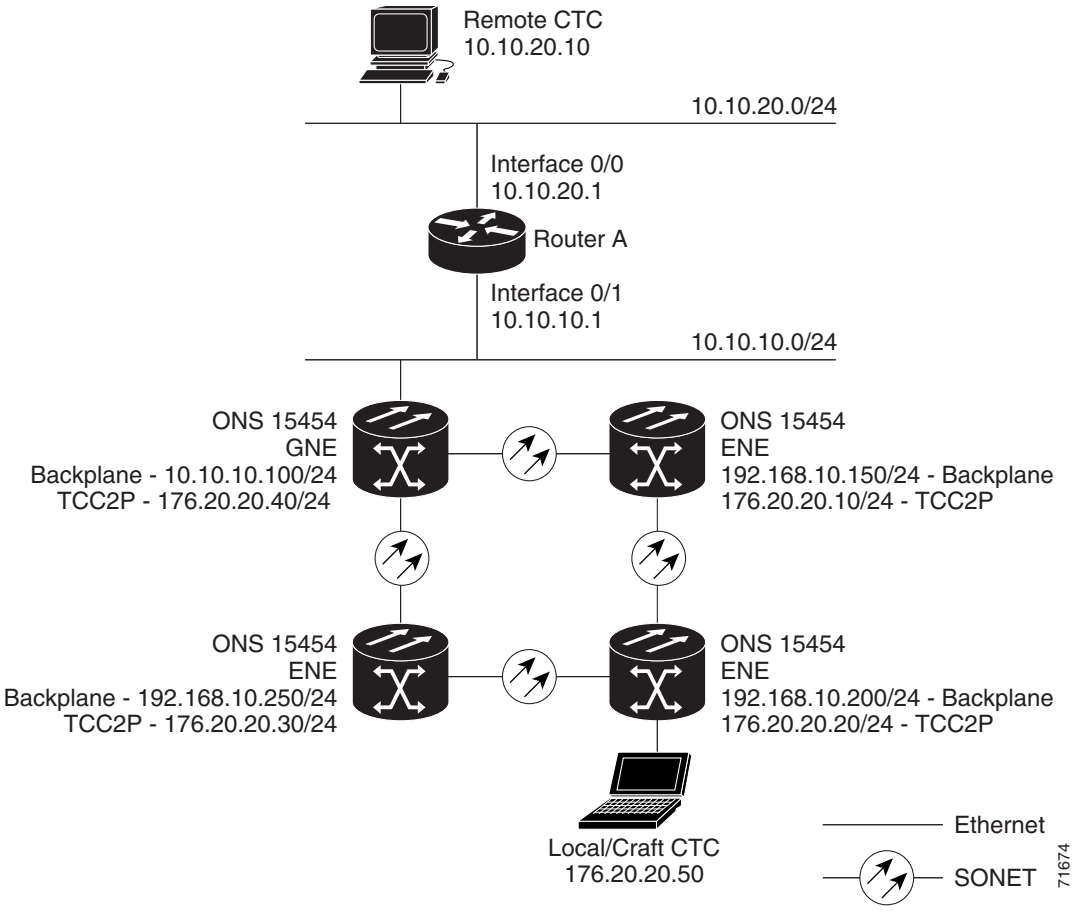


Figure 15-16 shows an example of ONS 15454 nodes connected to a router with secure mode enabled. In each example, the node's TCC2P port address (node address) resides on a different subnet from the node backplane addresses.

Figure 15-16 Scenario 9: ONS 15454 GNE and ENEs on Different Subnets with Secure Mode Enabled



15.2.9.2 Secure Node Locked and Unlocked Behavior

Secure mode can be locked or unlocked on a node operating in secure mode. The default status is unlocked, and only a Superuser can issue a lock. When secure mode is locked, the node's configuration (including Ethernet port status) and lock status cannot be changed by any network user. To have a secure node's lock removed, contact Cisco Technical Support to arrange a Return Material Authorization (RMA) for the shelf assembly. See the "Obtaining Documentation and Submitting a Service Request" section on page lxiv as needed. Enabling a lock makes a permanent change to the shelf's EEPROM.

A node's configuration lock is maintained if the active TCC2P card's database is reloaded. For example, if you attempt to load an unlocked node database onto a locked node's standby TCC2P card for transfer to the active TCC2P card (an action that is not recommended), the unlocked node's status (via the uploaded database) will not override the node's lock status. If you attempt to load a locked database onto the standby TCC2P card of an unlocked secure node, the active TCC2P card will upload the database. If the uploaded defaults indicate a locked status, this will cause the node to become locked. If a software load has been customized before a lock is enabled, all lockable provisioning features are permanently set to the customized NE defaults provided in the load and cannot be changed by any user.

15.3 DCN Case Studies

The ONS 15454 network is managed over the IP DCN and the optical service channels (OSCs), DCCs, and generic communications channels (GCCs). ONS 15454s perform many of the same functions as Layer 3 routers because they manage traffic between the DCN network management system (NMS) and the dense wavelength division multiplexing (DWDM) optical networks.

This section provides case studies that show different ways an ONS 15454 network can be implemented within the DCN. The case studies are based on actual field installations. They include the network problem, the network topology created to solve it, IP addressing examples, and strengths and weaknesses of the solution. Routing principles followed throughout the case studies include:

- If the ONS 15454 is connected to a DCN router, the default gateway points to the router.
- If the default gateway must advertise to the OSC/DCC/GCC network, a static route is added for the default gateway.
- If the network element (NE) is not connected to a DCN router, the default gateway is set to 0.0.0.0.

15.3.1 SOCKS Proxy Settings

SOCKS proxy (described in the "15.2.7 Scenario 7: Provisioning the ONS 15454 Proxy Server" section on page 15-12) enables the ONS 15454 to serve as a proxy for connections between CTC clients and ONS 15454 nodes connected by OSCs, GCCs, or DCCs. Although SOCKS proxy can make DCN implementations easier, it should not be used when any of the following conditions exist:

- Network management is based on SNMP and SNMP traps. The ONS 15454 can proxy SNMP traps, but if a redundant DCN connection is required, trap duplication on the network management platform will occur.
- Telnet and debug session are required. These are not possible over SOCKS proxy.
- Direct IP connectivity to every node is required.

If these conditions are not present and no requirement to have direct IP connectivity to every node exists (that is, management is performed using CTC and/or Cisco Transport Manager [CTM]), Cisco recommends that you use the SOCKS proxy only option for all nodes that connect to a DCN router.

15.3.2 OSPF

Activating OSPF (described in the "15.2.6 Scenario 6: Using OSPF" section on page 15-10) on the ONS 15454 LAN interface is another option that can be used to create resilient DCN connections. However, this option can only be enabled if every element in the network, from the NEs to the NOC, runs OSPF. This is not always possible, for example, the DCN connections might be on a public network out of the control of the organization using the ONS 15454 network. If you are considering enabling OSPF on the LAN, the following limitations must be considered:

- If OSPF is enabled on the LAN, the internal OSC/DCC/GCC OSPF area cannot be 0.0.0.0.
- The ONS 15454 can act as an OSPF area border gateway and support OSPF virtual links. However, virtual links cannot pass over the OSC/DCC/GCC network.

If all elements in the DCN network are not running OSPF, enabling OSPF on the LAN is very difficult without creating isolated areas and/or segmentation of OSPF area 0. However, if the DCN network is a full OSPF network, enabling OSPF on the LAN might be employed for resilient DCN networks.

15.3.3 Management of Non-LAN Connected Multishelf Node

When using dense wavelength division multiplexing (DWDM) multishelf management feature to subtend shelves from a node controller shelf, the Node Controller must be specially provisioned in case it does not have direct LAN reachability.

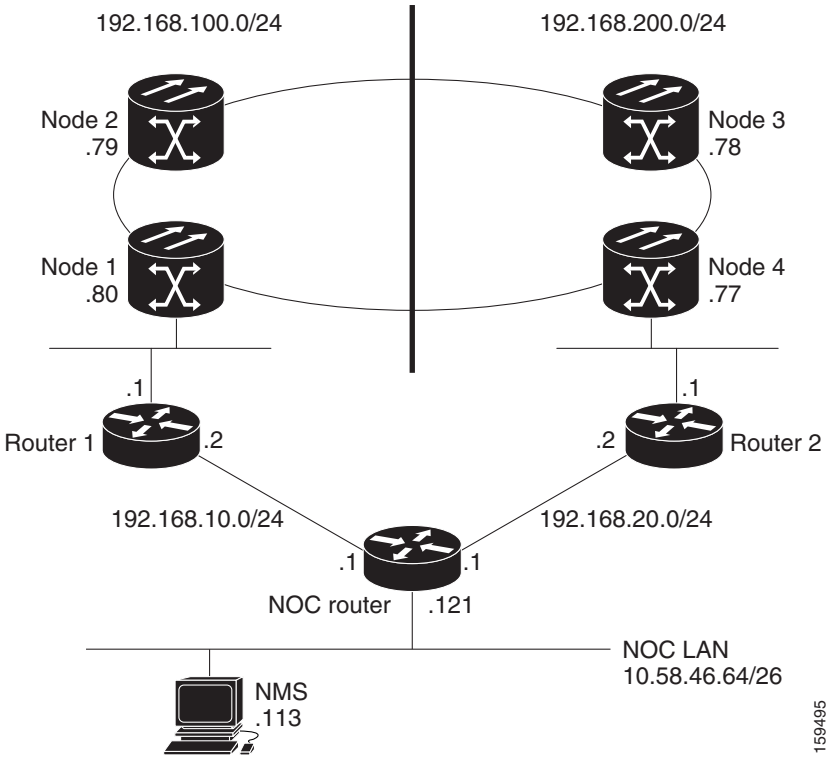
Non-LAN connected Multishelf nodes are not manageable from CTC unless SOCKS Proxy is enabled on the node. In a GNE/ENE firewall configuration, non-LAN connected network elements must be set up as end network elements (ENEs) if Firewall is required. If firewall is not required on the non-LAN connected Multishelf node, then the node must be set up as SOCKS Proxy

LAN-connected network elements (LNEs) can be set up as gateway network elements (GNEs) or as SOCKS proxies, depending upon network security requirements. If the GNE/ENE firewall feature is required, the LNE must be set up as a GNE. If the design does not require the firewall feature but does require all-IP networking, the LNE must be set up as a SOCKS proxy. For procedures to provision a node or shelf as a GNE, ENE or SOCKS proxy, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

15.3.4 DCN Case Study 1: Ring Topology with Two Subnets and Two DCN Connections

DCN Case Study 1 (Figure 15-17) shows an ONS 15454 ring (DWDM or SONET/SDH). The ring is divided into two subnets and has two DCN connections for resiliency.

Figure 15-17 DCN Case Study 1: ONS 15454 Ring with Two Subnets and Two DCN Connections

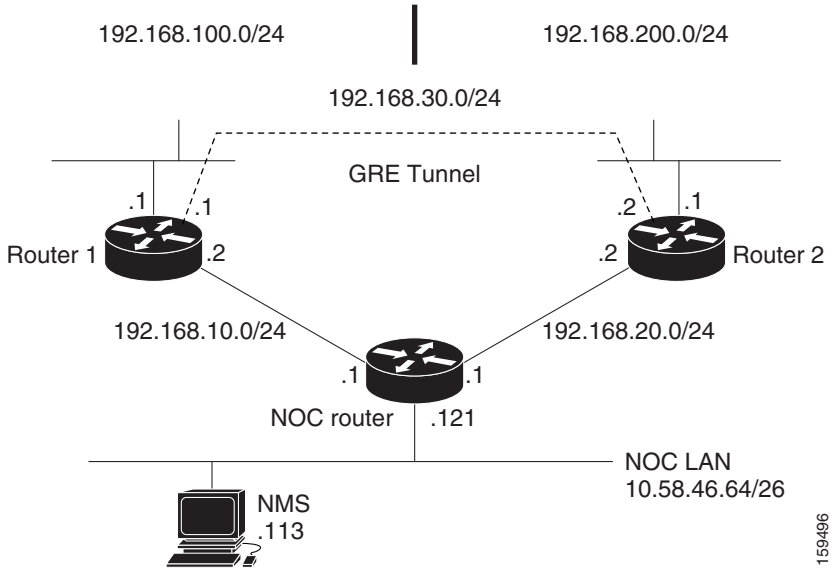


During normal operation, this configuration balances the management traffic load over the two available DCN connections. If one of the two DCN connections fails, the second DCN connection maintains accessibility so NE management can continue. However, if complete IP connectivity is required, for example, for SNMP when SOCKS proxy cannot be used, connection resilience is difficult to achieve because:

- The ONS 15454 does not support route overloading. Configuring different routers with different costs for the same network destination is not possible.
- The ONS 15454 always tries to route traffic on the LAN interface when its link is up, and the link on the NE connected to DCN router is always up.
- If the DCN connection fails, the route is longer available.

One solution is to create a generic routing encapsulation (GRE) tunnel to logically connect the remote Router 1 and remote Router 2 using the OSC/DCC/GCC network (Figure 15-18). With the GRE tunnel, both remote routers have an alternate path to reach the NOC network in case of DCN failure. However, the alternate path might become overloaded on the routing tables, resulting in higher costs.

Figure 15-18 DCN Case Study 1: ONS 15454 Ring with Two Subnets, Two DCN Connections, and GRE Tunnel



15.3.4.1 DCN Case Study 1 IP Configuration

The following sections show sample IP configuration at the routers and ONS 15454 nodes in DCN Case Study 1.

15.3.4.1.1 NOC Router Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
```

```
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 192.168.100.0 255.255.255.0 192.168.10.2
ip route 192.168.100.0 255.255.255.0 192.168.20.2 10
ip route 192.168.200.0 255.255.255.0 192.168.20.2
ip route 192.168.200.0 255.255.255.0 192.168.10.2 10
```

15.3.4.1.2 Router 1 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
!
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.1 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.200.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.200.0 255.255.255.0 Tunnel0 10
ip route 192.168.200.1 255.255.255.255 192.168.100.80
```

Note the host route to the peer Router 2 (192.168.200.1) points to the ONS 15454 network (through 192.168.100.80). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading might occur on this last-resort route.

15.3.4.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.200.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.2 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.0 255.255.255.0 Tunnel0 10
ip route 192.168.100.1 255.255.255.255 192.168.200.77
```

The host routing path to the Router 1 (192.168.100.1) points to the ONS 15454 network (by 192.168.200.77). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading the last-resort route might occur. Table 15-5 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes advertise their capability to act as last-resort routers.

Table 15-5 DCN Case Study 1 Node IP Addresses

Node	IP Address/Mask	Default Gateway	Static Routes: Destination/Mask – Next Hop
Node 1	192.168.100.80/24	192.168.100.1	0.0.0.0/0 – 192.168.100.1
Node 2	192.168.100.79/24	0.0.0.0	—
Node 3	192.168.100.78/24	0.0.0.0	—
Node 4	192.168.100.77/24	192.168.100.1	0.0.0.0/0 – 192.168.200.1

15.3.4.2 DCN Case Study 1 Limitations

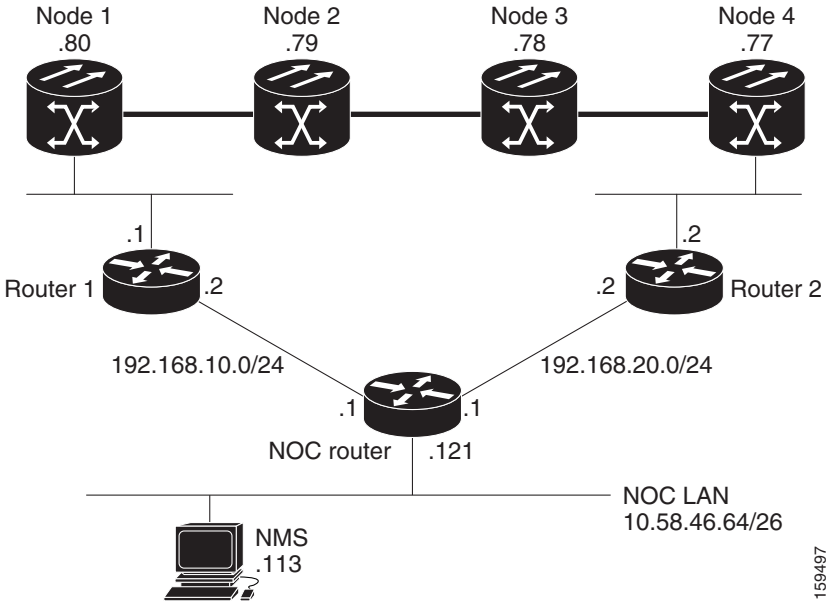
DCN Case Study 1 shows how a GRE tunnel can be created between two routers to create DCN connection resiliency. While the resiliency is a benefit, when a DCN failure forces traffic to the GRE tunnel, the path calculated by the ONS 15454 OSPF algorithm running in the OSC/DCC/GCC network is no longer the shortest one. Subsequently, the round-trip delay time (RTT) might increase significantly because the DCN protection in this configuration is transparent to the ONS 15454 network. The ONS 15454 continues to use the same routing table. In addition, if a DCN failure occurs, the routing path that uses the GRE tunnel adds additional latency because of the number and length of OSC/DCC/GCC spans that the tunnel has to travel over the ONS 15454 network.

This latency makes this DCN Case Study 1 solution difficult to scale to large networks. If this solution is used and the network grows significantly, a larger number of DCN-connected NEs are required. For example, the common rule in ONS 15454 DCN design is that all nodes should be within five section data communications channel (LDCC)/regeneration section DCC (RS-DCC/OSC or eight line DCC (LDCC) /multiplex section DCC (MS-DCC) spans from the network attached node. If Case Study 1 design is implemented, the maximum span numbers should be cut in half. However, if the DCN Case Study 1 design is used in networks that have full IP routing, have connectivity to every NE, and require only CTC/CTM management, the SOCKS proxy feature can be used to provide the same DCN connectivity resilience.

15.3.5 DCN Case Study 2: Linear Topology with DCN Connections on Both Ends

DCN Case Study 2, shown in Figure 15-19, shows a four-node linear topology with DCN connectivity at both ends.

Figure 15-19 DCN Case Study 2: ONS 15454 Linear Topology with DCN Connections at Both Ends



To maintain DCN resilience, static routes are used and a GRE tunnel is created between Router 1 and Router 2 over the DCC/OSC/GCC optical link. In this example, all ONS 15454s are part of the same subnet. Therefore, the Router 1 and Router 2 static route tables have more entries because alternate paths must be configured for every host.

15.3.5.1 DCN Case Study 2 IP Configurations

The following sections provide sample IP configurations at routers and ONS 15454 nodes in DCN Case Study 2.

15.3.5.1.1 NOC Router IP Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 192.168.100.0 255.255.255.0 192.168.10.2
ip route 192.168.100.0 255.255.255.0 192.168.20.2 100
ip route 192.168.100.77 255.255.255.255 192.168.20.2
ip route 192.168.100.77 255.255.255.255 192.168.10.2 10
ip route 192.168.100.78 255.255.255.255 192.168.20.2
ip route 192.168.100.78 255.255.255.255 192.168.10.2 10
ip route 192.168.100.79 255.255.255.255 192.168.10.2
ip route 192.168.100.79 255.255.255.255 192.168.20.2 10
ip route 192.168.100.80 255.255.255.255 192.168.10.2
ip route 192.168.100.80 255.255.255.255 192.168.20.2 10
```

15.3.5.1.2 Router 1 IP Configuration

Site 1 router interface:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.1 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.2
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.2 255.255.255.255 192.168.100.80
```

Note that the host routing path to the peer DCN router (Site 2, 192.168.100.2) points to the ONS 15454 network (by 192.168.100.80) that is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that include the NOC network) is overloaded with the alternate path, but overloading of the last-resort route might also occur.

15.3.5.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.2 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.2 255.255.255.0
tunnel source Ethernet1/0
```

```
tunnel destination 192.168.100.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.1 255.255.255.255 192.168.100.77
```

Note that the host route to the Router 1 (192.168.100.1) points to the ONS 15454 network (by 192.168.200.77). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading the last-resort route might also occur.

Table 15-6 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes advertise their capability to act as last-resort routers.

Table 15-6 DCN Case Study 2 Node IP Addresses

Node	IP Address/Mask	Default Gateway	Static Routes: Destination/Mask – Next Hop
Node 1	192.168.100.80/24	192.168.100.1	0.0.0.0/0 – 192.168.100.1
Node 2	192.168.100.79/24	0.0.0.0	—
Node 3	192.168.100.78/24	0.0.0.0	—
Node 4	192.168.100.77/24	192.168.100.1	0.0.0.0/0 – 192.168.200.1

15.3.5.2 DCN Case Study 2 Limitations

The linear configuration in DCN Case Study 2 does not effectively protect the management network communication for every fiber failure because the DCN router is not notified of the failures. Therefore, it continues to send packets on the low-cost path. This problem does not occur in ring topologies where the fiber failure is internally protected from the optical ring network. However, the OSPF dynamic routing protocol can be used over the DCN network to provide a solution to this problem. An OSPF configuration is shown in DCN Case Study 3.

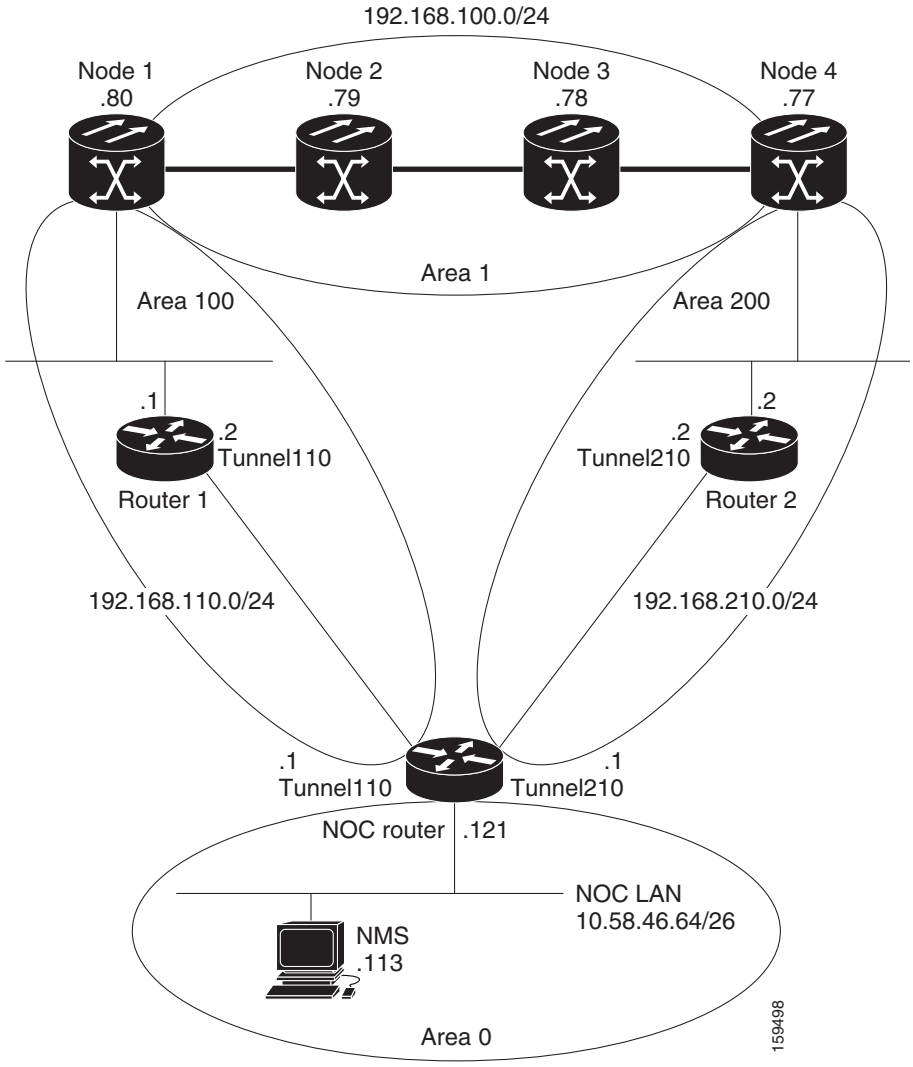
15.3.6 DCN Case Study 3: Linear Topology with DCN Connections on Both Ends Using OSPF Routing

DCN Case Study 3 is the same linear topology as DCN Case Study 2 except OSPF routing is used on the DCN network. This requires the OSPF active on LAN option, located on the node view (single-shelf mode) or multishelf view (multishelf mode) Provisioning > Network > OSPF tab, to be enabled at the end ONS 15454 nodes. In addition, OSPF must be running between Router 1, Router 2, and the NOC router.

Because the DCN connection usually passes over a public network where OSPF is not always an option, the connection between Router 1, Router 2, and the NOC router is configured as a GRE tunnel so OSPF can run on the tunnel itself.

Figure 15-20 shows the linear configuration with the separate OSPF areas, the tunnel connections, and the required OSPF virtual link. (The physical connections where the tunnels are passed are not shown in the figure because they are not directly part of the actual routing path.)

Figure 15-20 DCN Case Study 3: ONS 15454 Linear Topology with DCN Connections at Both Ends Using OSPF



15.3.6.1 DCN Case Study 3 IP Configurations

The following sections provide sample IP configurations at routers and ONS 15454 nodes for DCN Case Study 3.

15.3.6.1.1 NOC Router IP Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
```

```
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
interface Loopback0
 ip address 1.1.1.1 255.255.255.0
 no ip directed-broadcast
!
```

GRE tunnel interface configuration:

```
interface Tunnel110
 ip address 192.168.110.1 255.255.255.0
 tunnel source Ethernet2/0
 tunnel destination 192.168.10.2
!
interface Tunnel210
 ip address 192.168.210.1 255.255.255.0
 tunnel source Ethernet1/0
 tunnel destination 192.168.20.2
!
```

OSPF routing configuration:

```
router ospf 1
 network 1.1.1.0 0.0.0.255 area 0
 network 10.0.0.0 0.255.255.255 area 0
 network 192.168.110.0 0.0.0.255 area 100
 network 192.168.210.0 0.0.0.255 area 200
 area 100 virtual-link 192.168.100.80
 area 200 virtual-link 192.168.100.77
!
```

Note that the OSPF virtual link to the end ONS 15454s is created to connect the DCC/OSC/GCC OSPF area 1 to the backbone area 0. No static routes are defined on the NOC router.

15.3.6.1.2 Router 1 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel110
 ip address 192.168.110.2 255.255.255.0
 tunnel source Ethernet0/0
 tunnel destination 192.168.10.1
!
```

OSPF and static routing configuration:

```
router ospf 1
 log-adjacency-changes
 network 192.168.100.0 0.0.0.255 area 100
 network 192.168.110.0 0.0.0.255 area 100
!
```

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
```

15.3.6.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.2 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel210
 ip address 192.168.210.2 255.255.255.0
 tunnel source Ethernet0/0
 tunnel destination 192.168.20.1
!
```

OSPF and static routing configuration:

```
router ospf 1
 network 192.168.100.0 0.0.0.255 area 200
 network 192.168.210.0 0.0.0.255 area 200
!
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
```

Table 15-7 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes can advertise their capability to act as last-resort routers.

Table 15-7 DCN Case Study 3 Node IP Addresses

Node	IP Address/Mask	Default Gateway	OSPF Configuration
Node 1	192.168.100.80/24	192.168.100.1	DCC/OSC/GCC area: 0.0.0.1 LAN area: 0.0.0.100 OSPF Area Range Table: • 192.168.100.79/32 - Area 0.0.0.1 • 192.168.100.78/32 - Area 0.0.0.1 • 192.168.100.77/32 - Area 0.0.0.1 Virtual Link Table: 1.1.1.1
Node 2	192.168.100.79/24	0.0.0.0	DCC/OSC/GCC area: 0.0.0.1 OSPF disabled on LAN

Table 15-7 DCN Case Study 3 Node IP Addresses (continued)

Node	IP Address/Mask	Default Gateway	OSPF Configuration
Node 3	192.168.100.78/24	0.0.0.0	DCC/OSC/GCC area: 0.0.0.1 OSPF disabled on LAN
Node 4	192.168.100.77/24	192.168.100.1	DCC/OSC/GCC area: 0.0.0.1 LAN area: 0.0.0.200 OSPF Area Range Table: • 192.168.100.80/32 - Area 0.0.0.1 • 192.168.100.79/32 - Area 0.0.0.1 • 192.168.100.78/32 - Area 0.0.0.1 Virtual Link Table: 1.1.1.1

The OSPF virtual link requires its neighbor to be indicated with its router ID, not the physical or tunnel interface connected to the network. Using a loopback interface on the NOC router makes the router ID selection independent from real interface IP address.

15.3.6.2 DCN Case Study 3 Limitations

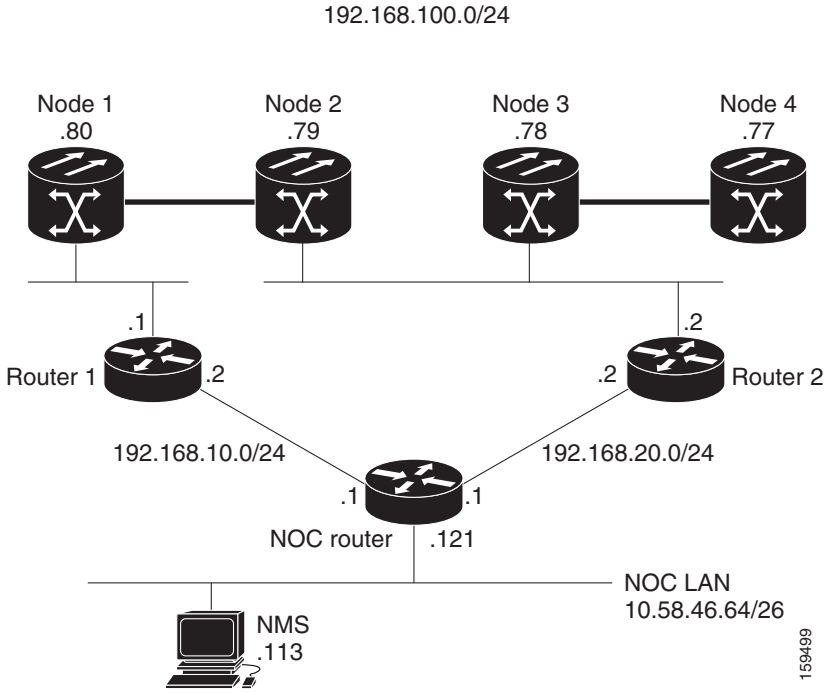
DCN Case Study 3 shows that OSPF can provide better DCN resilience and more efficient routing choices, which results in better performance. OSPF also provides better network scalability. Some limitations of using OSPF include:

- OSPF introduces additional complexity, for example, provisioning the OSPF virtual links and advertisement on the ONS 15454s and routers requires thought and planning.
- OSPF must be enabled on the DCN connection between the NOC and the site routers. This can also be done through GRE tunnels, as shown in this case study.
- Planning and thought must be given to the separation of the OSPF areas. Creation of virtual links to overcome the limitations described in the "15.3.2 OSPF" section on page 15-23 and to avoid isolated areas and segmentation in the backbone area requires planning as well.

15.3.7 DCN Case Study 4: Two Linear Cascaded Topologies With Two DCN Connections

DCN Case Study 4, shown in Figure 15-21, extends the simple linear topology shown in DCN Case Study 3. However in this example, two linear DCN connections go to the same site router and all the ONS 15454s are in the same subnet. A GRE tunnel logically connects the remote Router 1 and Router 2 over the OSC/DCC/GCC network, which is similar to the DCN Case Study 1 configuration (Figure 15-18). The GRE tunnel provides the remote routers with an alternate path to reach the NOC network in case a DCN failure occurs. However, the alternate paths might overload the router routing tables and carry a higher cost because all alternate paths are host-based due to the fact the ONS 15454s reside in the same subnet.

Figure 15-21 DCN Case Study 4: Two Linear Cascaded Topologies with Two DCN Connections



15.3.7.1 DCN Case Study 4 IP Configurations

The following sections provide sample IP configurations at the routers and ONS 15454 nodes for DCN Case Study 4.

15.3.7.1.1 NOC Router IP Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 192.168.100.0 255.255.255.0 192.168.10.2
ip route 192.168.100.0 255.255.255.0 192.168.20.2 100
ip route 192.168.100.77 255.255.255.255 192.168.20.2 10
ip route 192.168.100.77 255.255.255.255 192.168.10.2 20
ip route 192.168.100.78 255.255.255.255 192.168.20.2
ip route 192.168.100.78 255.255.255.255 192.168.10.2 10
ip route 192.168.100.79 255.255.255.255 192.168.20.2
```

```
ip route 192.168.100.79 255.255.255.255 192.168.10.2 10
ip route 192.168.100.80 255.255.255.255 192.168.10.2
ip route 192.168.100.80 255.255.255.255 192.168.20.2 10
ip route 192.168.200.0 255.255.255.0 192.168.20.2
ip route 192.168.200.0 255.255.255.0 192.168.10.2 100
```

15.3.7.1.2 Router 1 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.1 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.2
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.2 255.255.255.255 192.168.100.80
ip route 192.168.100.77 255.255.255.255 Tunnel0 20
ip route 192.168.100.78 255.255.255.255 Tunnel0 10
ip route 192.168.100.79 255.255.255.255 Tunnel0 10
```

Note that the host routing path to the peer DCN router (Router 2, 192.168.100.2) points to the ONS 15454 network (by 192.168.100.80). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading of the last-resort route could also occur.

15.3.7.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.2 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.2 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
```

```
ip route 10.0.0.0 255.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.1 255.255.255.255 192.168.100.79
ip route 192.168.100.80 255.255.255.255 Tunnel0 10
```

Note that the host routing path to the peer DCN router (Router, IP 192.168.100.1) points to the ONS 15454 network (by 192.168.200.79). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that include the NOC network) is overloaded with the alternate path. However, overloading the last-resort route is also possible.

Table 15-8 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes can advertise their capability to act as last-resort routers.

Table 15-8 DCN Case Study 4 Node IP Addresses

Node	IP Address/Mask	Default Gateway	Static Routes: Destination/Mask – Next Hop
Node 1	192.168.100.80/24	192.168.100.1	0.0.0.0/0 – 192.168.100.1 192.168.100.1/32 – 192.168.100.80
Node 2	192.168.100.79/24	192.168.100.2	192.168.100.2/32 – 192.168.100.79
Node 3	192.168.100.78/24	192.168.100.2	0.0.0.0/0 – 192.168.100.2
Node 4	192.168.100.77/24	0.0.0.0	—

15.3.7.2 DCN Case Study 4 Limitations

Many limitations described in the "15.3.4.2 DCN Case Study 1 Limitations" section on page 15-27 also apply to this case study. However, the problems are less acute because of the DCN connection in the middle of the optical network. For DWDM networks, increased latency might became a problem if the linear topology has many spans with intermediate line amplifier or optical add/drop multiplexing (OADM) nodes, which is sometimes done to cover long-distance connections. In this case, when one DCN fails, management packets for nodes near the middle of the span travel 1.5 times the complete point-to-point connection. The normal routing figure is 0.5. The full connection length of a GRE tunnel is used as an alternate routing path.

15.4 DCN Extension

ONS 15454 DWDM networks require a communication channel to exchange data among the different nodes within the network. Until Software Release 7.0, the only usable channel was the optical service channel (OSC) provided by the OSCM and OSC-CSM cards. In a long DWDM metro network, usage of OSC channel adds limitations in terms of cost and performance because the OSC channel maximum loss is 37 dB.

The primary aim of the DCN extension feature is to remove the OSC constraint and leverage on already available external DCN or traffic matrix that allows nodes to be reached without using an OSC channel.

You can connect two nodes in a DWDM network without using an OSC channel in the following two methods:

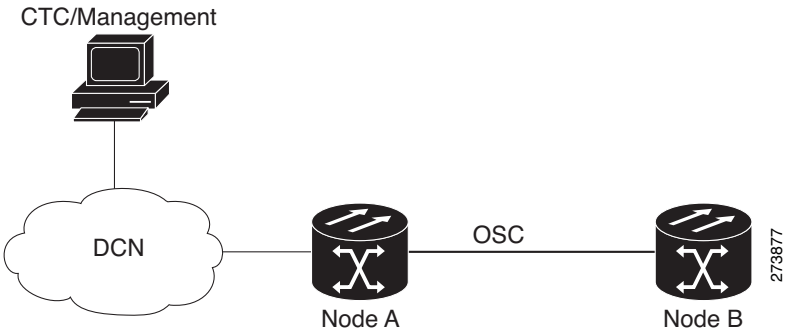
- Using external DCN
- Using GCC/DCC

The following sections describe the different communication methods and the factors to be considered while provisioning the connectivity.

15.4.1 Network Using OSC

Figure 15-22 shows a point-to-point network that uses OSC as the communication channel.

Figure 15-22 Network Using OSC

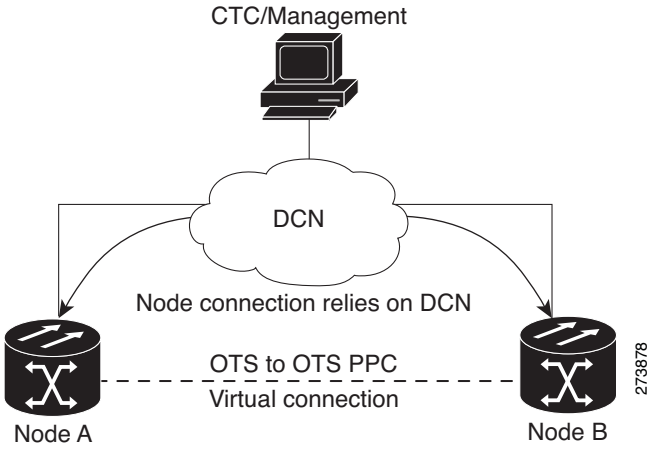


In a network using OSC channel, it is possible to supervise all the nodes from the network operations center (NOC) and all nodes can communicate with each other using the OSC channel. Network topology discovery is automatic when you use an OSC channel.

15.4.2 Network Using External DCN

Figure 15-23 shows a point-to-point network that uses external DCN as the communication channel.

Figure 15-23 Network Using External DCN



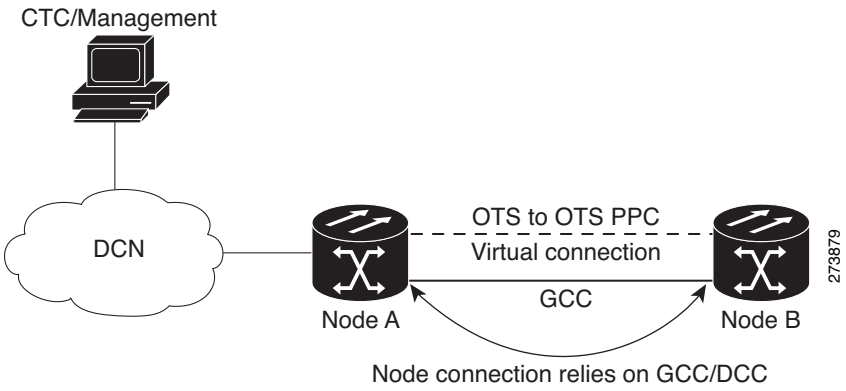
In a network using external DCN, it is possible to supervise all the nodes from the network operations center (NOC) and all nodes can communicate with each other using external DCN. The NOC is connected to each node through the external DCN. Since nodes do not have OSC connectivity, you must

create an OTS-to-OTS PPC between the nodes. The OTS-to-OTS PPC creates a DCN connection between the nodes. Refer to the "Create Circuits and Provisionable Patchcords" chapter in the *Cisco ONS 15454 DWDM Procedure Guide* for instructions on how to provision an OTS-to-OTS PPC.

15.4.3 Network Using GCC/DCC

Figure 15-24 shows a point-to-point network network that uses GCC/DCC as the communication channel.

Figure 15-24 Network Using GCC/DCC



In a network using GCC/DCC, one ONS 15454 node (for example, Node A) is provisioned as a gateway network element (GNE). The NOC is connected only to the GNE. It is possible to supervise all the nodes from the network operations center (NOC) and all nodes can communicate with each other using GCC/DCC.

However in such a network, because of the absence of the embedded OSC channel, discovery of the network topology is not automatic. You must manually provision the adjacency of nodes inorder to configure the correct topology. Refer to the "Create Circuits and Provisionable Patchcords" chapter in the *Cisco ONS 15454 DWDM Procedure Guide* for instructions on how to provision DCN extension for a network using GCC/DCC.

15.5 Routing Table

ONS 15454 routing information is displayed on the Maintenance > Routing Table tab. 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/TCC2P and, for ANSI shelves, the LAN 1 pins on the backplane or, for ETSI shelves, the LAN connection on the MIC-C/T/P.

- pdcc0—An SDCC or RS-DCC interface, that is, an OC-N/STM-N trunk card identified as the SDCC or RS-DCC termination.
- lo0—A loopback interface.

Table 15-9 shows sample routing entries for an ONS 15454.

Table 15-9 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.

15.6 External Firewalls

This section provides sample access control lists for external firewalls. Table 15-10 lists the ports that are used by the TCC2/TCC2P.

Table 15-10 Ports Used by the TCC2/TCC2P

Port	Function	Action[1]
0	Never used	D
20	FTP	D
21	FTP control	D
22	SSH	D
23	Telnet	D
80	HTTP	D
111	SUNRPC	NA
161	SNMP traps destinations	D
162	SNMP traps destinations	D
513	rlogin	D
683	CORBA IIOP	OK
1080	Proxy server (socks)	D
2001-2017	I/O card Telnet	D
2018	DCC processor on active TCC2/TCC2P	D
2361	TL1	D
3082	Raw TL1	D
3083	TL1	D
5001	BLSR server port	D
5002	BLSR client port	D
7200	SNMP alarm input port	D
9100	EQM port	D
9401	TCC boot port	D
9999	Flash manager	D
10240-12287	Proxy client	D
57790	Default TCC listener port	OK

1. D = deny, NA = not applicable, OK = do not deny

The following access control list (ACL) 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 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 is 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 ***
```

15.7 Open GNE

The ONS 15454 can communicate with non-ONS nodes that do not support Point-to-Point Protocol (PPP) vendor extensions or OSPF type 10 opaque link-state advertisements (LSA), both of which are necessary for automatic node and link discovery. An open GNE configuration allows a GCC-based network to function as an IP network for non-ONS nodes.

To configure an open GNE network, you can provision GCC terminations to include a far-end, non-ONS node using either the default IP address of 0.0.0.0 or a specified IP address. You provision a far-end, non-ONS node by checking the Far End is Foreign check box during GCC creation. The default 0.0.0.0 IP address allows the far-end, non-ONS node to identify itself with any IP address; if you set an IP address other than 0.0.0.0, a link is established only if the far-end node identifies itself with that IP address, providing an extra level of security.

By default, the proxy server only allows connections to discovered ONS peers and the firewall blocks all IP traffic between the GCC network and LAN. You can, however, provision proxy tunnels to allow up to 12 additional destinations for SOCKS version 5 connections to non-ONS nodes. You can also provision firewall tunnels to allow up to 12 additional destinations for direct IP connectivity between the GCC network and LAN. Proxy and firewall tunnels include both a source and destination subnet. The connection must originate within the source subnet and terminate within the destination subnet before either the SOCKS connection or IP packet flow is allowed. A proxy connection is allowed if the CTC client is in a source subnet and the requested destination is in the destination subnet. Firewall tunnels allow IP traffic to route between the node Ethernet and pdcc interfaces. An inbound Ethernet packet is allowed through the firewall if its source address matches a tunnel source and its destination matches a tunnel destination. An inbound pdcc packet is allowed through the firewall if its source address matches a tunnel destination and its destination address matches a tunnel source. Tunnels only affect TCP and UDP packets.

The availability of proxy and/or firewall tunnels depends on the network access settings of the node:

- If the node is configured with the proxy server enabled in GNE or ENE mode, you must set up a proxy tunnel and/or a firewall tunnel.
- If the node is configured with the proxy server enabled in proxy-only mode, you can set up proxy tunnels. Firewall tunnels are not allowed.
- If the node is configured with the proxy server disabled, neither proxy tunnels nor firewall tunnels are allowed.

Figure 15-25 shows an example of a foreign node connected to the GCC network. Proxy and firewall tunnels are useful in this example because the GNE would otherwise block IP access between the PC and the foreign node.

Figure 15-25 Proxy and Firewall Tunnels for Foreign Terminations

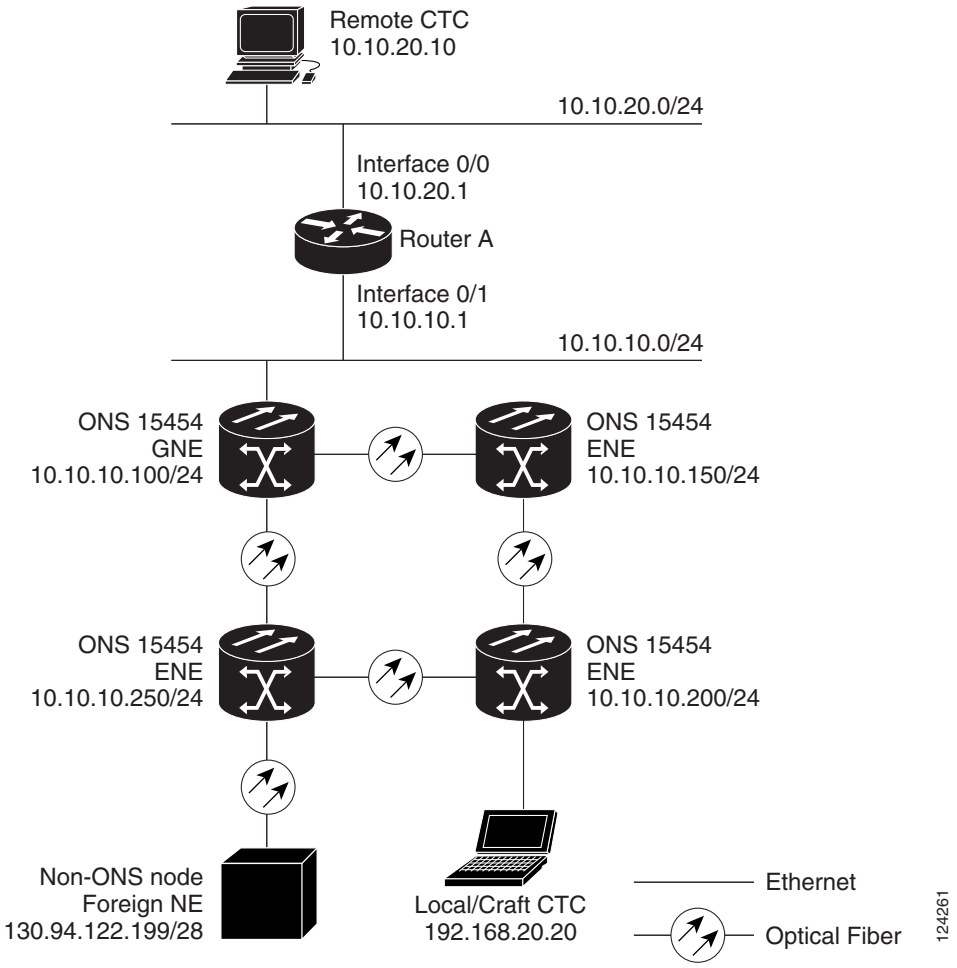
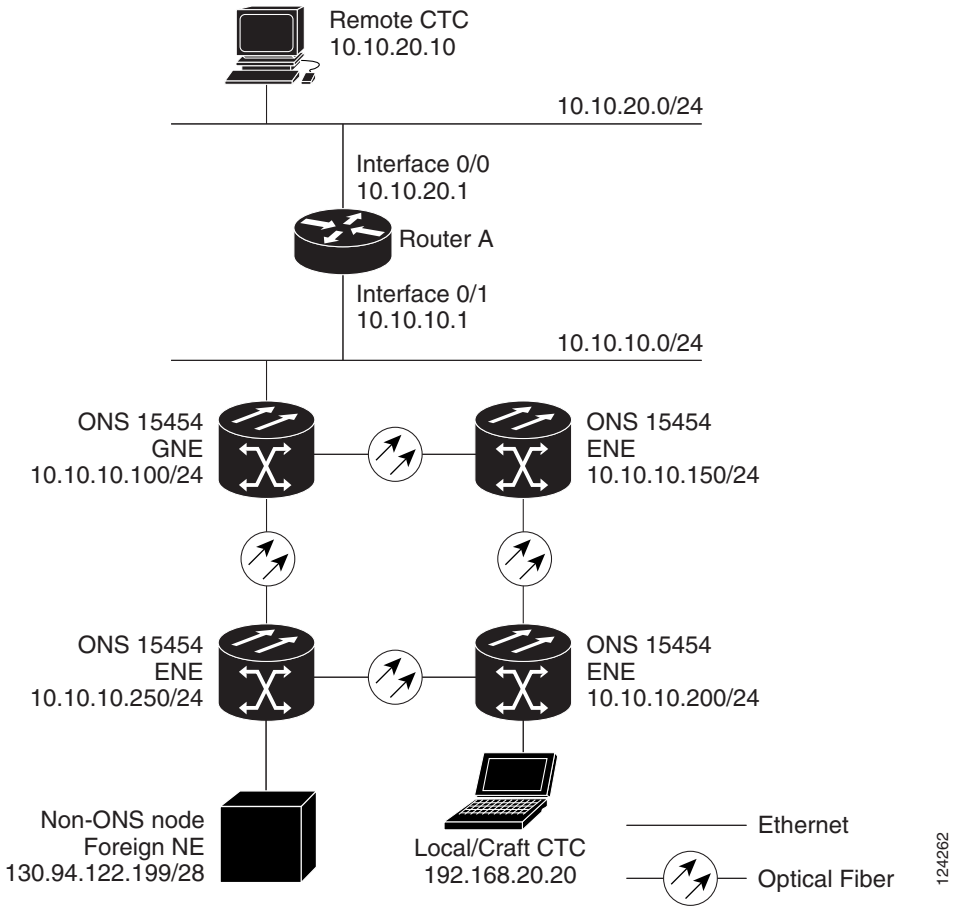


Figure 15-26 shows a remote node connected to an ENE Ethernet port. Proxy and firewall tunnels are useful in this example because the GNE would otherwise block IP access between the PC and foreign node. This configuration also requires a firewall tunnel on the ENE.

Figure 15-26 Foreign Node Connection to an ENE Ethernet Port



15.8 TCP/IP and OSI Networking

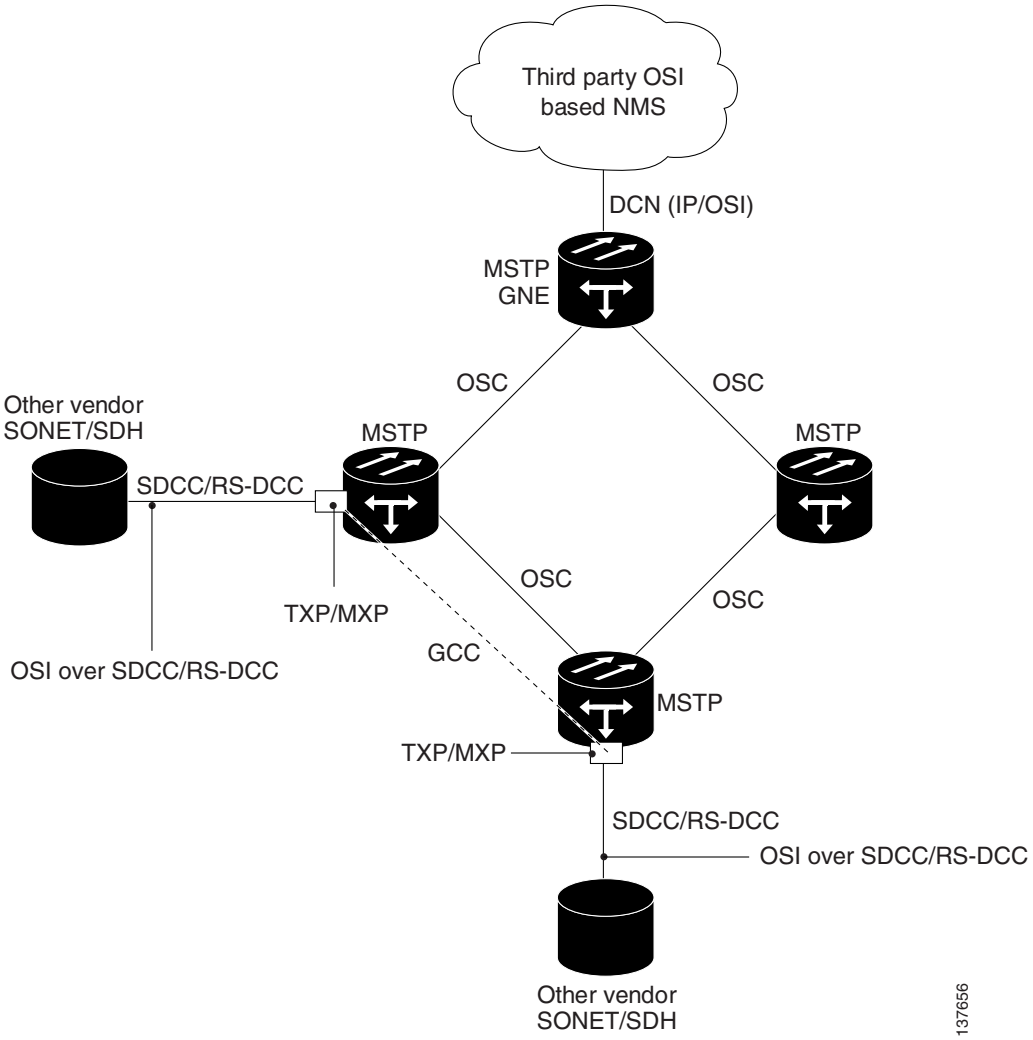
ONS 15454 DCN communication is based on the TCP/IP protocol suite. However, ONS 15454s can also be networked with equipment that uses the OSI protocol suite. While TCP/IP and OSI protocols are not directly compatible, they do have the same objectives and occupy similar layers of the OSI reference model. For detailed information about OSI protocols, processes, and scenarios, refer to the "Management Network Connectivity" chapter in the *ONS 15454 Reference Manual*. OSI/MultiService Transport Platform (MSTP) scenarios are provided in the following sections.

In OSI/MSTP Scenario 1 (Figure 15-27), an SDCC or RS-DCC carries an OC-N/STM-N signal from an OSI-based third-party NE to a transponder (TXP) or muxponder (MXP) card on an ONS NE. It is carried by GCC to a TXP/MXP card on another MSTP NE and then by SDCC or RS-DCC to a second third-party NE. This scenario requires TXPs/MXPs whose client interfaces can be provisioned in section or line termination mode. These include:

- TXP_MR_2.5 and TXPP_MR_2.5 (when equipped with OC-N/STM-N SFPs)
- TXP_MR_10G and TXP_MR_10E (when the client is configured as OC-192/STM-64)
- MXP_2.5_10G and MXP_2.5_10E

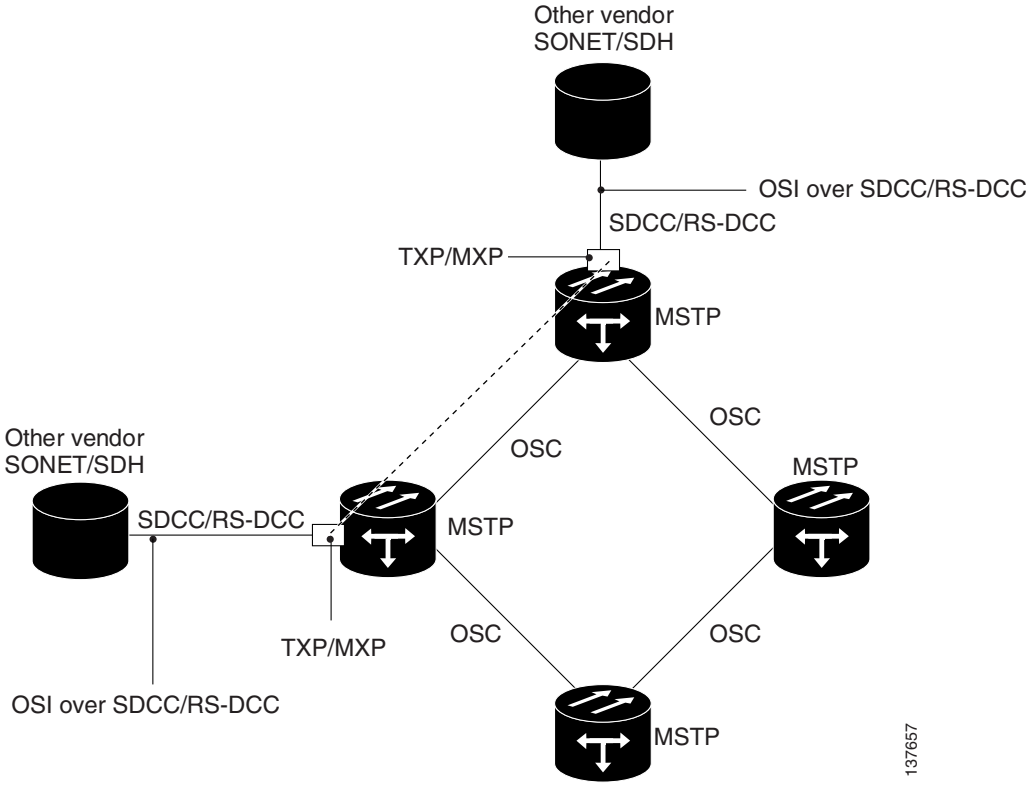
OSI has to be carried or tunneled to the other TXP/MXP card through an OSC termination, GCC termination, or both. The third-party NMS has OSI connectivity to its NEs with the MSTP ONS NE serving as the GNE for third-party vendor, OSI-based SONET equipment.

Figure 15-27 OSI/MSTP Scenario 1



OSI/MSTP Scenario 2 (Figure 15-28) is similar to Scenario 1, except the MSTP NEs do not have connectivity to an OSI NMS.

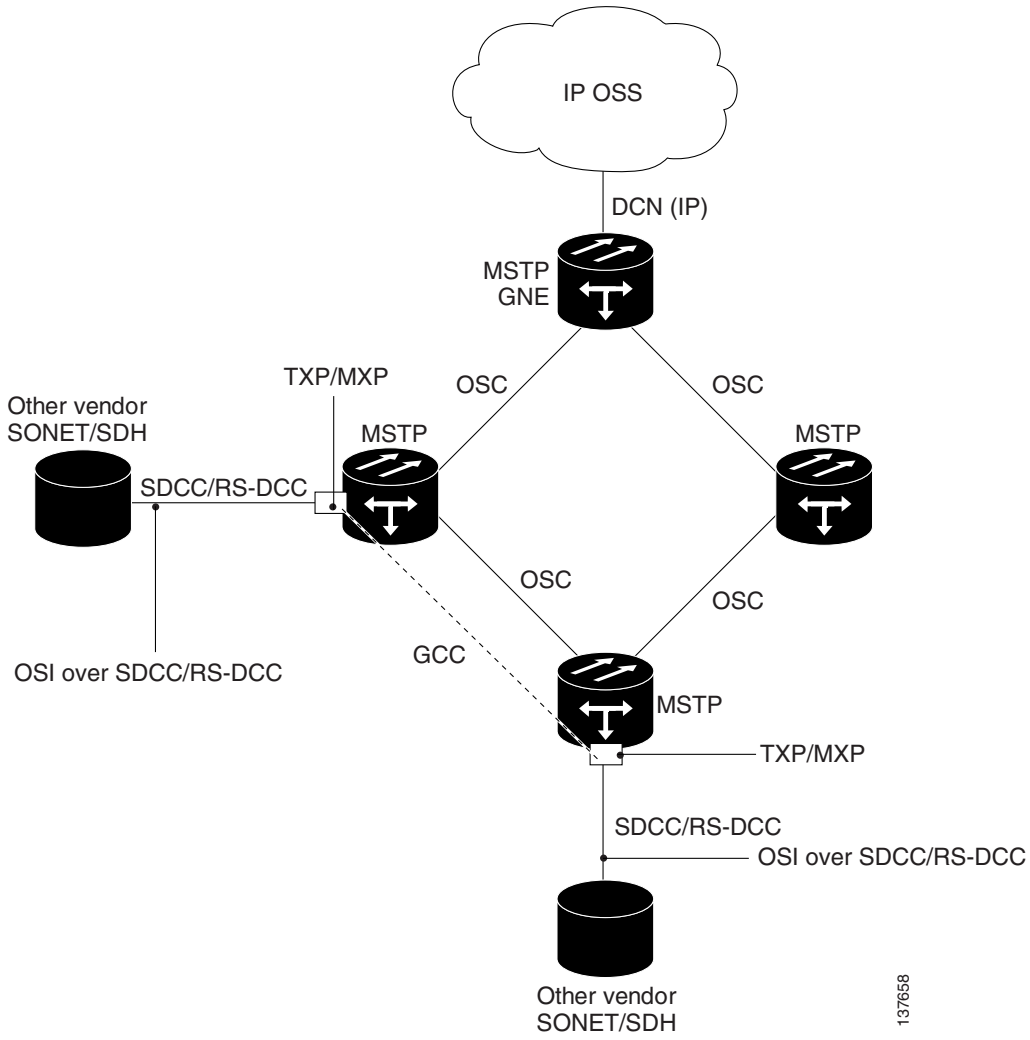
Figure 15-28 OSI/MSTP Scenario 2



OSI/MSTP Scenario 3 (Figure 15-29) shows the following:

- OSI is carried over an SDCC or RS-DCC termination.
- OSI has to be carried or tunneled to the other peer TXP/MXP through an OSC termination, GCC termination, or both.
- An OSS has IP connectivity to all the NEs.
- The MSTP NE is a GNE for the third-party OSI-based SONET NEs. The MSTP NEs perform all mediation functions.

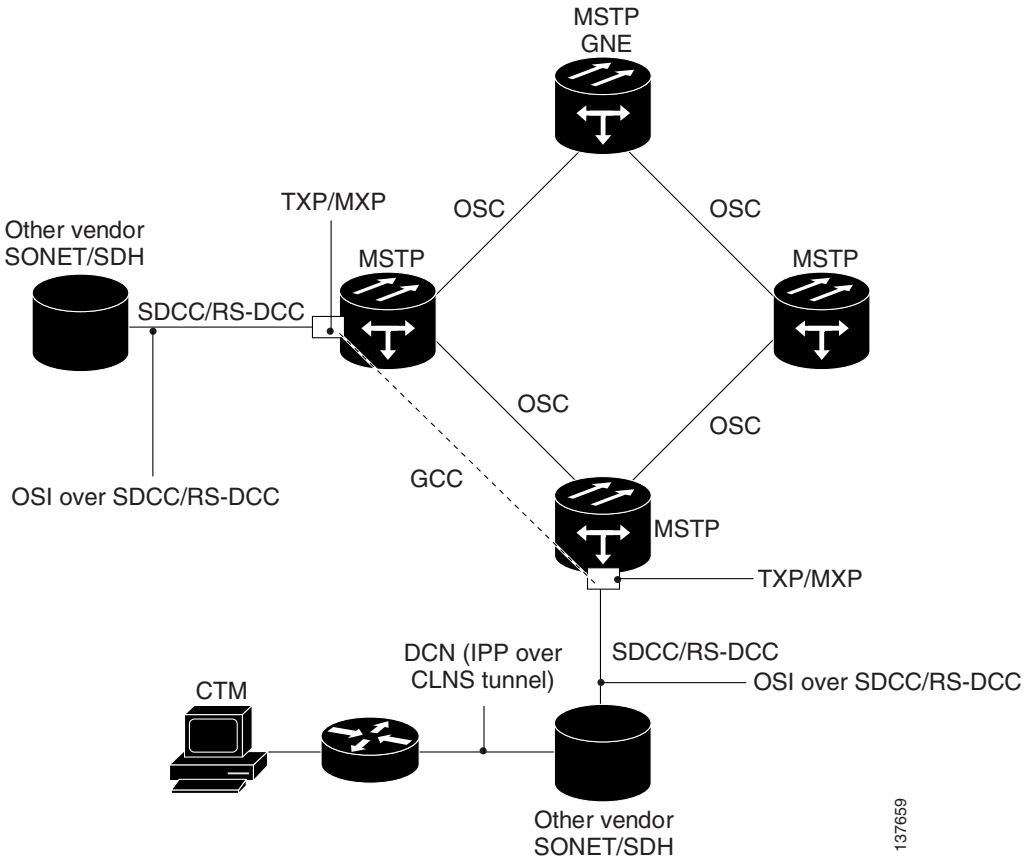
Figure 15-29 OSI/MSTP Scenario 3



OSI/MSTP Scenario 4 (Figure 15-30) shows the following:

- OSI is carried over an SDCC or RS-DCC termination.
- OSI has to be carried or tunneled to the other peer TXP/MXP through an OSC termination, GCC termination, or both
- An OSS has IP connectivity to all the NEs through third-party NE network.
- The MSTP NE is a GNE for the third-party OSI-based SONET NEs. The MSTP NEs perform all mediation functions.
- The third-party vendor NE is a GNE for the Cisco MSTP network.

Figure 15-30 OSI/IP Scenario 4



15.9 Link Management Protocol

This section describes Link Management Protocol[1] (LMP) management and configuration. To troubleshoot specific alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*. To configure LMP, refer to the *Cisco ONS 15454 DWDM Procedure Guide.*

Note CTM support is not required for LMP.

LMP is used to establish traffic engineering (TE) links between Cisco ONS 15454 nodes or between Cisco ONS 15454 nodes and selected non-Cisco nodes that use vendor-specific hardware.

15.9.1 Overview

LMP manages TE links between nodes through the use of control channels. TE links are designed to define the most efficient paths possible for traffic to flow over a network and through the Internet. Traffic engineering encompasses traffic management, capacity management, traffic measurement and modeling,

1. The LMP protocol is specified by the IETF in an Internet-Draft, draft-ietf-ccamp-lmp-10.txt, which was published as a Proposed Standard, RFC 4204, (http://www.ietf.org/rfc/rfc4204.txt), on 2005-10-28.

network modeling, and performance analysis. Traffic engineering methods include call routing, connection routing, quality of service (QoS) resource management, routing table management, and capacity management.

LMP manages TE links between peer nodes, such as two optical cross-connect (OXC) nodes. Peer nodes have equivalent signaling and routing. LMP also manages TE links between a node such as an OXC and an adjacent optical line system (OLS) node. An example of an OLS node is an ONS 15454 DWDM node.

Networks with routers, switches, OXC nodes, DWDM OLS nodes, and add/drop multiplexers (ADM) use a common control plane such as Generalized Multiprotocol Label Switching (GMPLS) to provision resources and provide network survivability using protection and restoration techniques. LMP is part of the GMPLS protocol suite.

A single TE link can be formed from several individual links. Management of TE links can be accomplished with in-band messaging, as well as with out-of-band methods. The following material describes the LMP between a pair of nodes that manages TE links. LMP accomplishes the following:

- Maintains control channel connectivity
- Verifies the physical connectivity of the data links
- Correlates the link property information
- Suppresses downstream alarms
- Localizes link failures for protection/restoration purposes in multiple types of networks

DWDM networks often use Multiprotocol Label Switching (MPLS) and GMPLS as common-control planes to control how packets are routed through the network.

LMP manages the control channel that must exist between nodes for routing, signaling, and link management. For a control channel to exist, each node must have an IP interface that is reachable from the other node. Together, the IP interfaces form a control channel. The interface for the control messages does not have to be the same interface as the one for the data.

15.9.1.1 MPLS

MPLS provides a mechanism for engineering network traffic patterns that is independent of routing tables and routing protocols. MPLS assigns short labels to network packets that describe how to forward the packets through the network. The traditional Layer 3 forwarding mechanism requires each hop to analyze the packet header and determine the next hop based on routing table lookup. With MPLS, the analysis of the packet header is performed just once, when a packet enters the MPLS cloud. The packet is then assigned to a stream known as a Label Switch Path (LSP), which is identified with a label. The short, fixed-length label is an index into a forwarding table, which is more efficient than the traditional routing table lookup at each hop. Using MPLS, both the control protocol (used to manage the LSPs) and user data can be carried over the same bearer interfaces.

15.9.1.2 GMPLS

GMPLS is based on MPLS, with protocol extensions to support additional technologies, including time division multiplexing (TDM) slots (such as SONET and SDH), wavelength division multiplexing (WDM) wavelengths at Layer 1, and fiber. For MPLS, the control traffic (signaling and routing) can run over bearer interfaces. This is not the case with GMPLS, where a separate control channel is used. The GMPLS control channel is managed with LMP. With GMPLS, the control channels between two adjacent nodes do not need to use the same physical medium as the data links between those nodes.

15.9.2 Configuring LMP

Configuring LMP consists of the following four topics:

- Control channel management
- TE link management
- Link connectivity verification
- Fault management

15.9.2.1 Control Channel Management

Control channel management establishes and maintains control channels between adjacent nodes. Control channels use a Config message exchange and a fast keep-alive mechanism between the nodes. The latter is required if lower-level mechanisms are not available to detect control-channel failures. A maximum of four LMP control channels can be supported.

The nodes initially exchange configuration messages (Config, ConfigAck, and ConfigNack), which are used to exchange identifiers and negotiate parameters for the keep-alive protocol. The nodes then perform a continuous rapid exchange of Hello messages, which are used to monitor the health on the channel.

Note The identifiers are Local Node Id, Remote Node Id, Local Control Channel Id, and Remote Control Channel Id. The parameters are the HelloInterval and the HelloDeadInterval.

LMP out-of-fiber and LMP out-of-band control channels are supported and terminated on the shelf. An out-of-fiber control channel includes using the control plane network (Ethernet) for the control channel because Ethernet is separate from the fiber used for the data plane. An out-of-band control channel includes using overhead bytes, such as the SDCC and LDCC bytes, for the control channel because overhead bytes are separate from the payload. In-band means that the control messages are in the same channel as the data messages; therefore, out-of-band refers to overhead bytes in the same fiber, separate circuits dedicated to control messages in the same fiber (SONET/SDH circuits), or separate wavelengths in the same fiber (DWDM).

Note Overhead bytes are SDCC or LDCC for SONET networks, RS-DCC or MS-DCC for SDH networks, and GCC or OSC for DWDM networks.

Out-of-band implies in-fiber, but not in-band. In-fiber means that the control messages are in the same fiber as the data messages, and includes both in-band and out-of-band. Out-of-fiber means that the control messages take a path separate from the data plane. This includes separate fiber and Ethernet.

The control channel management for a peer node to OLS link is the same as that for a link between two peer nodes.

Note The software supports gracefully taking a control channel down for administration purposes (refer to Section 3.2.3 of the IETF LMP document). However, there is no provision for a graceful restart (refer to Section 8 of RFC 4204).

- Graceful means that the nodes participating in the control channel agree that the link should go down. To gracefully take down a control channel, the node sets the ControlChannelDown flag in its messages to the other node until either the HelloDeadInterval expires or the other node sends a

message back with the ControlChannelDown flag set. In either case, the node then stops sending messages for this control channel. Before a control channel is taken down, there should be a backup control channel in place that can be used to manage the data links.

- Non-graceful means that one of the nodes just stops sending messages. The other side would declare a failure after the HelloDeadInterval, but would continue to send Hello messages to see if the control channel will come back up.

15.9.2.2 TE Link Management

LMP ensures that links are grouped into TE links and that the properties of those links are the same at both endpoints. This is called TE link management, or link property correlation.

Link property correlation is used to synchronize the TE link properties and verify the TE link configuration. The link property correlation function of LMP aggregates one or more data links into a TE link and synchronizes the properties of the TE link with the neighbor node. The procedure starts by sending a LinkSummary message to the neighbor. The LinkSummary message includes the local and remote Link Identifier, a list of all data links that make up the TE link, and various link properties. It is mandatory that a LinkSummaryAck or LinkSummaryNack message be sent in response to the receipt of a LinkSummary message, indicating agreement or disagreement with the link properties.

Note A maximum of 256 LMP TE links is supported.

15.9.2.3 Link Connectivity Verification

Link connectivity verification is not supported in this release, but might be supported in the future.

15.9.2.4 Fault Management

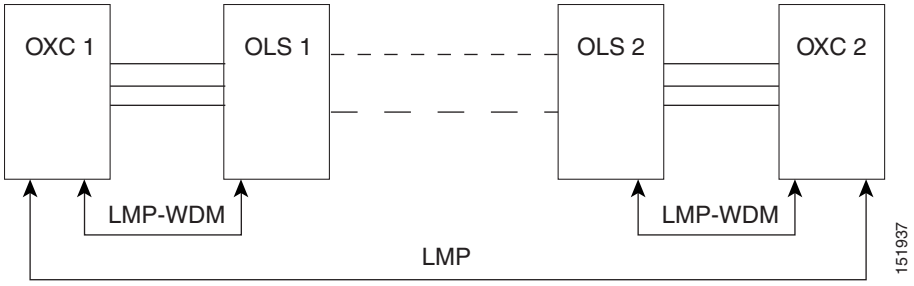
Fault management is particularly useful when the control channels are physically diverse from the data links. It is used for rapid notification regarding the status of one or more TE-link data channels. The use of fault management is negotiated as part of the TE link's LinkSummary exchange. Data links and TE link failures can be rapidly isolated and fault management supports both unidirectional and bidirectional LSPs. Transparent devices are useful because traditional methods for monitoring the health of allocated data links might no longer be appropriate. Instead, fault detection is delegated to the physical layer (for example, loss of light or optical monitoring of the data) instead of Layer 2 or Layer 3. Fault management uses the ChannelStatus, ChannelStatusAck, ChannelStatusRequest, and ChannelStatusResponse messages.

Note The LMP Channel Activation/Deactivation Indication procedures are not supported; they are described in the IETF LMP document, Sections 6.4 and 6.5.

15.9.3 LMP WDM

LMP manages traffic engineering links between peer nodes (nodes that are peers in signaling and/or routing). The purpose of the LMP WDM extensions[1] is to allow LMP to be used between an OXC node and an adjacent DWDM OLS node. Figure 15-31 illustrates the relationship between LMP and LMP-WDM. OXC 1 and OXC 2 are peer nodes whose control channel is managed with LMP. LMP-WDM manages the control channel between an OXC node and an OLS node.

Figure 15-31 LMP and LMP-WDM Relationship



When the two OLS nodes can communicate their configuration and the current state of their optical link to the two peer nodes (OXC 1 and OXC 2) through LMP-WDM, network usability is improved through the reduction of manual configuration and enhanced fault detection and recovery.

15.9.4 LMP Network Implementation

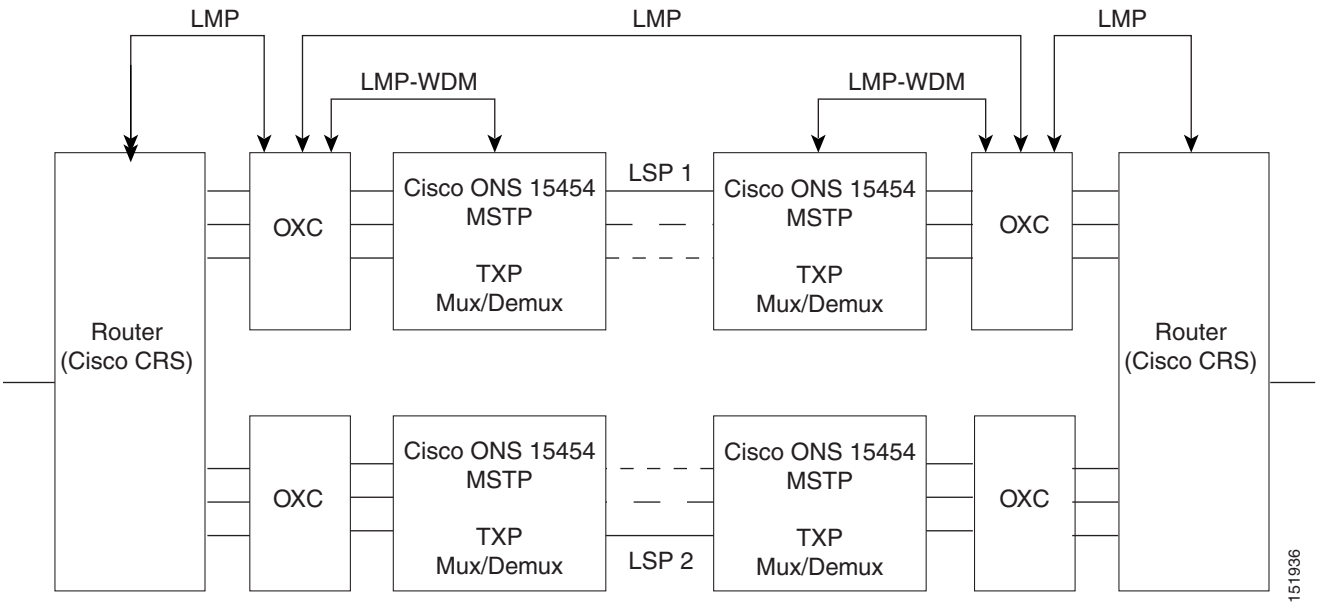
Figure 15-32 shows a network-level LMP implementation. It is an IP-plus-optical network, with end-to-end routing based on MPLS and GMPLS. The primary network components are:

- Routers
  - Cisco Carrier Router System (CSR)
  - Cisco Gigabit Switch Router (GSR)
- An OXC node
- Ultra long-haul (ULH) DWDM equipment

LMP and other features allow the Cisco ONS 15454 DWDM node to fulfill the ULH DWDM role. Figure 15-32 illustrates the relationship between the network components.

1. LMP-WDM extensions that allow management of links between a peer node and an adjacent OLS node are described in the following IETF document: Internet-Draft, draft-ietf-ccamp-lmp-wdm-03.txt, published as a Proposed Standard, RFC 4209 (http://www.ietf.org/rfc/rfc4209.txt), 2005-11-1

Figure 15-32 LMP System Implementation



15.10 IPv6 Network Compatibility

Cisco ONS 15xxx products can function in an IPv6 network when an internet router that supports Network Address Translation - Protocol Translation (NAT-PT) is positioned between the GNE, such as an ONS 15454 DWDM, and the client workstation. NAT-PT is defined in RFC-2766. IPv4 and IPv6 nodes communicate with each other using NAT-PT by allowing both IPv6 and IPv4 stacks to interface between the IPv6 DCN and the IPv4 DCC networks.

NAT-PT binds addresses in IPv6 networks with addresses in IPv4 networks and vice versa to provide transparent routing for the packets traveling between address types. This requires no changes to end nodes and IP packet routing is completely transparent to end nodes. It does, however, require NAT-PT to track the sessions it supports and mandates that inbound and outbound datagrams pertaining to a session traverse the same NAT-PT router. Protocol translation is used to extend address translation with protocol syntax/semantics translation.

Note Only Mozilla 1.7 is supported on clients interfacing with IPv6 networks.

CHAPTER 16

Alarm and TCA Monitoring and Management

This chapter describes Cisco Transport Controller (CTC) alarm and threshold crossing alert (TCA) monitoring and management. To troubleshoot specific alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 16.1 Overview, page 16-1
- 16.2 Alarm Counts on the LCD for a Node, Slot, or Port, page 16-2
- 16.3 Alarm Display, page 16-2
- 16.4 Alarm Severities, page 16-8
- 16.5 Alarm Profiles, page 16-9
- 16.6 External Alarms and Controls, page 16-13
- 16.7 Alarm Suppression, page 16-15
- 16.8 Multishelf Configuration Alarming, page 16-16
- 16.9 Threshold Crossing Alert Suppression, page 16-17

16.1 Overview

CTC detects and reports alarms generated by the Cisco ONS 15454 and the larger 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-474-CORE standard, but you can set 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 DWDM Troubleshooting Guide.*

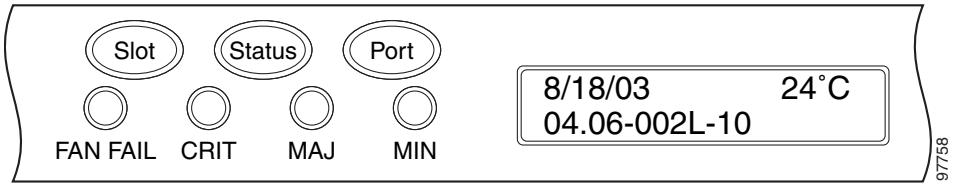
Note ONS 15454 alarms can also be monitored and managed through Transaction Language One (TL1) or a network management system (NMS).

16.2 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 16-1 shows the LCD panel layout.

Figure 16-1 Shelf LCD Panel



16.3 Alarm Display

In the card, node, or network CTC view, click the Alarms tab to display the alarms for that card, node, or network. The Alarms window shows alarms in compliance with Telcordia GR-253-CORE. 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.

The Path Width column in the Alarms and Conditions tabs expands on the alarmed object information contained in the access identifier (AID) string (such as "STS-4-1-3") by giving the number of STSs contained in the alarmed path. For example, the Path Width tells 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 16-1 lists the column headings and the information recorded in each column.

Table 16-1 Alarm Column Descriptions

Column	Information Recorded
Num	Sequence number of the original alarm. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Num**.)
Ref	Reference number of the original alarm. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Ref**.)
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	Shows the name of the node where the condition or alarm occurred. (Visible in network view.)

Table 16-1 Alarm Column Descriptions (continued)

Column	Information Recorded
Object	TL1 access identifier (AID) for the alarmed object; for an STSmon or VTmon, this is the monitored STS or VT.
Eqpt Type	If an alarm is raised on a card, the card type in this slot.
Slot	If an alarm is raised on a card, the slot where the alarm occurred [appears only in network and node view (single-shelf mode) or shelf view (multishelf mode)].
Port	If an alarm is raised on a card, the 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 complements the alarm object notation, which is explained in the *Cisco ONS 15454 DWDM Troubleshooting Guide*
Sev	Severity level: CR (Critical), MJ (Major), MN (minor), NA (Not Alarmed), NR (Not Reported).
ST	Status: R (raised), C (clear), T (transient).
SA	When checked, indicates a service-affecting alarm.
Cond	The error message/alarm name; these names are alphabetically defined in the *Cisco ONS 15454 DWDM Troubleshooting Guide.*
Description	Description of the alarm.

Table 16-2 lists the color codes for alarm and condition severities.

Table 16-2 Color Codes for Alarms and Condition Severities

Color	Description
Red	Raised Critical (CR) alarm
Orange	Raised Major (MJ) alarm
Yellow	Raised Minor (MN) alarm
Magenta (pink)	Raised Not Alarmed (NA) condition
Blue	Raised Not Reported (NR) condition
White	Cleared (C) alarm or condition

16.3.1 Viewing Alarms by Time Zone

By default, alarms and conditions are displayed with the time stamp of the CTC workstation where you are viewing them. However, you can set the node to report alarms (and conditions) using the time zone where the node is located.

16.3.2 Controlling Alarm Display

You can control the display of the alarms shown on the Alarms window. Table 16-3 shows the actions you can perform in the Alarms window.

Table 16-3 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, or reflect specific conditions. For example, you can set the filter so that only critical alarms display in the window. If you enable the Filter feature by clicking the Filter button in one CTC view, such as node view (single-shelf mode) or shelf view (multishelf mode), 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, from the view, 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.

16.3.3 Filtering Alarms

The alarm display can be filtered to prevent display of alarms with certain severities or alarms that occurred between certain dates and times. 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 you log in.

16.3.4 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 LOF and 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 the “Exclude Same Root Cause” 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 DWDM Troubleshooting Guide* for more information about alarm and condition classifications.

16.3.5 Controlling the Conditions Display

You can control the display of the conditions on the Conditions window. Table 16-4 shows the actions you can perform in the window.

Table 16-4 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 frame. For example, you can set the filter so that only critical conditions display on the window. There is a Filter button on the lower-right of the window that allows you to enable or disable the filter feature.
Exclude Same Root Cause	Retrieves conditions that obey a root-cause hierarchy (LOS supersedes and replaces LOF).

16.3.5.1 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 CTC view. For example, if you click the button while displaying the node view (single-shelf mode) or shelf view (multishelf mode), node-specific conditions appear. If you click the button while displaying the network view, all conditions for the network (including ONS 15454 nodes and other connected nodes) appear, 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.

16.3.5.2 Conditions Column Descriptions

Table 16-5 lists the Conditions window column headings and the information recorded in each column.

Table 16-5 Conditions Column Description

Column	Information Recorded
Date	Date and time of the condition.
Node	Shows the name of the node where the condition or alarm occurred. (Visible in network view.)
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.
Path Width	Width of the data path.

Table 16-5 Conditions Column Description (continued)

Column	Information Recorded
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 *Cisco ONS 15454 DWDM Troubleshooting Guide.*
Description	Description of the condition.

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.

16.3.5.3 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.

16.3.6 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 > Shelf window. You can view network-level alarm and condition history, such as for circuits, for all the nodes visible in network view. At the node level, you can see all port (facility), card, STS, and system-level history entries for that node. 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.

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 (single-shelf mode) or shelf view (multishelf mode), and card view. It shows alarms and conditions that occurred during the current user CTC session.
- The History > Shelf window is only shown in node view (single-shelf mode) or shelf view (multishelf mode). 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 (single-shelf mode) or shelf view (multishelf mode).

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.

16.3.6.1 History Column Descriptions

Table 16-6 lists the History window column headings and the information recorded in each column.

Table 16-6 History Column Description

Column	Information Recorded
Num	Num (number) is the quantity of alarm messages received, and is incremented automatically as alarms occur to display the current total of received error messages. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Num**.)
Ref	Ref (reference) is a unique identification number assigned to each alarm to reference a specific alarm message that is displayed. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Ref**.)
Date	Date and time of the condition.
Node	Shows the name of the node where the condition or alarm occurred. (Visible in network view.)
Object	TL1 AID for the condition object. For an STSmon or VTmon, the object.
Slot	Slot where the condition occurred [only displays in network view and node view (single-shelf mode) or shelf view (multishelf mode)].
Port	Port where the condition occurred. For STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Path Width	Width of the data path.
Sev	Severity level: Critical (CR), Major (MJ), Minor (MN), Not Alarmed (NA), Not Reported (NR).
ST	Status: raised (R), cleared (C), or transient (T).
SA	Indicates a service-affecting alarm (when checked).
Cond	Condition name.
Description	Description of the condition.
Eqpt Type	Card type in this slot.

16.3.6.2 Retrieving and Displaying Alarm and Condition History

You can retrieve and view the history of alarms and conditions, including transient conditions (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 (single-shelf mode) or shelf view (multishelf mode), and card history in the card view).

The node and card history views are each divided into two tabs. In node view (single-shelf mode) or shelf view (multishelf mode), 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.

16.3.7 Alarm History and Log Buffer Capacities

The ONS 15454 alarm history log, stored in the TCC2/TCC2P RSA memory, contains four categories of alarms. These include:

- CR severity alarms
- MJ severity alarms
- MN severity alarms
- the combined group of cleared, Not Alarmed severity, and Not Reported severity alarms

Each category can store between 4 and 640 alarm chunks, or entries. In each category, when the upper limit is reached, the oldest entry in the category is deleted. The capacity is not user-provisionable.

CTC also has a log buffer, separate from the alarm history log, that pertains to the total number of entries displayed in the Alarms, Conditions, and History windows. The total capacity is provisionable up to 5,000 entries. When the upper limit is reached, the oldest entries are deleted.

16.4 Alarm Severities

ONS 15454 alarm severities follow the Telcordia GR-474-CORE standard, so a condition might be Alarmed (at a severity of Critical [CR], Major [MJ], or Minor [MN]), 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-474-CORE 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 "16.5 Alarm Profiles" section on page 16-9.) 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 (the side not carrying traffic)
- If the alarmed entity has no traffic provisioned on it, 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.

16.5 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.

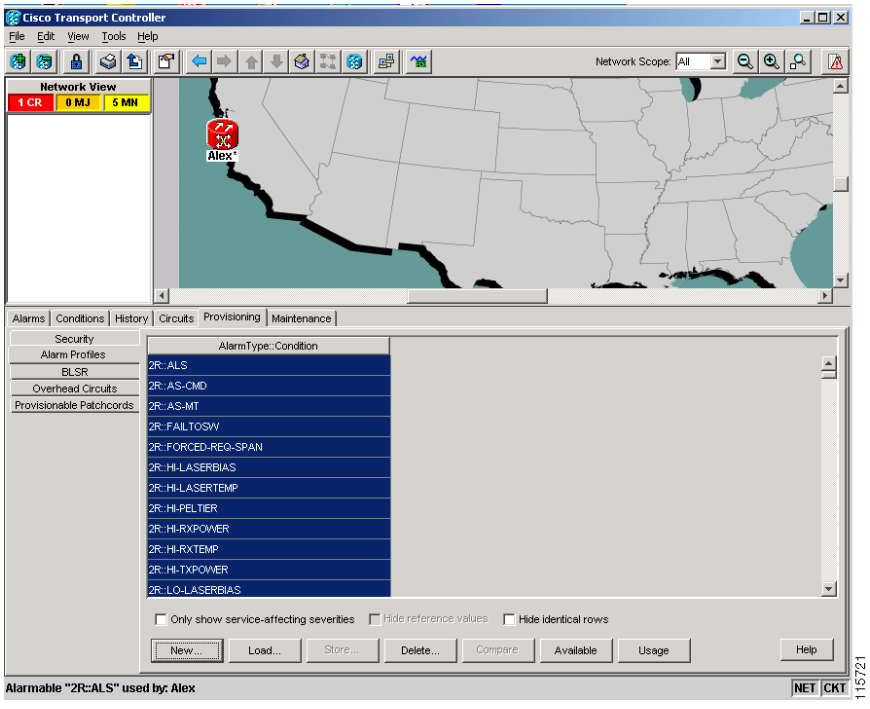
CTC can store up to ten active alarm profiles at any time to apply to the node. Custom profiles can take eight of these active profile positions. Two other profiles, Default profile and Inherited profile, are reserved by the NE, and cannot be edited.The reserved Default profile contains Telcordia GR-474-CORE 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.

16.5.1 Creating and Modifying Alarm Profiles

Alarm profiles are created in the network view using the node view (single-shelf mode) or shelf view (multishelf mode) Provisioning > Alarm Profiles tabs. Figure 16-2 shows the default list of alarm severities. A default alarm severity following Telcordia GR-474-CORE standards is preprovisioned for every alarm. After loading the default profile or another profile on the node, you can clone a profile 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 16-2 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-474-CORE.

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-CORE.

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-474-CORE 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.

The Load and Store buttons are not available for Retrieve and Maintenance users.

The Delete and Store options will only display nodes to delete profiles from or store profiles to if the user has provisioning permission for those nodes. If the user does not have the proper permissions, CTC greys out the buttons and they are not available to the user.

16.5.2 Alarm Profile Buttons

The Alarm Profiles window displays six buttons at the bottom of the screen. Table 16-7 lists and describes each of the alarm profile buttons and their functions.

Table 16-7 Alarm Profile Buttons

Button	Description
New	Creates a new profile.
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.

16.5.3 Alarm Profile Editing

Table 16-8 lists and describes the five profile-editing options available when you right-click an alarm item in the profile column (such as Default).

Table 16-8 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.

16.5.4 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)
- Use Default
- Inherited

Inherited and Use Default severity levels only appear in alarm profiles. They do not appear when you view alarms, history, or conditions.

16.5.5 Row Display Options

In the network or node view (single-shelf mode) or shelf view (multishelf mode), the Alarm Profiles window (Alarm Profile Editor for node view) displays three check boxes at the bottom of the window:

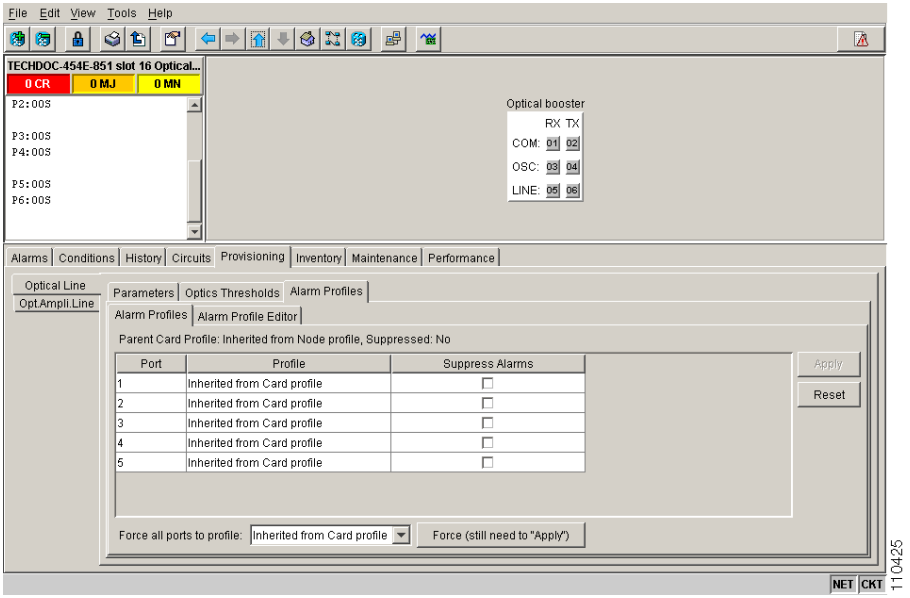
- Only show service-affecting severities—If unchecked, the editor shows severities in the format *sev1/sev2* where *sev1* is a service-affecting severity and *sev2* is not service-affecting. If checked, the editor only shows *sev1* alarms.
- Hide reference values—Highlights alarms with nondefault severities by clearing alarm cells with default severities.
- Hide identical rows—Hides rows of alarms that contain the same severity for each profile.

16.5.6 Applying Alarm Profiles

In CTC node view (single-shelf mode) or shelf view (multishelf mode), 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 16-3 shows alarm profiles for an OPT-BST card.

Figure 16-3 OPT-BST Card Alarm Profiles



16.6 External Alarms and Controls

External alarm inputs can be provisioned on the Alarm Interface Controller–International (AIC-I) card 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.

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), there are 32 inputs and 16 outputs. The AEP is compatible with the ONS 15454 ANSI shelf only. It is not compatible with the ONS 15454 ETSI shelf.

16.6.1 External Alarms

You can provision each alarm input separately. Provisionable characteristics of external alarm inputs include:

- Alarm Type—List of alarm types.
- Severity—CR, MJ, MN, NA, and NR.
- Virtual Wire—The virtual wire associated with the alarm.
- Raised When—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 when current stops flowing.
- Description—CTC alarm log description (up to 63 characters).

Note If you provision an external alarm to raise when a contact is open, and you have not attached the alarm cable, the alarm will remain raised until the alarm cable is connected.

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.

16.6.2 External Controls

You can provision each alarm output separately. Provisionable characteristics of alarm outputs include:

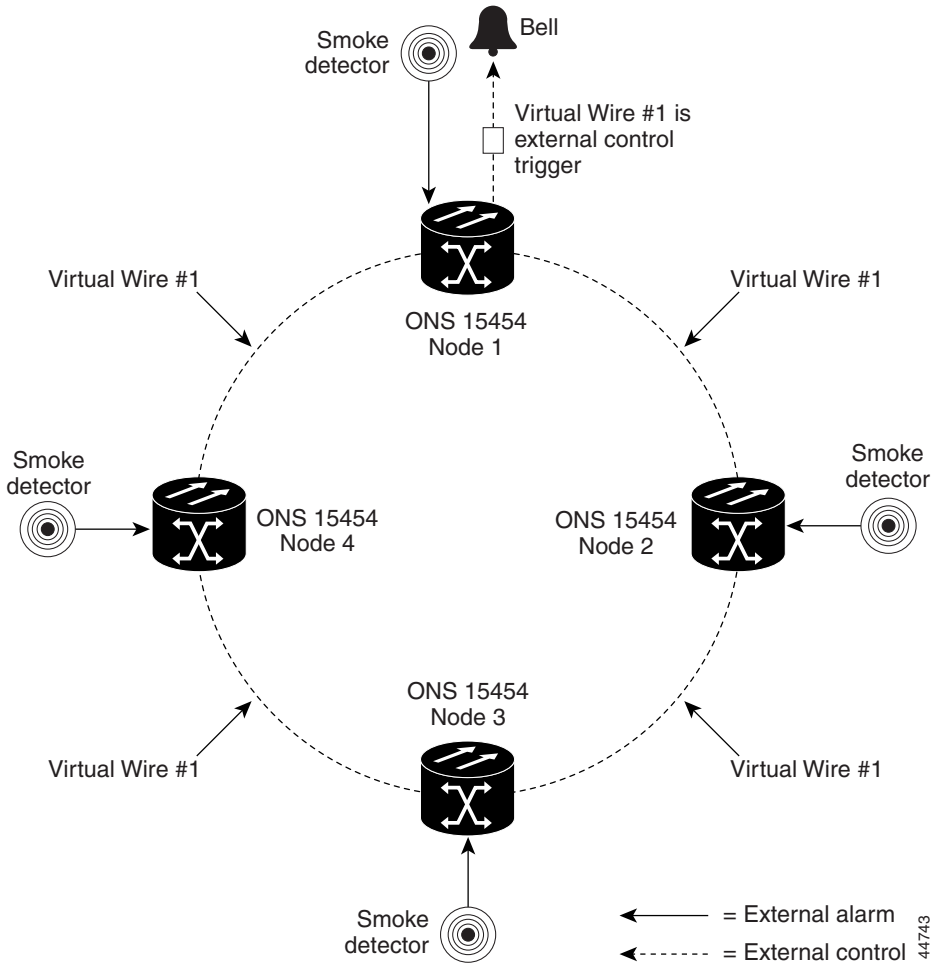
- Control type.
- Trigger type (alarm or virtual wire).
- Description for CTC display.
- Closure setting (manually or by trigger). If you provision the output closure to be triggered, the following characteristics can be used as triggers:
  - Local NE alarm severity—A chosen alarm severity (for example, 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.

16.6.3 Virtual Wires

Provisioning the AIC and AIC-I card provides a "virtual wires" option used to route external alarms and controls from different nodes to one or more alarm collection centers. In Figure 16-4, smoke detectors at Nodes 1, 2, 3, and 4 are assigned to Virtual Wire #1, and Virtual Wire #1 is provisioned as the trigger for an external bell at Node 1.

Figure 16-4 External Alarms and Controls Using a Virtual Wire



When using AIC virtual wires, you can:

- Assign different external devices to the same virtual wire.
- Assign virtual wires as the trigger type for different external controls.

16.7 Alarm Suppression

The following sections explain alarm suppression features for the ONS 15454.

16.7.1 Alarms Suppressed for Maintenance

When you place a port in OOS,MT administrative state, this raises the alarm suppressed for maintenance (AS-MT) alarm in the Conditions and History windows and causes subsequently raised alarms for that port to be suppressed.

Note AS-MT can be seen in the Alarms window as well if you have set the Filter dialog box to show NA severity events.

While the facility is in the OOS,MT state, any alarms or conditions that are raised and suppressed on it (for example, a transmit failure [TRMT] alarm) are reported in the Conditions window and show their normal severity in the Sev column. The suppressed alarms are not shown in the Alarms and History windows. (These windows only show AS-MT). When you place the port back into IS,AINS administrative state, the AS-MT alarm is resolved in all three windows. Suppressed alarms remain raised in the Conditions window until they are cleared.

16.7.2 Alarms Suppressed by User Command

In the node view (single-shelf mode) or shelf view (multishelf mode) Provisioning > Alarm Profiles tabs > Alarm Behavior tabs, the ONS 15454 has an alarm suppression option that clears raised alarm messages for the node, chassis, one or more slots (cards), or one or more ports. Using this option raises the alarms suppressed by user command, or AS-CMD alarm. The AS-CMD alarm, like the AS-MT alarm, appears in the Conditions, and History windows. Suppressed conditions (including alarms) appear only in the Conditions window--showing their normal severity in the Sev column. When the Suppress Alarms check box is unchecked, the AS-CMD alarm is cleared from all three windows.

Note AS-MT can be seen in the Alarms window as well if you have set the Filter dialog box to show NA severity events.

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.

Caution 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.

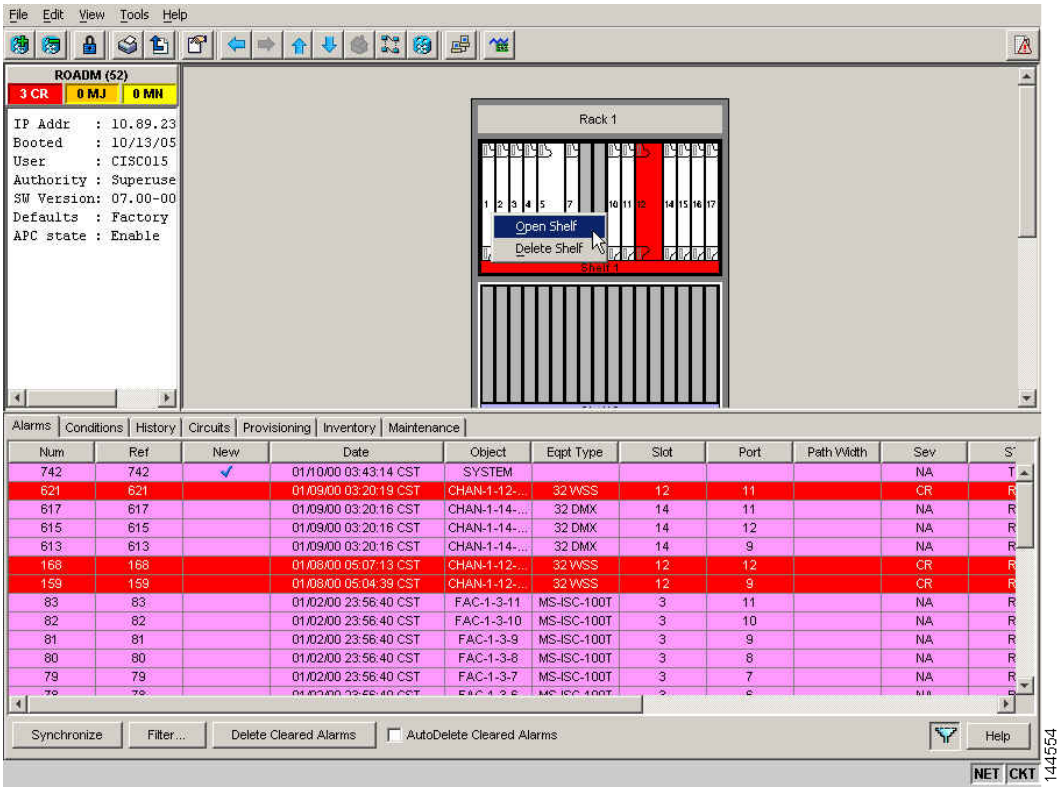
16.8 Multishelf Configuration Alarming

Multishelf systems can share a single IP address among shelves and also correlate optical signal alarms. Ethernet alarm-raising for this configuration also differs from alarm-raising for single-shelf configurations. This section explains how alarms are viewed on a multishelf configuration, how alarm locations are determined, and how multishelf alarming differs from single-shelf alarming.

16.8.1 Viewing Multishelf Alarmed Entities

The multishelf view in CTC shows which slots are occupied in each shelf of the configuration (Figure 16-5).

Figure 16-5 Navigating to Shelf View from Multishelf View



You can determine where an alarm is raised by viewing the Object column. The entry there (for example, FAC-1-3-1) tells you the entity ("fac," or facility), shelf, slot, and port. In shelf view, the Alarms and Conditions tabs also contain a Shelf column that indicates where the alarmed card is located.

16.8.2 Multishelf-Specific Alarming

The following sections explain how Ethernet communication alarms and correlated multishelf alarms are processed in the ONS 15454 DWDM system.

16.8.2.1 Ethernet Communication Alarms

The Ethernet interface card (MS-ISC) that is required for multishelf configurations does not raise traditional Ethernet alarms, such as CARLOSS, that apply to transponder (TXP) or muxponder (MXP) client ports. Instead, MS-ISC card alarms are raised on the shelf as EQPT alarms. These alarms include Duplicate Shelf ID (DUP-SHELF-ID) and Shelf Communication Failure (SHELF-COMM-FAIL).

16.8.2.2 Multishelf Correlated Alarms

ITU-T G.798-based alarm correlation simplifies alarm reporting for DWDM channels. Communication failures including Loss of Signal (LOS), Loss of Signal Payload (LOS-P), and Optical Power Receive Fail-Loss of Light (OPWR-LFAIL) generate multiple conditions at each affected node and channel. Correlation simplifies troubleshooting because a single alarm is reported for each root cause. (The original alarms retain their severity in the Conditions window.)

The Payload Missing Indication (PMI) condition is raised at the far end to correlate optical multiplex section (OMS) and optical transmission section (OTS) communication failures. A single PMI condition is sent when every channel on the aggregated port is lost, that is, when there are no pass-through channels or active added channels in service. If there are added channels on the node, the Forward Defect Indication (FDI) condition is raised at the near end to indicate there are no pass-through optical channels (OCH) in service.

16.9 Threshold Crossing Alert Suppression

This section describes threshold crosssing alert (TCA) suppression on TXP and MXP cards when they are installed in a DWDM node.

16.9.1 Overview

Threshold default settings define the default cumulative values (thresholds) beyond which a TCA will be raised. TCAs make it possible to monitor the network and detect errors early.

The following thresholds are monitored for TXP and MXP cards:

- Optical Thresholds
- ITU-T G.709 Thresholds
- SONET and SDH Thresholds
- FEC Thresholds

Threshold defaults are defined for near end and/or far end and at 15-minute or one-day intervals.

When LOS-P, LOS, or LOF alarms occur on the TXP./MXP cards, different TCAs are suppressed. Which TCAs are suppressed by an alarm depends on how the trunk is configured (ITU-T G.709, SONET, or SDH). The reason for suppressing the TCAs after the alarm occurs is to prevent a flood of TCAs after a system failure.

TCA suppression does not extend to optical thresholds such as OPR (optical power received). Optical threshold TCAs can effectively be suppressed by setting their thresholds to the maximum value.TCA suppression also does not extend to client ports; it only applies to TXP and MXP trunk ports when they are configured as ITU-T G.709, SONET, or SDH. TCA suppression does not extend to 10GE payloads.

Note Suppressed TCAs are not reported as Not Reported (NR) conditions. As a result, suppressed TCAs do not appear in the CTC Conditions tab and they cannot be retrieved with the RTRV-COND TL1 command.

16.9.2 G.709, SONET, and SDH TCA Groups

This section lists the TCAs that are suppressed for each alarm. TCA suppression is determined by how framing is configured for TXP and MXP trunks.

Table 16-9 lists the TCAs for each type of trunk framing and alarm.

Table 16-9 TCA Suppression Groups

Alarm	TXP/MXP Trunk Framing	TCA Suppressed
LOS-P and LOF	G.709	BBE-SM
		ES-SM
		SES-SM
		UAS-SM
		FC-SM
		ESR-SM
		SESR-SM
		BBER-SM
		BBE-PM
		ES-PM
		SES-PM
		UAS-PM
		FC-PM
		ESR-PM
		SESR-PM
		BBER-PM
		BIT-EC
		UNC-WORDS

Table 16-9 TCA Suppression Groups (continued)

Alarm	TXP/MXP Trunk Framing	TCA Suppressed
LOS or LOF	SONET	ES-S
		SES-S
		SEFS-S
		CV-S
		ES-L
		SES-L
		UAS-L
		CV-L
		FC-L
LOS or LOF	SDH	RS-ES
		RS-ESR
		RS-SES
		RS-SESR
		RS-BBR
		RS-BBER
		RS-UAS
		RS-EB
		MS-ES
		MS-ESR
		MS-SES
		MS-SESR
		MS-BBR
		MS-BBER
		MS-UAS
		MS-EB

CHAPTER 17

Performance Monitoring

Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds for, and report performance data for early detection of problems. In this chapter, PM parameters and concepts are defined for transponder, muxponder, and dense wavelength division multiplexing (DWDM) cards in the Cisco ONS 15454 including optical amplifier, multiplexer, demutiplexer, optical add/drop multiplexer (OADM), and optical service channel (OSC) cards.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

For information about enabling and viewing PM values, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Chapter topics include:

- 17.1 Threshold Performance Monitoring, page 17-2
- 17.2 Transponder and Muxponder Card Performance Monitoring, page 17-2
- 17.3 DWDM Card Performance Monitoring, page 17-16
- 17.4 Optics and 8b10b PM Parameter Definitions, page 17-20
- 17.5 ITU G.709 and ITU-T G.8021 Trunk-Side PM Parameter Definitions, page 17-21
- 17.6 Full RMON Statistics PM Parameter Definitions, page 17-23
- 17.7 FEC PM Parameter Definitions, page 17-25
- 17.8 SONET PM Parameter Definitions, page 17-26
- 17.9 SDH PM Parameter Definitions, page 17-27
- 17.10 Pointer Justification Count Performance Monitoring, page 17-29

Note For additional information regarding PM parameters, refer to ITU G.826, ITU-T G.8021, ITU G.709, Telcordia documents GR-1230-CORE, GR-820-CORE, GR-499-CORE, and GR-253-CORE, and the ANSI T1.231 document entitled *Digital Hierarchy - Layer 1 In-Service Digital Transmission Performance Monitoring*.

17.1 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 about provisioning card thresholds, such as line and path thresholds, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

During the accumulation cycle, if the current value of a PM parameter reaches or exceeds its corresponding threshold value, a threshold crossing alert (TCA) is generated by the node and is 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 zero is entered as the threshold value, generation of TCAs is disabled but performance monitoring continues.

Note Due to memory limitations and the number of TCAs generated by different platforms, you can manually add or modify the following two properties to the platform property file (CTC.INI for Windows and .ctcrc for UNIX) to fit the need:

- **ctc.15***xxx***.node.tr.lowater=***yyy* (where *xxx* is platform and *yyy* is the number of the lowater mark. The default lowater mark is 25.)
- **ctc.15***xxx***.node.tr.hiwater=***yyy* (where *xxx* is platform and *yyy* is the number of the hiwater mark. The default hiwater mark is 50.)

If the number of the incoming TCA is greater than the hiwater mark, the node will keep the latest lowater mark and discard older ones.

Change the threshold if the default value does not satisfy your error monitoring needs. For example, customers with a critical OC192/STM64 transponder installed for 911 calls must guarantee the best quality of service on the line; therefore, they lower all thresholds on the client side so that the slightest error raises a TCA.

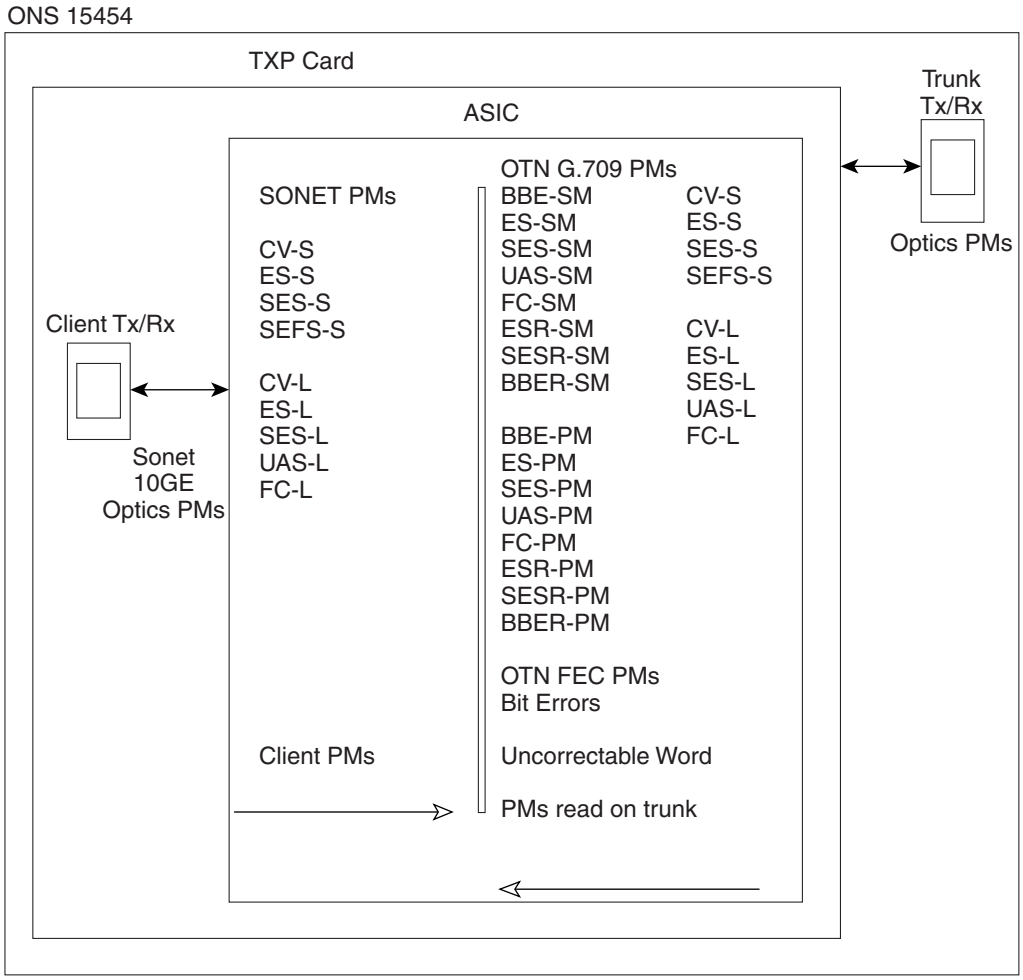
Note When LOS, LOS-P, or LOF alarms occur on TXP and MXP trunks, ITU-T G.709/SONET/SDH TCAs are suppressed. For details, see Chapter 16, "Alarm and TCA Monitoring and Management."

17.2 Transponder and Muxponder Card Performance Monitoring

This section lists PM parameters for transponder cards (TXP_MR_10G, TXP_MR_2.5G, TXPP_MR_2.5G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L), muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_2.5G, MXPP_MR_2.5G, MXP_MR_10DME-C, and MXP_MR_10DME-L), GE_XP, 10GE_XP, and ADM-10G cards. The transponder and muxponder PM parameters are divided into Optics PM, Payload PM, and OTN PM tabs. The tabs displayed vary depending on the card installed. For more information, see the "17.2.1 Optics PM Window" section on page 17-4, the "17.2.2 Payload PM Window" section on page 17-5, or the "17.2.3 OTN PM Window" section on page 17-10.

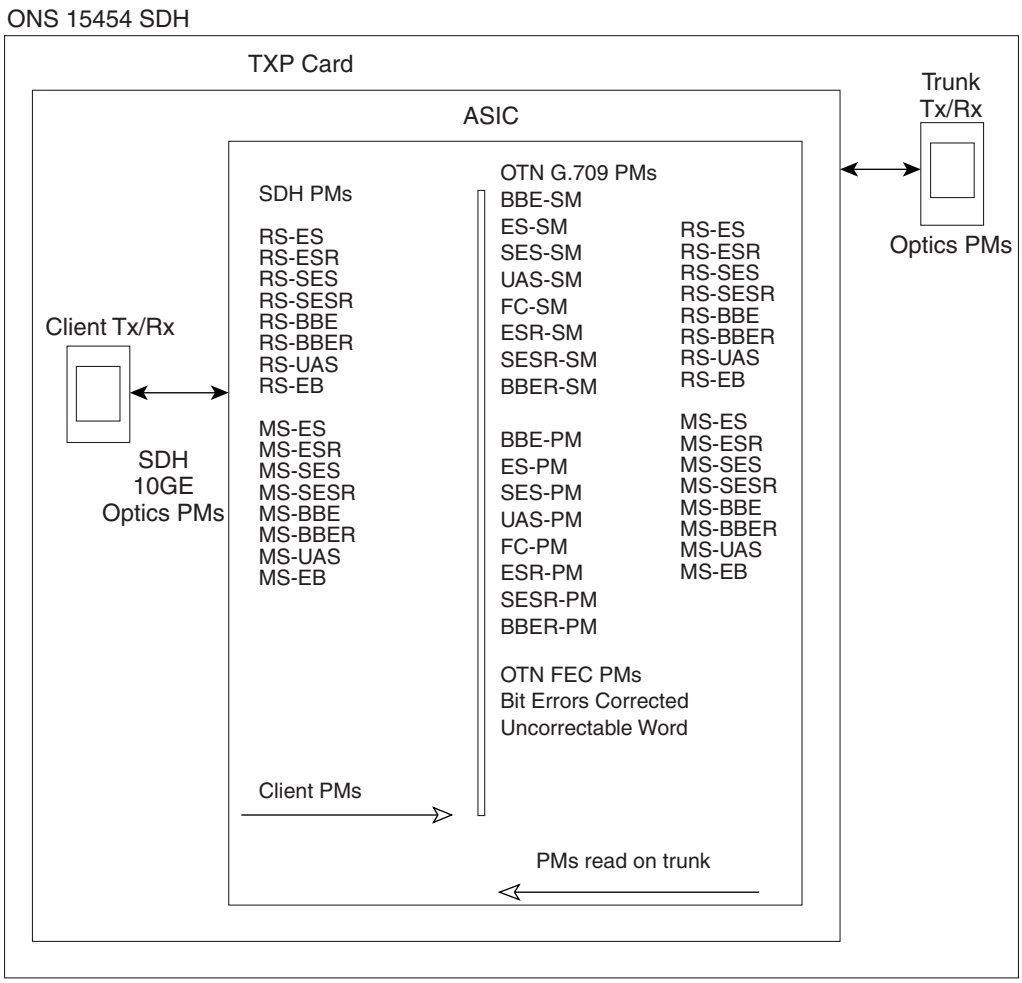
For ONS 15454 ANSI nodes, Figure 17-1 shows where overhead bytes detected on the application-specific integrated circuits (ASICs) produce PM parameters for the TXP_MR_10G card. The remaining transponder and muxponder cards perform similarly to this illustration.

Figure 17-1 ONS 15454 ANSI Node PM Read Points for TXP_MR_10G Card



For ONS 15454 ETSI nodes, Figure 17-2 shows where overhead bytes detected on the ASICs produce PM parameters for the TXP_MR_10G card. The remaining transponder and muxponder cards perform similarly to this illustration.

Figure 17-2 ONS 15454 ETSI Node PM Read Points on TXP_MR_10G Cards



17.2.1 Optics PM Window

The Optics PM window lists parameters at the trunk and client side for all transponder, muxponder, GE_XP and 10GE_XP cards. The Optics PM window provides buttons to change the statistical values shown. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs. In the Historical PM subtab, the Clear button sets the values on the card to zero. All counters on the card are cleared. The Help button activates context sensitive help. Table 17-1 lists the trunk-side and client-side optics PM parameters.

Table 17-1 Trunk-Side and Client-Side Optics PM Parameters

Trunk-Side/Client-Side Optics PM Parameters	Definition
Laser Bias (Avg,%)	Average Laser Bias Current (Laser Bias Avg) is the average percentage of laser bias current during the PM time interval.
Laser Bias (Max,%)	Maximum Laser Bias Current (Laser Bias Max) is the maximum percentage of laser bias current during the PM time interval.
Laser Bias (Min,%)	Minimum Laser Bias Current (Laser Bias Min) is the minimum percentage of laser bias current during the PM time interval.
Link Status	Indicates if the Fibre Channel link is receiving a valid Fibre Channel signal (carrier) from the attached Fibre Channel device. Up means present, and down means not present.
Rx Optical Pwr (Min,dBm)	Minimum Receive Optical Power (Rx Optical Pwr Min, dBm) is the minimum received optical power during the PM time interval.
Rx Optical Pwr (Avg,dBm)	Average Receive Optical Power (Rx Optical Pwr Avg, dBm) is the average received optical power during the PM time interval.
Rx Optical Pwr (Max,dBm)	Maximum Receive Optical Power (Rx Optical Pwr Max, dBm) is the maximum received optical power during the PM time interval.
Tx Optical Pwr (Min,dBm)[1]	Minimum Transmit Optical Power (Tx Optical Pwr Min, dBm) is the minimum optical power transmitted during the PM time interval.
Tx Optical Pwr (Avg,dBm)[1]	Average Transmit Optical Power (Tx Optical Pwr Avg, dBm) is the average optical power transmitted during the PM time interval.
Tx Optical Pwr (Max,dBm)[1]	Maximum Transmit Optical Power (Tx Optical Pwr Max, dBm) is the maximum optical power transmitted during the PM time interval.

1. On the trunk side, this PM is not available for the following cards: TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, and MXPP_MR_2.5G.

17.2.2 Payload PM Window

The Payload PM window subtabs change depending on the card provisioning. For more information about provisioning TXP and MXP cards, refer to the "Provision Transponder and Muxponder Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*. Possible Payload PM subtabs are: SONET, SDH, Statistics, Utilization, and History. The following buttons function the same on all of the tabs. Not all tabs have all of these buttons.

- The Refresh button manually refreshes statistics.
- Auto-Refresh sets a time interval at which automatic refresh occurs.
- The Baseline button resets the displayed statistics values to zero.
- (Statistics window only) The Clear button allows you to set the values to zero for displayed statistics, all statistics for a port, and all statistics for all optical ports on a card.

- The Help button activates context sensitive help.

For a list of the payload PM provisioning options for all transponder and muxponder cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. The options selected in the Provisioning tab can affect the parameters displayed in the Performance > Payload PM tab.

Table 17-2 lists the PM parameter types that appear when a particular port type is provisioned for a transponder or muxponder card.

Table 17-2 Transponder and Muxponder Port Type PM Provisioning Options

If this Port Type is Provisioned[1]	The Following PM Types are Activated[2]
SONET/SDH (including 10G Ethernet WAN Phy) OC3/STM1 OC12/STM4 OC48/STM16	SONET or SDH PMs
10G Ethernet LAN Phy 10G FiberChannel ONE_GE FC1G FC2G FC1G ISL FC2G ISL FICON1G FICON2G FICON1G ISL FICON2G ISL ISC COMPAT ISC PEER	Full remote monitoring (RMON) statistics
ESCON DV6000 SDI_D1_VIDEO HDTV PASS_THRU ETR_CLO	Payload PMs are not applicable to 2R port types.

1. The port type is provisioned from card view on the Provisioning > Pluggable Port Modules tab. For pluggable port module (PPM) provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.
2. Performance monitoring parameters are displayed from the card view on the Performance tab.

17.2.2.1 Payload PM SONET/SDH Window

Table 17-3 lists SONET/SDH layer near-end and far-end PM parameters listed in the card view on the Performance > Payload PM > SONET or SDH tab. SONET/SDH layer PMs are available when the client type is set to OC3/STM1, OC12/STM4, or OC48/STM16 on the TXP_MR_2.5G or when OC192/STM64 is set on the TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, or ADM-10G on ONS 15454 SONET nodes. OC48/STM16 trunk PMs are available on MXP_MR_2.5G and MXPP_MR_2.5G cards on ONS 15454 SONET or ONS 15454 SDH nodes. OC48/STM16 client PMs are available on MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, and MXP_2.5G_10E_L cards on ONS 15454 SONET or ONS 15454 SDH nodes. For PM definitions, see Table 17-29 on page 17-26 and Table 17-30 on page 17-27.

Table 17-3 ONS 15454 SONET/SDH Layer Far-End and Near-End PMs

	Layer Far-End (FE)[1, 2]	Layer Near-End[1, 2]	Note
SONET	CV-LFE ES-LFE FC-LFE SES-LFE UAS-LFE	CV-L CV-S ES-L ES-S FC-L SES-L SES-S SEF-S UAS-L	Applicable standard is Telcordia GR-253.
SDH	MS-BBE MS-BBER MS-EB MS-ES MS-ESR MS-SES MS-SESR MS-UAS	RS-BBE RS-BBER RS-EB RS-ES RS-ESR RS-SES RS-SESR RS-UAS MS-BBE MS-BBER MS-EB MS-ES MS-ESR MS-SES MS-SESR MS-UAS	Applicable standard is Telcordia GR-253.

1. Applicable to optical channel (OCH) and Client (CLNT) facilities.
2. For MXP_MR_2.5G and MXPP_MR_2.5G cards, these parameters are shown in the Performance > Payload PM > SONET PM tabs in the card view.

17.2.2.2 Payload PM Statistics Window

Table 17-4 lists the 10 Gigabit Ethernet (10 GE) payload statistics that are available on the TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards. PPM provisioning must be completed under the card view Provisioning > Pluggable Port Modules tab for 10 GE to be enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. The parameters are listed under card view on the Performance > Payload PM > Statistics tab. For 10 GE payload definitions, see Table 17-27 on page 17-23.

Note Utilization PMs are also available per port.

Table 17-4 Full RMON Statistics on TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, GE_XP, and 10GE_XP cards

Full RMON Statistics	
dot3StatsFCSErrors	etherStatsBroadcastPkts
dot3StatsFrameTooLong	etherStatsCRCAlignErrors
ifInBroadcastPkts	etherStatsFragments
ifInErrors	etherStatsJabbers
ifInErrorsBytePkts	etherStatsMulticastPkts
ifInFramingErrorPkts	etherStatsOctets
ifInJunkInterPkts	etherStatsOversizePkts
ifInMulticastPkts	etherStatsPkts64Octets
ifInOctets	etherStatsPkts65to127Octets
ifOutBroadcastPkts	etherStatsPkts128to255Octets
ifOutMulticastPkts	etherStatsPkts256to511Octets
ifOutOctets	etherStatsPkts512to1023Octets
rxTotalPkts	etherStatsPkts1024to1518Octets
Time Last Cleared	etherStatsUndersizePkts
txTotalPkts	rxControlFrames
	rxPauseFrames
	rxUnknownOpcodeFrames

Table 17-5 lists the payload PM parameters that are available on the TXP_MR_2.5G and the TXPP_MR_2.5G cards when the ONE_GE or FC1G client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20 and the "17.6 Full RMON Statistics PM Parameter Definitions" section on page 17-23.

Note Payload PM is not available for the 2FC client type.

Table 17-5 Gigabit Ethernet (GE) or Fibre Channel (FC) Payload PMs for the TXP_MR_2.5G and TXPP_MR_2.5G Cards

GE or FC Payload Performance Parameters
8b/10bDataOrderedSets
8b/10bIdleOrderedSets
8b/10bNonIdleOrderedSets
8b/10bStatsEncodingDispErrors
ifInErrors
rxTotalPkts

Table 17-6 lists the payload PM parameters that are available on the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the ONE_GE or the FC1G client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20 and the "17.6 Full RMON Statistics PM Parameter Definitions" section on page 17-23.

Table 17-6 ONE_GE or FC1G Payload PMs for the MXP_MR_2.5G and MXPP_MR_2.5G Cards

ONE_GE or FC1G Payload Performance Parameters
8b10bInvalidOrderedSets
8b10bStatsEncodingDispErrors
ifInDiscards
ifInErrors
ifInOctets
ifOutDiscards
ifOutOctets
mediaIndStatsRxFramesBadCRC
mediaIndStatsRxFramesTooLong
mediaIndStatsRxFramesTruncated
mediaIndStatsTxFramesBadCRC
rxTotalPkts
txTotalPkts

Table 17-7 lists the FC client-side payload PM parameters. FC payload PMs are available on the FC port on both the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the FC1G client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "17.6 Full RMON Statistics PM Parameter Definitions" section on page 17-23.

Table 17-7 FC1G Payload PMs on the Client Side

FC1G Payload PMs on the Client Port
fcStatsLinkRecoveries
fcStatsRxCredits
fcStatsTxCredits
fcStatsZeroTxCredits
gfpStatsRoundTripLatencyUSec
gfpStatsRxDistanceExtBuffers
gfpStatsTxDistanceExtBuffers

Table 17-8 lists the Transparent Generic Framing Procedure (GFP-T) payload PMs. The GFP-T payload PMs are available on the GFP port on both the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the ONE_GE or the 1 FC client type is enabled. GFP-T payload PMs are also available on the client port on both the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the 1 FC client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "17.6 Full RMON Statistics PM Parameter Definitions" section on page 17-23.

Table 17-8 GFP-T Payload PMs

GFP-T Payload PMs on the GFP Port
gfpStatsCSFRaised
gfpStatsLFDRaised
gfpStatsRxCRCErrors
gfpStatsRxMBitErrors
gfpStatsRxSBitErrors
gfpStatsRxTypeInvalid

17.2.2.3 MXP_MR_2.5G/MXPP_MR_2.5G Payload Utilization Window

The Payload PM Utilization window in the card view Performance > Payload> Utilization tab shows the percentage of transmit (Tx) and receive (Rx) line bandwidth used by the ports during consecutive time segments. This tab cannot be viewed unless the appropriate PPM port type is provisioned. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. The Utilization window provides an Interval list that enables you to set time intervals of 15 minutes or 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 port (that is, 1 Gbps). The maxBaseRate for MXP_MR_2.5G and MXPP_MR_2.5G cards is shown for the ONS 15454 nodes in Table 17-9.

Table 17-9 maxBaseRate for STS and VC Circuits

STS/VC	maxBaseRate
STS-1/VC3	51840000
STS-3c/VC4	155000000
STS-6c/VC4-2c	311000000
STS-12c/VC4-4c	622000000

Note Line utilization numbers express the average of ingress and egress traffic as a percentage of capacity.

17.2.2.4 Payload History Window

The Payload PM History window in the card view Performance > Payload > History tab lists past statistics for the previous time intervals. This tab cannot be viewed unless the appropriate PPM port type is provisioned. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. 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 17-10.

Table 17-10 History Statistics per Time Interval

Time Interval	Number of Intervals Displayed
15 minutes	32 (current and previous)
1 day (24 hours)	2 (current and previous)

17.2.3 OTN PM Window

The OTN tab has an ITU-T G.709 PM subtab and an FEC PM subtab. Both subtabs provide buttons to change the statistical values shown in the Performance tab. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs. The Baseline button resets the displayed statistics values to zero. 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. The Help button activates context sensitive help. For more information about provisioning optical transport network (OTN) settings, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Table 17-11 lists the OTN PM provisioning options for all transponder, muxponder, GE_XP, and 10GE_XP cards. The options selected in the Provisioning tab affects the parameters displayed in the Performance > OTN PM tab.

Table 17-11 Transponder and Muxponder PM Provisioning Options

Card	OTN Provisioning[1]
MXPP_MR_2.5G	—
MXP_2.5G_10E	G.709 FEC FEC Thresholds
MXP_2.5G_10E_C	G.709 FEC FEC Thresholds
MXP_2.5G_10E_L	G.709 FEC FEC Thresholds
MXP_2.5G_10G	G.709 FEC FEC Thresholds
MXP_MR_2.5G	—
MXP_MR_10DME_C	G.709 FEC FEC Thresholds
MXP_MR_10DME_L	G.709 FEC FEC Thresholds
TXPP_MR_2.5G	G.709 FEC FEC Thresholds
TXP_MR_10E	G.709 FEC FEC Thresholds
TXP_MR_10E_C	G.709 FEC FEC Thresholds
TXP_MR_10E_L	G.709 FEC FEC Thresholds
TXP_MR_10G	G.709 FEC FEC Thresholds

Table 17-11 Transponder and Muxponder PM Provisioning Options (continued)

Card	OTN Provisioning[1]
TXP_MR_2.5G	G.709 FEC FEC Thresholds
ADM-10G	G.709 FEC FEC Thresholds
GE_XP	G.709 FEC FEC Thresholds
10GE_XP	G.709 FEC FEC Thresholds

1. OTN provisioning is performed from card view on the Provisioning > OTN > OTN Lines, G.709 Thresholds, and FEC Thresholds tabs.

Table 17-12 lists the OTN trunk-side PM parameters listed on the G.709 tab. OTN PMs are available when ITU G.709 is enabled from the card view Provisioning > OTN > OTN Lines tab. OTN PMs are not available on MXP_MR_2.5G and MXPP_MR_2.5G cards. For ITU G.709 section and path monitoring PM definitions, see the "17.5 ITU G.709 and ITU-T G.8021 Trunk-Side PM Parameter Definitions" section on page 17-21.

Table 17-12 ITU G.709 OTN Trunk-Side PMs

OTN Layer (Near End and Far End)[1]	Note
BBE-SM BBER-SM ES-SM ESR-SM FC-SM SES-SM SESR-SM UAS-SM FC-SM	ITU G.709 standard section monitoring ITU-T G.8021
BBE-PM BBER-PM ES-PM ESR-PM FC-PM SES-PM SESR-PM UAS-PM	ITU G.709 standard path monitoring ITU-T G.8021

1. Applicable to OCH facility.

Table 17-13 lists the forward error correction (FEC) PM parameters. FEC PMs are available when ITU-T G.709 is enabled and FEC is set to standard or enhanced. These parameters are provisioned from the card view Provisioning > OTN > OTN Lines tab. FEC PMs are not available on MXP_MR_2.5G and MXPP_MR_2.5G cards. For PM definitions, see the "17.7 FEC PM Parameter Definitions" section on page 17-25.

Table 17-13 FEC OTN Trunk-Side PMs

FEC Trunk-Side PMs	FEC (Near End)[1]
Bit Errors	BIT-EC
Uncorrectable Words	UNC-WORDS

1. Applicable to OCH facility.

Table 17-14 lists ONS 15454 optics and 8b10b PM parameters. For ONS 15454 optics and 8b10b definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

Table 17-14 ONS 15454 Optics and 8b10b PMs

Optics (Near End)[1]	8B10B (Near End)[2]
LBCL-AVG	CGV
LBCL-MAX	DCG
LBCL-MIN	IOS
OPT-AVG	IPC
OPT-MAX	NIOS
OPT-MIN	VPC
OPR-AVG	
OPR-MAX	
OPR-MIN	

1. The TXP_MR_2.5G and TXPP_MR_2.5G card Enterprise System Connection (ESCON) payload does not support optics PMs on the client port due to Small Form-factor Pluggable (SFP)-imposed restrictions.
2. Applicable to TXP_MR_2.5G and TXPP_MR_2.5G cards only.

17.2.4 Ether Ports PM Window

CTC provides Ethernet port performance information, including line-level parameters, port bandwidth consumption, and historical Ethernet statistics. The Ethernet performance information is divided into the Statistics, Utilization, and History tabbed windows within the card view Performance tab window. For more information about provisioning ether ports, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

17.2.4.1 Ether Port 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 17-15 defines the Ethernet Port statistics parameters.

Table 17-15 E-Series Ethernet Statistics Parameters

Parameter	Definition
Time Last Cleared	A time stamp indicating the last time statistics were reset.
ifInOctets	Number of bytes received since the last counter reset.
rxTotalPkts	Number of received packets.
ifInUcastPkts	Number of unicast packets received since the last counter reset.
ifInMulticastPkts	Number of multicast packets received since the last counter reset.
ifInDiscards	The number of inbound packets that were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free buffer space.
ifOutOctets	Number of bytes transmitted since the last counter reset.
txTotalPkts	Number of transmitted packets.
ifOutMulticastPkts	Number of multicast packets transmitted.
ifOutBroadcastPkts	Number of broadcast packets transmitted.
ifOutDiscards	Number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their transmission. A possible reason for discarding such packets could be to free up buffer space.
ifOurErrors	Number of outbound packets or transmission units that could not be transmitted because of errors.
dot3StatsAlignmentErrors	A count of frames received on a particular interface that are not an integral number of octets in length and do not pass the FCS check.
dot3StatsFCSErrors	A count of frames received on a particular interface that are an integral number of octets in length but do not pass the FCS check.
dot3StatsFrameTooLong	A count of frames received on a particular interface that exceed the maximum permitted frame size.
etherStatsUndersizePkts	The total number of packets received that were less than 64 octets long (excluding framing bits, but including FCS octets) and were otherwise well formed.
etherStatsFragments	The total number of packets received that were less than 64 octets in length (excluding framing bits but including FCS octets) and had either a bad FCS with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error). **Note** It is entirely normal for etherStatsFragments to increment. This is because it counts both runts (which are normal occurrences due to collisions) and noise hits.
etherStatsPkts64Octets	The total number of packets (including bad packets) received that were 64 octets in length (excluding framing bits but including FCS octets).
etherStatsPkts65to127Octets	The total number of packets (including bad packets) received that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets).

Table 17-15 E-Series Ethernet Statistics Parameters (continued)

Parameter	Definition
etherStatsPkts128to255Octets	The total number of packets (including bad packets) received that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts256to511Octets	The total number of packets (including bad packets) received that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts512to1023Octets	The total number of packets (including bad packets) received that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts1024to1518Octets	The total number of packets (including bad packets) received that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsBroadcastPkts	The total number of good packets received that were directed to the broadcast address. Note that this does not include multicast packets.
etherStatsMulticastPkts	The total number of good packets received that were directed to a multicast address. Note that this number does not include packets directed to the broadcast address.
etherStatsOversizePkts	The total number of packets received that were longer than 1518 octets (excluding framing bits, but including FCS octets) and were otherwise well formed. Note that for tagged interfaces, this number becomes 1522 bytes.
etherStatsJabbers	The total number of packets received that were longer than 1518 octets (excluding framing bits, but including FCS octets), and had either a bad FCS with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error).
etherStatsOctets	The total number of octets of data (including those in bad packets) received on the network (excluding framing bits but including FCS octets.
etherStatsCRCAlignErrors	The total number of packets received that had a length (excluding framing bits, but including FCS octets) of between 64 and 1518 octets, inclusive, but had either a bad FCS with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error).

17.2.4.2 Ether Ports 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 drop-down list 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).

17.2.4.3 Ether Ports History Window

The Ether Port 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 17-16. The parameters are defined in Table 17-15 on page 17-14.

Table 17-16 Ethernet History Statistics per Time Interval

Time Interval	Number of Previous Intervals Displayed
1 minute	60
15 minutes	32
1 hour	24
1 day (24 hours)	7

17.3 DWDM Card Performance Monitoring

The following sections define PM parameters and definitions for the ONS 15454 OPT-PRE, OPT-BST, OPT-BST-L, OPT-AMP-L, OPT-AMP-17-C, 32MUX-O, 32DMX-O, 32DMX, 32DMX-L, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 4MD-xx.x, AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, AD-4B-xx.x, OSCM, OSC-CSM, 32WSS, and 32WSS-LDWDM cards.

17.3.1 Optical Amplifier Card Performance Monitoring Parameters

The PM parameters for the OPT-PRE, OPT-AMP-L, OPT-AMP-17-C, OPT-BST, and OPT-BST-L cards are listed Table 17-17. For ONS 15454 optics definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

Table 17-17 Optical PM Parameters for Optical Amplifier Cards

Optical Line	Optical Amplifier Line
OPT	OPR

17.3.2 Multiplexer and Demultiplexer Card Performance Monitoring Parameters

The PM parameters for the 32MUX-O, 32WSS, 32WSS-L, 32DMX, 32DMX-L, 32DMX-O, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 40-DMX-C, 40-DMX-CE, and 40-MUX-C cards are listed in Table 17-18. For ONS 15454 optics definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

Table 17-18 Optical PM Parameters for 2MUX-O, 32WSS, 32WSS-L, 32DMX, 32DMX-L, 32DMX-O, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 40-DMX-C, 40-DMX-CE, and 40-MUX-C Cards

Optical Channel	Optical Line
OPR	OPT

17.3.3 4MD-xx.x Card Performance Monitoring Parameters

The PM parameters for the 4MD-xx.x cards are listed in Table 17-19. For ONS 15454 optics definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

Table 17-19 Optical PM Parameters for 4MD-xx.x Cards

Optical Channel	Optical Band
OPR	OPT

17.3.4 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 listed in Table 17-20. For ONS 15454 optics definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

Table 17-20 Optical PM Parameters for AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x Cards

Optical Channel	Optical Line
OPR	OPT

17.3.5 OADM Band Filter Card Performance Monitoring Parameters

The PM parameters for the AD-1B-xx.x and AD-4B-xx.x cards are listed in Table 17-21. For ONS 15454 optics definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

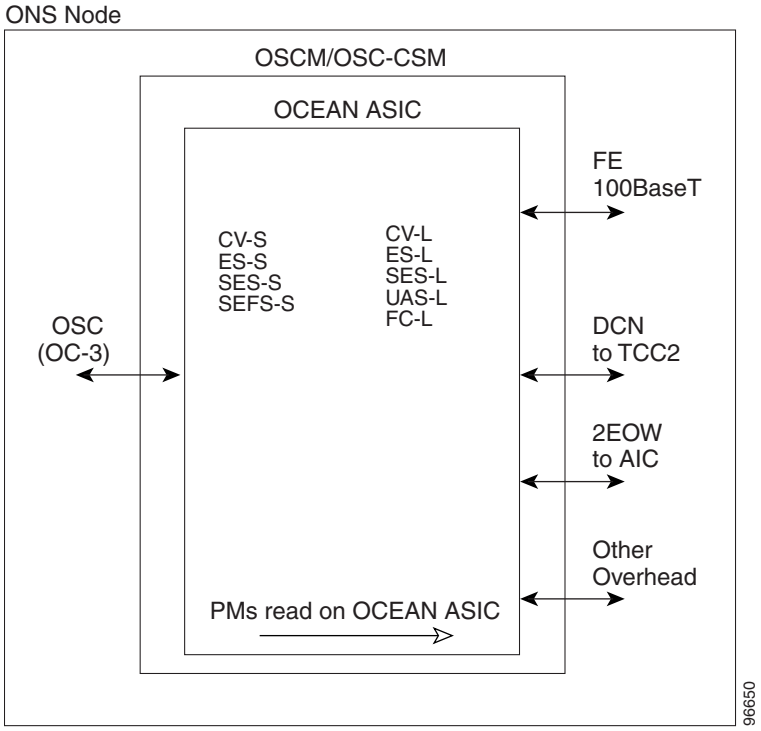
Table 17-21 Optical PM Parameters for AD-1B-xx.x and AD-4B-xx.x Cards

Optical Line	Optical Band
OPR	OPT

17.3.6 Optical Service Channel Card Performance Monitoring Parameters

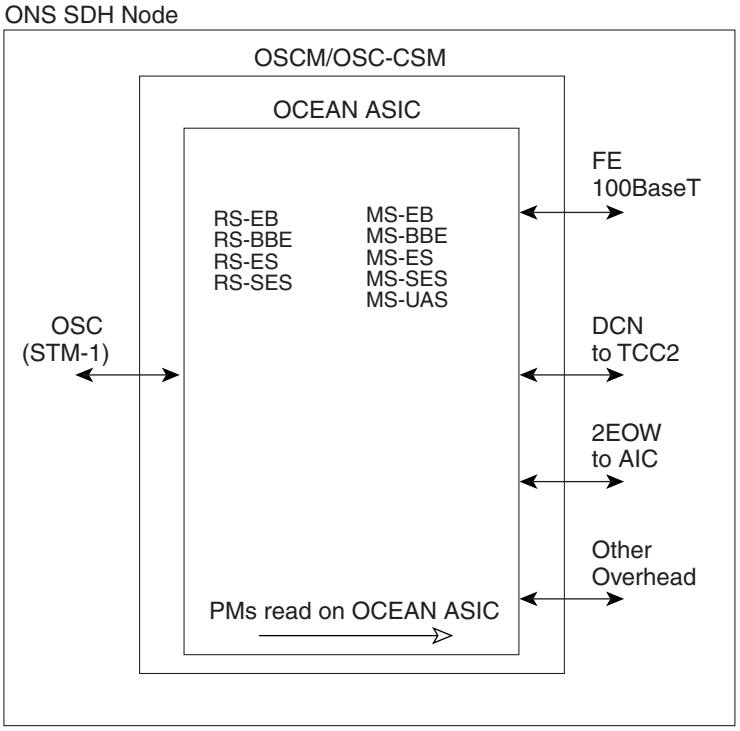
For ONS 15454 ANSI nodes, Figure 17-3 shows where overhead bytes detected on the ASICs produce PM parameters for the OSCM and OSC-CSM cards.

Figure 17-3 ONS 15454 ANSI Node PM Read Points on OSCM and OSC-CSM Cards



For ONS 15454 ETSI nodes, Figure 17-4 shows where overhead bytes detected on the ASICs produce PM parameters for the OSCM and OSC-CSM cards.

Figure 17-4 ONS 15454 ETSI Node PM Read Points on OSCM and OSC-CSM Cards



The ONS 15454 ANSI node PM parameters for the OSCM and OSC-CSM cards are listed in Table 17-22. For PM definitions, see the "17.8 SONET PM Parameter Definitions" section on page 17-26. For optics PM definitions, see the "17.4 Optics and 8b10b PM Parameter Definitions" section on page 17-20.

Table 17-22 ANSI OSCM/OSC-CSM (OC3) Card PMs

Section (Near End)[1]	Line (Near End/Far End)[1]	Optics (Near End)[2]
CV-S ES-S SEF-S SES-S	CV-L ES-L FC-L SES-L UAS-L	OPWR

1. Applicable to OC3
2. Applicable to OTS facilities

Table 17-23 ETSI OSCM and OSC-CSM Card PMs

Regeneration Section (Near End)	Multiplex Section (Near End/Far End)	Optics (Near End)
RS-BBE RS-EB RS-ES RS-SES	MS-BBE MS-EB MS-ES MS-SES MS-UAS	OPT

17.4 Optics and 8b10b PM Parameter Definitions

Table 17-24 on page 17-20 lists Cisco ONS 15454 optics and 8b10b PM parameter definitions.

Table 17-24 ONS 15454 Optics and 8b10b PM Definitions

Parameter	Definition
8b10bDataOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. DataOrderedSets is a count of data ordered sets.
8b10bErrors	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. Errors is a count of 10b errors received by the serial or deserializer (serdes 8b/10b).
8b10bIdleOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. IdleOrderedSets is a count of idle ordered sets.
8b10bInvalidOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. InvalidOrderedSets is a count of the received invalid work errors.
8b10bNonIdleOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. NonIdleOrderedSets is a count of ordered sets that are not idle.
8b10bStatsEncodingDispErrors	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. StatsEncodingDispErrors is a count of the received disparity errors.
BIE	The number of bit errors (BIE) corrected in the DWDM trunk line during the PM time interval.
BIT-EC	The number of Bit Errors Corrected (BIT-EC) in the DWDM trunk line during the PM time interval.
CGV	Code Group Violations (CGV) is a count of received code groups that do not contain a start or end delimiter.
DCG	Date Code Groups (DCG) is a count of received data code groups that do not contain ordered sets.
IOS	Idle Ordered Sets (IOS) is a count of received packets containing idle ordered sets.
IPC	Invalid Packets (IPC) is the count of received packets that contain errored data code groups that have start and end delimiters.
LBCL-AVG	Laser Bias Current Line-Average (LBCL-AVG) is the average percentage of laser bias current.
LBCL-MAX	Laser Bias Current Line-Maximum (LBCL-MAX) is the maximum percentage of laser bias current.
LBCL-MIN	Laser Bias Current Line-Minimum (LBCL-MIN) is the minimum percentage of laser bias current.

Table 17-24 ONS 15454 Optics and 8b10b PM Definitions (continued)

Parameter	Definition
LOFC	Loss of Frame Count (LOFC) is a count of the lost frames.
NIOS	Non-Idle Ordered Sets (NIOS) is a count of received packets containing non-idle ordered sets.
OPR	Optical Power Received (OPR) is the measure of average optical power received as a percentage of the nominal OPR.
OPR-AVG	Average Receive Optical Power (OPR-AVG) is the average received optical power measured in dBm.
OPR-MAX	Maximum Receive Optical Power (OPR-MAX) is the maximum received optical power measured in dBm.
OPR-MIN	Minimum Receive Optical Power (OPR-MIN) is the minimum received optical power measured in dBm.
OPT	Optical Power Transmitted (OPT) is the average optical power transmitted as a percentage of the nominal OPT.
OPT-AVG	Average Transmit Optical Power (OPT-AVG) is the average transmitted optical power measured in dBm.
OPT-MAX	Maximum Transmit Optical Power (OPT-MAX) is the maximum transmitted optical power measured in dBm.
OPT-MIN	Minimum Transmit Optical Power (OPT-MIN) is the minimum transmitted optical power measured in dBm.
OPWR-AVG	Optical Power - Average (OPWR-AVG) is the measure of average optical power on the unidirectional port.
OPWR-MAX	Optical Power - Maximum (OPWR-MAX) is the measure of maximum value of optical power on the unidirectional port.
OPWR-MIN	Optical Power - Minimum (OPWR-MIN) is the measure of minimum value of optical power on the unidirectional port.
UNC-WORDS	Uncorrectable Words (UNC-WORDS) is the number of uncorrectable words detected in the DWDM trunk line during the PM time interval.
VPC	Valid Packets (VPC) is a count of received packets that contain non-errored data code groups that have start and end delimiters.

17.5 ITU G.709 and ITU-T G.8021 Trunk-Side PM Parameter Definitions

Table 17-27 defines the ITU G.709 and ITU-T G.8021 section monitoring trunk-side PM parameters. For more information, see the "17.2 Transponder and Muxponder Card Performance Monitoring" section on page 17-2.

Table 17-25 ITU G.709 and ITU-T G.8021 Section Monitoring PM Definitions

Parameter	Definition
BBE-SM	Section Monitoring Background Block Errors (BBE-SM) shows the number of background block errors recorded in the OTN section during the PM time interval.
BBER-SM	Section Monitoring Background Block Errors Ratio (BBER-SM) shows the background block errors ratio recorded in the OTN path during the PM time interval.
ES-SM	Section Monitoring Errored Seconds (ES-SM) shows the errored seconds recorded in the OTN section during the PM time interval.
ESR-SM	Section Monitoring Errored Seconds Ratio (ESR-SM) shows the severely errored seconds ratio recorded in the OTN section during the PM time interval.
FC-SM	Section Monitoring Failure Counts (FC-SM) shows the failure counts recorded in the OTN section during the PM time interval.
SES-SM	Section Monitoring Severely Errored Seconds (SES-SM) shows the severely errored seconds recorded in the OTN section during the PM time interval.
SESR-SM	Section Monitoring Severely Errored Seconds Ratio (SESR-SM) shows the severely errored seconds ratio recorded in the OTN section during the PM time interval.
UAS-SM	Section Monitoring Unavailable Seconds (UAS-SM) shows the unavailable seconds recorded in the OTN section during the PM time interval.

Table 17-26 defines the ITU G.709 path monitoring trunk-side PM parameters. For more information, see the "17.2 Transponder and Muxponder Card Performance Monitoring" section on page 17-2.

Table 17-26 ITU G.709 Path Monitoring PM Definitions

Parameter	Definition
BBE-PM	Path Monitoring Background Block Errors (BBE-PM) shows the number of background block errors recorded in the OTN path during the PM time interval.
BBER-PM	Path Monitoring Background Block Errors Ratio (BBER-PM) shows the background block errors ratio recorded in the OTN path during the PM time interval.
ES-PM	Path Monitoring Errored Seconds (ES-PM) shows the errored seconds recorded in the OTN path during the PM time interval.
ESR-PM	Path Monitoring Errored Seconds Ratio (ESR-PM) shows the severely errored seconds ratio recorded in the OTN path during the PM time interval.
FC-PM	Path Monitoring Failure Counts (FC-PM) shows the failure counts recorded in the OTN path during the PM time interval.

Table 17-26 ITU G.709 Path Monitoring PM Definitions (continued)

Parameter	Definition
SES-PM	Path Monitoring Severely Errored Seconds (SES-PM) shows the severely errored seconds recorded in the OTN path during the PM time interval.
SESR-PM	Path Monitoring Severely Errored Seconds Ratio (SESR-PM) shows the severely errored seconds ratio recorded in the OTN path during the PM time interval.
UAS-PM	Path Monitoring Unavailable Seconds (UAS-PM) shows the unavailable seconds recorded in the OTN path during the PM time interval.

17.6 Full RMON Statistics PM Parameter Definitions

Table 17-27 defines the MXP_MR_2.5G, MXPP_MR_2.5G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L card full RMON statistics PM parameters. For more information, see the "17.2 Transponder and Muxponder Card Performance Monitoring" section on page 17-2.

Table 17-27 Full RMON Statistics PM Definitions

Parameter	Definition
dot3StatsFCSErrors	The number of frames with frame check errors.
dot3StatsFrameTooLong	The number of packets at least 64 octets long, without a bad Frame Check Sequence (FCS), where the 802.3 length/type field did not match the computed DATA field length.
etherStatsBroadcastPkts	The number of broadcast packets, excluding multicast packets, that are 64–16376 octets in length, and have a valid FCS.
etherStatsCRCAlignErrors	The number of packets that are 64–1518 octets in length without an integral number of octets, or with a bad FCS.
etherStatsFragments	The number of packets less than 64 octets long that do not have an integral number of octets or that have a bad FCS.
etherStatsJabbers	The number of octets of data, including bad packets, that were received on the network.
etherStatsMulticastPkts	The number of multicast packets, excluding broadcast packets, that are 64–16376 octets in length, and have a valid FCS.
etherStatsOctets	The number in bytes of received packets, including bad packets and excluding framing bits except for FCS bytes.
etherStatsOversizePkts	The number of packets more than 16376 octets long that have a valid FCS.
etherStatsPkts64Octets	The number of packet received, including error packets, that are 64 octets in length.
etherStatsPkts65to127Octets	The number of packets received, including error packets, that are 65–127 octets in length.
etherStatsPkts128to255Octets	The number of packets received, including error packets, that are 128–255 octets in length.

Table 17-27 Full RMON Statistics PM Definitions (continued)

Parameter	Definition
etherStatsPkts256to511Octets	The number of packets received, including error packets, that are 256–511 octets in length.
etherStatsPkts512to1023Octets	The number of packets received, including error packets, that are 512–1023 octets in length.
etherStatsPkts1024to1518Octets	The number of packets received, including error packets, that are 1024–1518 octets in length.
etherStatsUndersizePkts	The number of packets less than 64 octets long that have a valid FCS.
fcStatsLinkRecoveries	The number of link recoveries.
fcStatsRxCredits	The number of current receive buffer to buffer credits.
fcStatsTxCredits	The number of current transmit buffer to buffer credits.
fcStatsZeroTxCredits	This is a count that increments when the FC/FICON Tx credits go from a nonzero value to zero.
gfpStatsLFDRaised	The number of loss of frame delineation (LFD) raised.
gfpStatsRoundTripLatencyUSec	Round trip delay for the end-to-end Fibre Channel transport in microseconds.
gfpStatsRxCRCErrors	The number of packets received with a payload FCS error.
gfpStatsRxCSFRaised	Received GFP loss of client character synchronization (LOCCS).
gfpStatsRxDistanceExtBuffers	The number of receive buffer credit for GFP-T (valid only if distance extension is enabled).
gfpStatsRxMBitErrors	The received multibit errored core header count (cHEC).
gfpStatsRxSBitErrors	The received single-bit errored cHEC.
gfpStatsRxSblkCRCErrors	The number of packets received with a payload FCS error. Sblk stands for super block in the GFP payload.
gfpStatsRxTypeInvalid	Received invalid type.
gfpStatsTxDistanceExtBuffers	The number of transmit buffer credit for GFP-T (valid only if distance extension is enabled).
ifInBroadcastPkts	The number of packets delivered to a higher sublayer and addressed to a broadcast address at this sublayer.
ifInDiscards	The number of inbound packets that were chosen to be discarded even though no errors were detected, to prevent them from being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free buffer space.
ifInErrors	The number of inbound packets (or transmission units) that contained errors preventing them from being delivered to a higher-layer protocol.
ifInErrorBytePkts	The number of received packets with an error symbol detected.
ifInFramingErrorPkts	The number of received packets with a control symbol other than an error detected.

Table 17-27 Full RMON Statistics PM Definitions (continued)

Parameter	Definition
ifInJunkInterPkts	The number of interpacket gaps between valid start symbols during which a symbol other than idle is detected, including packets of length 1–8 octets.
ifInMulticastPkts	The total number of multicast frames received error-free.
ifInOctets	The number of bytes received since the last counter reset.
ifOutBroadcastPkts	The number of packets requested by higher-level protocols and addressed to a broadcast address at this sublayer, including those not transmitted.
ifOutDiscards	The number of outbound packets that were chosen to be discarded even though no errors had been detected to prevent their being transmitted. One possible reason for discarding such a packet could be to free buffer space.
ifOutMulticastPkts	The number of multicast frames transmitted error-free.
ifOutOctets	The number of bytes transmitted since the last counter reset.
InvalidCRCError	A count of invalid cyclic redundancy checks (CRCs).
mediaIndStatsRxFramesBadCRC	The number of received frames with a CRC error.
mediaIndStatsRxFramesTooLong	The number of received frames that are too long.
mediaIndStatsRxFramesTruncated	The number of received frames that are too small.
mediaIndStatsTxFramesBadCRC	The number of transmitted frames with a CRC error.
Running Disparity Count	A count of errors that affect the disparity of the received data stream.
rxControlFrames	The number of MAC control packets that are type 0x8808 and contain at least 64 octets in length.
rxFrames	A count of the number of frames received without errors.
rxLinkReset (Only for FC Mode)	A count of the received link resets.
rxPauseFrames	The number of received 802.x paused frames.
rxTotalPkts	The number of received packets.
rxUnknownOpcodeFrames	Number of packets of at least 64 octets in length and type 0x8808, with opcode not equal to 1.
Time Last Cleared	A time stamp indicating the last time statistics were reset.
txBytes	A count of the number of bytes transmitted from the frame since the last counter reset.
txFrames	A count of the number of transmitted frames.
txTotalPkts	The number of transmitted packets.

17.7 FEC PM Parameter Definitions

Table 17-28 defines the MXP_MR_2.5G, MXPP_MR_2.5G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L card FEC PM parameters. For more information, see the "17.2 Transponder and Muxponder Card Performance Monitoring" section on page 17-2.

Table 17-28 FEC PM Definitions

Parameter	Definition
Bit Errors	Bit Errors are the number of bit errors corrected.
FEC (NE)	FEC enables correction and detection of errors along the optical links where OTN and FEC are provisioned. FEC uses Reed Solomon code RS (255,239) encoding. The FEC field is found in Rows 1 to 4 and Columns 3835 to 4080. It will contain either the Reed-Solomon RS(255,239) codes, or if FEC is disabled, fixed stuff bytes (zeros). **Note** The FEC PM information can be found in the card view Performance > OTN PM tab. FEC must be enabled on the transponder units in order for FEC PM values to be reported.
UNC-Words	Uncorrectable Words (UNC-Words) occur when FEC detects and corrects errors to deliver a 7 to 8 dB improvement in the signal-to-noise ratio (also called margin). For ITU G.709, the FEC code used is Reed-Solomon RS (255, 239).

17.8 SONET PM Parameter Definitions

Table 17-29 gives definitions for each type of SONET PM parameter available on an ONS 15454 ANSI node. These parameters become available when the client type is set to OC-3, OC-12, or OC-48 on a TXP_MR_2.5G or TXPP_MR_2.5G card or to OC-192 on a TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, or TXP_MR_10E_L card. The OC-48 client PM is available on MXP_2.5_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards. The OC-48 trunk PM is available on MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 17-29 SONET PM Parameters

Parameter	Definition
CV-L	Line Coding 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.
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-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.
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 17-29 SONET PM Parameters (continued)

Parameter	Definition
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 Alarm Indication Signal Line (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.
SEF-S	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. **Note** The RTRV-PM-<MOD2> command does not retrieve SEF-S counter for OC192/STM64 payloads on ADM-10G cards.
SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ ≥ 44) and/or defects on the line.
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.
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.

17.9 SDH PM Parameter Definitions

Table 17-30 gives definitions for each type of SDH PM parameter available on an ONS 15454 ETSI node. These parameters become available when the client type is set to STM-1, STM-4, or STM-16 on a TXP_MR_2.5G or TXPP_MR_2.5G card or to STM-64 on a TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, or TXP_MR_10E_L card. The STM-16 client PM is available on MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards. The STM-16 trunk PM is available on MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 17-30 SDH PM Parameters

Parameter	Definition
MS-BBE	Multiplex Section Background Block Error (MS-BBE) is an errored block not occurring as part of an SES.
MS-BBER	Multiplex Section Background Block Error Ratio (MS-BBER) is the ratio of BBE to total blocks in available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs.
MS-EB	Multiplex Section Errored Block (MS-EB) indicates that one or more bits are in error within a block.

Table 17-30 SDH PM Parameters (continued)

Parameter	Definition
MS-ES	Multiplex Section Errored Second (MS-ES) is a one-second period with one or more errored blocks or at least one defect.
MS-ESR	Multiplex Section Errored Second Ratio (MS-ESR) is the ratio of errored seconds to total seconds in available time during a fixed measurement interval.
MS-SES	Multiplex Section Severely Errored Second (MS-SES) is a one-second period that contains 30 percent or more errored blocks or at least one defect. SES is a subset of ES. For more information, refer to ITU-T G.829 Section 5.1.3.
MS-SESR	Multiplex Section Severely Errored Second ratio (MS-SESR) is the ratio of SES to total seconds in available time during a fixed measurement interval.
MS-UAS	Multiplex Section Unavailable Seconds (MS-UAS) is a count of the seconds when the section was unavailable. A section becomes unavailable when ten consecutive seconds occur that qualify as MS-SESs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as MS-SESs. When the condition is entered, MS-SESs decrement and then count toward MS-UAS.
RS-BBE	Regenerator Section Background Block Error (RS-BBE) is an errored block not occurring as part of an SES.
RS-BBER	Regenerator Section Background Block Error Ratio (RS-BBER) is the ratio of BBE to total blocks in available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs.
RS-EB	Regenerator Section Errored Block (RS-EB) indicates that one or more bits are in error within a block.
RS-ES	Regenerator Section Errored Second (RS-ES) is a one-second period with one or more errored blocks or at least one defect.
RS-ESR	Regenerator Section Errored Second Ratio (RS-ESR) is the ratio of errored seconds to total seconds in available time during a fixed measurement interval.
RS-SES	Regenerator Section Severely Errored Second (RS-SES) is a one-second period which contains 30 percent or more errored blocks or at least one defect. SES is a subset of ES.
RS-SESR	Regenerator Section Severely Errored Second Ratio (RS-SESR) is the ratio of SES to total seconds in available time during a fixed measurement interval.
RS-UAS	Regenerator Section Unavailable Second (RS-UAS) is a count of the seconds when the regenerator section was unavailable. A section becomes unavailable when ten consecutive seconds occur that qualify as RS-UASs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as RS-UASs.

17.10 Pointer Justification Count Performance Monitoring

For the MultiService Transport Platform (MSTP), only the MXP_2.5G_10G card uses pointer justification counts. Pointers are used to compensate for frequency and phase variations. Pointer justification counts indicate timing errors on networks. When a network is out of synchronization, 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.

For ONS 15454 ANSI nodes, 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.

For ONS 15454 ETSI nodes, pointers provide a way to align the phase variations in VC4 payloads. The VC4 payload pointer is located in the H1 and H2 bytes of the AU pointers section and is a count of the number of bytes the VC4 path overhead (POH) J1 byte is away from the H3 byte, not including the section overhead bytes. Clocking differences are measured by the offset in bytes from the pointer to the first byte of the VC4 POH 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 that the node transmitting the original pointer justification has timing variations with the node detecting and transmitting this count. For ONS 15454 SONET nodes, positive pointer adjustments occur when the frame rate of the SPE is too slow in relation to the rate of the STS-1. For ONS 15454 SDH nodes, positive pointer adjustments occur when the frame rate of the path overhead (POH) is too slow in relation to the rate of the VC4.

In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the card view Provisioning tab.

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 DWDM Procedure Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 18.1 SNMP Overview, page 18-1
- 18.2 Basic SNMP Components, page 18-3
- 18.3 SNMP External Interface Requirement, page 18-4
- 18.4 SNMP Version Support, page 18-4
- 18.5 SNMP Message Types, page 18-4
- 18.6 SNMP Management Information Bases, page 18-5
- 18.7 SNMP Trap Content, page 18-9
- 18.8 SNMP Community Names, page 18-17
- 18.9 SNMP in Multishelf Management, page 18-17
- 18.10 Proxy Over Firewalls, page 18-19
- 18.11 Remote Monitoring, page 18-20

18.1 SNMP Overview

SNMP is an application-layer communication protocol that allows ONS 15454 network devices to exchange management information among these systems and with other devices outside the network. Through SNMP, network administrators can manage network performance, find and solve network problems, and plan network growth. Up to 10 SNMP trap destinations and five concurrent Cisco Transport Controller (CTC) user sessions are allowed per node.

The ONS 15454 uses SNMP for 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 DS-1, DS-3, SONET, and Ethernet read-only management. SNMP allows a generic SNMP manager such as HP OpenView Network Node Manager (NNM) or Open Systems Interconnection (OSI) NetExpert to be utilized for limited management functions.

The Cisco ONS 15454 supports SNMP Version 1 (SNMPv1) and SNMP Version 2c (SNMPv2c). These versions share many features, but SNMPv2c includes additional protocol operations and 64-bit performance monitoring support. This chapter describes both versions and gives SNMP configuration parameters for the ONS 15454.

Note It is recommended that the SNMP Manager timeout value be set to 60 seconds. Under certain conditions, if this value is lower than the recommended time, the TCC card can reset. However, the response time depends on various parameters such as object being queried, complexity, and number of hops in the node, etc.

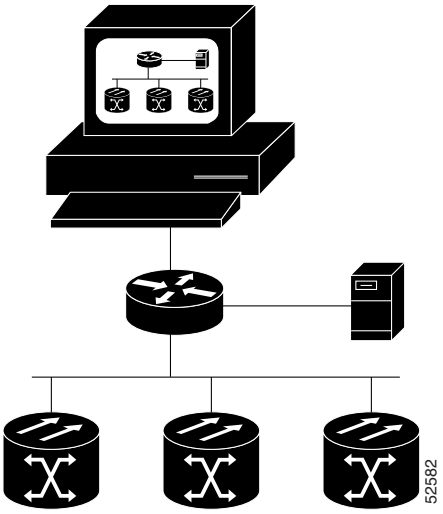
Note In Software Release 8.0 and later, you can retrieve automatic in service (AINS) state and soak time through the SNMP and Transaction Language One (TL1) interfaces.

Note The CERENT-MSDWDM-MIB.mib, CERENT-FC-MIB.mib, and CERENT-GENERIC-PM-MIB.mib in the CiscoV2 directory support 64-bit performance monitoring counters. The 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.

The SNMP management interface supports the IEEE 802.3 LAG MIB.

Figure 18-1 illustrates the basic layout idea of an SNMP-managed network.

Figure 18-1 Basic Network Managed by SNMP

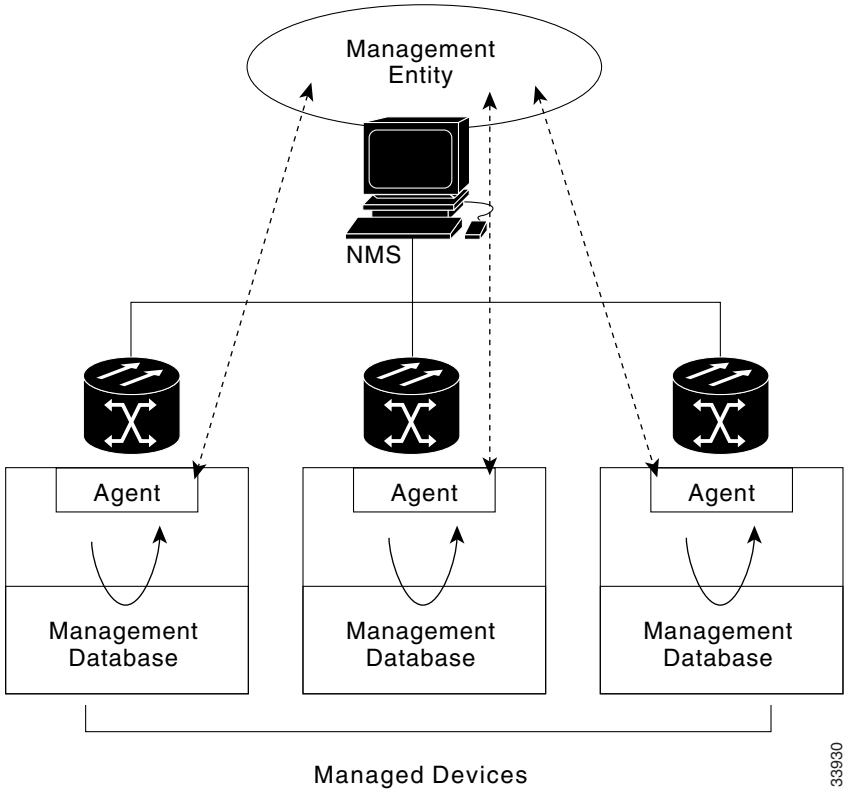


18.2 Basic SNMP Components

In general terms, an SNMP-managed network consists of a management system, agents, and managed devices.

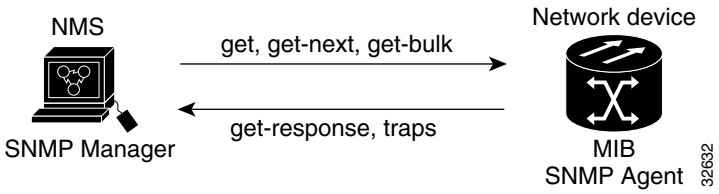
A management system such as HP OpenView executes monitoring applications and controls managed devices. Management systems execute most of the management processes and provide the bulk of memory resources used for network management. A network might be managed by one or several management systems. Figure 18-2 illustrates the relationship between the network manager, the SNMP agent, and the managed devices.

Figure 18-2 Example of the Primary SNMP Components



An agent (such as SNMP) residing on each managed device translates local management information data—such as performance information or event and error information—caught in software traps, into a readable form for the management system. Figure 18-3 illustrates SNMP agent get-requests that transport data to the network management software.

Figure 18-3 Agent Gathering Data from a MIB and Sending Traps to the Manager



The SNMP agent captures data from MIBs, which are device parameter and network data repositories, or from error or change traps.

A managed element—such as a router, access server, switch, bridge, hub, computer host, or network element (such as an ONS 15454)—is accessed through the SNMP agent. Managed devices collect and store management information, making it available through SNMP to other management systems having the same protocol compatibility.

18.3 SNMP External Interface Requirement

Since all SNMP requests come from a third-party application, the only external interface requirement is that a third-party SNMP client application can upload RFC 3273 SNMP MIB variables in the etherStatsHighCapacityTable, etherHistoryHighCapacityTable, or mediaIndependentTable.

18.4 SNMP Version Support

The ONS 15454 supports SNMPv1 and SNMPv2c traps and get requests. The ONS 15454 SNMP MIBs define alarms, traps, and status. Through SNMP, NMS applications can query a management agent for data from functional entities such as Ethernet switches and SONET multiplexers using a supported MIB.

Note ONS 15454 MIB files in the CiscoV1 and CiscoV2 directories are almost identical in content except for the difference in 64-bit performance monitoring features. The CiscoV2 directory contains three MIBs with 64-bit performance monitoring counters:. CERENT-MSDWDM-MIB.mib, CERENT-FC-MIB.mib, and CERENT-GENERIC-PM-MIB.mib The CiscoV1 directory does not contain any 64-bit counters, but it does support the lower and higher word values used in 64-bit counters. The two directories also have somewhat different formats.

18.5 SNMP Message Types

The ONS 15454 SNMP agent communicates with an SNMP management application using SNMP messages. Table 18-1 describes these messages.

Table 18-1 ONS 15454 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.

18.6 SNMP Management Information Bases

A managed object, sometimes called a MIB object, is one of many specific characteristics of a managed device. The MIB consists of hierarchically organized object instances (variables) that are accessed by network-management protocols such as SNMP.

18.6.1 IETF-Standard MIBs for the ONS 15454

Table 18-2 lists the IETF-standard MIBs implemented in the ONS 15454 SNMP agents.

First compile the MIBs in Table 18-2, then compile the MIBs in Table 18-3.

Caution If you do not compile MIBs in the correct order, one or more might not compile correctly.

Table 18-2 IETF Standard MIBs Implemented in the ONS 15454 System

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.)

Table 18-2 IETF Standard MIBs Implemented in the ONS 15454 System (continued)

RFC[1] Number	Module Name	Title/Comments
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 SNMPv2
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
3273	HC-RMON-MIB	The MIB module for managing remote monitoring device implementations, augmenting the original RMON MIB as specified in RFC 2819 and RFC 1513 and RMON-2 MIB as specified in RFC 2021

1. RFC = Request for Comment

18.6.2 Proprietary ONS 15454 MIBs

Each ONS 15454 is shipped with a software CD containing applicable proprietary MIBs. Table 18-3 lists the proprietary MIBs for the ONS 15454.

Table 18-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
1	CERENT-GLOBAL-REGISTRY.mib
2	CERENT-TC.mib
3	CERENT-454.mib
4	CERENT-GENERIC.mib (not applicable to ONS 15454)
5	CISCO-SMI.mib
6	CISCO-VOA-MIB.mib
7	CERENT-MSDWDM-MIB.mib
8	CERENT-OPTICAL-MONITOR-MIB.mib
9	CERENT-HC-RMON-MIB.mib

Table 18-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
10	CERENT-ENVMON-MIB.mib
11	CERENT-GENERIC-PM-MIB.mib

Note If you cannot compile the proprietary MIBs correctly, log into the Technical Support Website at http://www.cisco.com/techsupport or call Cisco TAC (800) 553-2447.

Note When SNMP indicates that the wavelength is unknown, it means that the corresponding card (MXP_2.5G_10E, TXP_MR_10E, MXP_2.5G_10G, TXP_MR_10G, TXP_MR_2.5G, or TXPP_MR_2.5G) works with the first tunable wavelength. For more information about MXP and TXP cards, see Chapter 8, "Transponder and Muxponder Cards."

18.6.3 Generic Threshold and Performance Monitoring MIBs

A MIB called CERENT-GENERIC-PM-MIB allows network management stations (NMS) to use a single, generic MIB for accessing threshold and performance monitoring data of different interface types. The MIB is generic in the sense that it is not tied to any particular kind of interface. The MIB objects can be used to obtain threshold values, current performance monitoring (PM) counts, and historic PM statistics for each kind of monitor and any supported interval at the near end and far end.

Previously existing MIBs in the ONS 15454 system provide some of these counts. For example, SONET interface 15-minute current PM counts and historic PM statistics are available using the SONET-MIB. DS-1 and DS-3 counts and statistics are available through the DS1-MIB and DS-3 MIB respectively. The generic MIB provides these types of information and also fetches threshold values and single-day statistics. In addition, the MIB supports optics and dense wavelength division multiplexing (DWDM) threshold and performance monitoring information.

The CERENT-GENERIC-PM-MIB is organized into three different tables:

- cerentGenericPmThresholdTable
- cerentGenericPmStatsCurrentTable
- cerentGenericPmStatsIntervalTable

The cerentGenericPmThresholdTable is used to obtain the threshold values for the monitor types. It is indexed based on the following items:

- Interface index (cerentGenericPmThresholdIndex)
- Monitor type (cerentGenericPmThresholdMonType). The syntax of cerentGenericPmThresholdMonType is type cerentMonitorType, defined in CERENT-TC.mib.
- Location (cerentGenericPmThresholdLocation). The syntax of cerentGenericPmThresholdLocation is type cerentLocation, defined in CERENT-TC.mib.
- Time period (cerentGenericPmThresholdPeriod). The syntax of cerentGenericPmThresholdPeriod is type cerentPeriod, defined in CERENT-TC.mib.

Threshold values can be provided in 64-bit and 32-bit formats. (For more information about 64-bit counters, see the "18.11.2 HC-RMON-MIB Support" section on page 18-21.) The 64-bit values in cerentGenericPmThresholdHCValue can be used with agents that support SNMPv2. The two 32-bit values (cerentGenericPmThresholdValue and cerentGenericPmThresholdOverFlowValue) can be used by NMSs that only support SNMPv1.

Due to the 64-bit counter, the negative values for cerentGenericPmThresholdHCValue are displayed as large positive integers. If the cerentGenericPmThresholdOverFlowValue is less than zero, it indicates that the cerentGenericPmThresholdHCValue is representing a negative value.

The objects compiled in the cerentGenericPmThresholdTable are shown in Table 18-4.

Table 18-4 cerentGenericPmThresholdTable

Index Objects	Information Objects
cerentGenericPmThresholdIndex	cerentGenericPmThresholdValue
cerentGenericPmThresholdMonType	cerentGenericPmThresholdOverFlowValue
cerentGenericPmThresholdLocation	cerentGenericPmThresholdHCValue
cerentGenericPmThresholdPeriod	—

The second table within the MIB, cerentGenericPmStatsCurrentTable, compiles the current performance monitoring (PM) values for the monitor types. The table is indexed based on interface index (cerentGenericPmStatsCurrentIndex), monitor type (cerentGenericPmStatsCurrentMonType), location (cerentGenericPmStatsCurrentLocation) and time period (cerentGenericPmStatsCurrentPeriod). The syntax of cerentGenericPmStatsCurrentIndex is type cerentLocation, defined in CERENT-TC.mib. The syntax of cerentGenericPmStatsCurrentMonType is type cerentMonitor, defined in CERENT-TC.mib. The syntax of cerentGenericPmStatsCurrentPeriod is type cerentPeriod, defined in CERENT-TC.mib.

The cerentGenericPmStatsCurrentTable validates the current PM value using the cerentGenericPmStatsCurrentValid object and registers the number of valid intervals with historical PM statistics in the cerentGenericPmStatsCurrentValidIntervals object.

PM values are provided in 64-bit and 32-bit formats. The 64-bit values in cerentGenericPmStatsCurrentHCValue can be used with agents that support SNMPv2. The two 32-bit values (cerentGenericPmStatsCurrentValue and cerentGenericPmStatsCurrentOverFlowValue) can be used by NMS that only support SNMPv1.

Due to the 64-bit counter, the negative values for cerentGenericPmStatsCurrentHCValue are displayed as large positive integers. If the cerentGenericPmStatsCurrentOverFlowValue is less than zero, it indicates that the cerentGenericPmStatsCurrentHCValue is representing a negative value.

The cerentGenericPmStatsCurrentTable is shown in Table 18-5.

Table 18-5 32-Bit cerentGenericPmStatsCurrentTable

Index Objects	Informational Objects
cerentGenericPmStatsCurrentIndex	cerentGenericPmStatsCurrentValue
cerentGenericPmStatsCurrentMonType	cerentGenericPmStatsCurrentOverFlowValue
cerentGenericPmStatsCurrentLocation	cerentGenericPmStatsCurrentHCValue
cerentGenericPmStatsCurrentPeriod	cerentGenericPmStatsCurrentValidData
—	cerentGenericPmStatsCurrentValidIntervals

The third table in the MIB, cerentGenericPmStatsIntervalTable, obtains historic PM values for the monitor types. It validates the current PM value in the cerentGenericPmStatsIntervalValid object. This table is indexed based on interface index (cerentGenericPmStatsIntervalIndex), monitor type (cerentGenericPMStatsIntervalMonType), location (cerentGenericPmStatsIntervalLocation), and period (cerentGenericPmStatsIntervalPeriod). The syntax of cerentGenericPmStatsIntervalIndex is type cerentLocation, defined in CERENT-TC.mib. The syntax of cerentGenericPmStatsIntervalMonType is type cerentMonitor, defined in CERENT-TC.mib. The syntax of cerentGernicPmStatsIntervalPeriod is type cerentPeriod, defined in CERENT-TC.mib.

The table provides historic PM values in 64-bit and 32-bit formats. The 64-bit values contained in the cerentGenericPmStatsIntervalHCValue table can be used with SNMPv2 agents. The two 32-bit values (cerentGenericPmStatsIntervalValue and cerentGenericPmStatsIntervalOverFlowValue) can be used by SNMPv1 NMS.

Due to the 64-bit counter, the negative values for cerentGenericPmStatsIntervalHCValue are displayed as large positive integers. If the cerentGenericPmStatsIntervalOverFlowValue is less than zero, it indicates that the cerentGenericPmStatsIntervalHCValue is representing a negative value.

The cerentGenericPmStatsIntervalTable is shown in Table 18-6.

Table 18-6 32-Bit cerentGenericPmStatsIntervalTable

Index Objects	Informational Objects
cerentGenericPmStatsIntervalIndex	cerentGenericPmStatsIntervalValue
cerentGenericPmStatsIntervalMonType	cerentGenericPmStatsIntervalOverFlowValue
cerentGenericPmStatsIntervalLocation	cerentGenericPmStatsIntervalHCValue
cerentGenericPmStatsIntervalPeriod	cerentGenericPmStatsIntervalValidData
cerentGenericPmStatsIntervalNumber	—

18.7 SNMP Trap Content

The ONS 15454 uses SNMP traps to generate all alarms and events, such as raises and clears. The traps contain the following information:

- Object IDs that uniquely identify each event with information about the generating entity (the slot or port; synchronous transport signal [STS] and Virtual Tributary [VT]; bidirectional line switched ring [BLSR], Spanning Tree Protocol [STP], etc.).
- Severity and service effect of the alarm (critical, major, minor, or event; service-affecting or non-service-affecting).
- Date and time stamp showing when the alarm occurred.

18.7.1 Generic and IETF Traps

The ONS 15454 supports the generic IETF traps listed in Table 18-7.

Table 18-7 Supported Generic IETF Traps

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	The value of an instance of dsx1LineStatus has changed. 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	The value of an instance of dsx3LineStatus has changed. 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.

18.7.2 Variable Trap Bindings

Each SNMP trap contains variable bindings that are used to create the MIB tables. ONS 15454 traps and variable bindings are listed in Table 18-8. For each group (such as Group A), all traps within the group are associated with all of its variable bindings.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
A	dsx1LineStatusChange (from RFC 2495)	(1)	dsx1LineStatus	This variable indicates the line status of the interface. It contains loopback, failure, received alarm and transmitted alarm information.
		(2)	dsx1LineStatusLastChange	The value of MIB II's sysUpTime object at the time this DS1 entered its current line status state. If the current state was entered prior to the last proxy-agent reinitialization, the value of this object is zero.
		(3)	cerent454NodeTime	The time that an event occurred.
		(4)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(5)	snmpTrapAddress	The address of the SNMP trap.
B	dsx3LineStatusChange (from RFC 2496)	(1)	dsx3LineStatus	This variable indicates the line status of the interface. It contains loopback state information and failure state information.
		(2)	dsx3LineStatusLastChange	The value of MIB II's sysUpTime object at the time this DS3/E3 entered its current line status state. If the current state was entered prior to the last reinitialization of the proxy-agent, then the value is zero.
		(3)	cerent454NodeTime	The time that an event occurred.
B (cont.)		(4)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(5)	snmpTrapAddress	The address of the SNMP trap.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
C	coldStart (from RFC 1907)	(1)	cerent454NodeTime	The time that the event occurred.
	warmStart (from RFC 1907)	(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
	newRoot (from RFC)	(3)	snmpTrapAddress	The address of the SNMP trap.
	topologyChange (from RFC)		—	—
	entConfigChange (from RFC 2737)		—	—
	authenticationFailure (from RFC 1907)		—	—
D1	risingAlarm (from RFC 2819)	(1)	alarmIndex	This variable uniquely identifies each entry in the alarm table. When an alarm in the table clears, the alarm indexes change for each alarm listed.
		(2)	alarmVariable	The object identifier of the variable being sampled.
		(3)	alarmSampleType	The method of sampling the selected variable and calculating the value to be compared against the thresholds.
		(4)	alarmValue	The value of the statistic during the last sampling period.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
D1 (cont.)		(5)	alarmRisingThreshold	When the current sampled value is greater than or equal to this threshold, and the value at the last sampling interval was less than this threshold, a single event is generated. A single event is also generated if the first sample after this entry is greater than or equal to this threshold.
		(6)	cerent454NodeTime	The time that an event occurred.
		(7)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(8)	snmpTrapAddress	The address of the SNMP trap.
D2	fallingAlarm (from RFC 2819)	(1)	alarmIndex	This variable uniquely identifies each entry in the alarm table. When an alarm in the table clears, the alarm indexes change for each alarm listed.
		(2)	alarmVariable	The object identifier of the variable being sampled.
		(3)	alarmSampleType	The method of sampling the selected variable and calculating the value to be compared against the thresholds.
		(4)	alarmValue	The value of the statistic during the last sampling period.
		(5)	alarmFallingThreshold	When the current sampled value is less than or equal to this threshold, and the value at the last sampling interval was greater than this threshold, a single event is generated. A single is also generated if the first sample after this entry is less than or equal to this threshold.
		(6)	cerent454NodeTime	The time that an event occurred.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
D2 (cont.)		(7)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(8)	snmpTrapAddress	The address of the SNMP trap.
E	failureDetectedExternal ToTheNE (from CERENT-454-mib)	(1)	cerent454NodeTime	The time that an event occurred.
		(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(3)	cerent454AlarmObjectType	The entity that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
		(4)	cerent454AlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of objects in each table; if the alarm is interface-related, this is the index of the interface in the interface table.
		(5)	cerent454AlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
		(6)	cerent454AlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
		(7)	cerent454AlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.
		(8)	cerent454AlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
E (cont.)		(9)	cerent454AlarmAdditionalInfo	Additional information for the alarm object. In the current version of the MIB, this object contains provisioned description for alarms that are external to the NE. If there is no additional information, the value is zero.
		(10)	snmpTrapAddress	The address of the SNMP trap.
F	performanceMonitor ThresholdCrossingAlert (from CERENT-454-mib)	(1)	cerent454NodeTime	The time that an event occurred.
		(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(3)	cerent454AlarmObjectType	The entity that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
		(4)	cerent454AlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of objects in each table; if the alarm is interface-related, this is the index of the interface in the interface table.
		(5)	cerent454AlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
		(6)	cerent454AlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
		(7)	cerent454AlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.
		(8)	cerent454AlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.
		(9)	cerent454ThresholdMonitorType	This object indicates the type of metric being monitored.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
F (cont.)		(10)	cerent454ThresholdLocation	Indicates whether the event occurred at the near or far end.
		(11)	cerent454ThresholdPeriod	Indicates the sampling interval period.
		(12)	cerent454ThresholdSetValue	The value of this object is the threshold provisioned by the NMS.
		(13)	cerent454ThresholdCurrentValue	—
		(14)	cerent454ThresholdDetectType	—
		(15)	snmpTrapAddress	The address of the SNMP trap.
G	All other traps (from CERENT-454-MIB) not listed above	(1)	cerent454NodeTime	The time that an event occurred.
		(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(3)	cerent454AlarmObjectType	The entity that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
		(4)	cerent454AlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of objects in each table; if the alarm is interface-related, this is the index of the interface in the interface table.
		(5)	cerent454AlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
		(6)	cerent454AlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
		(7)	cerent454AlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.

Table 18-8 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
G (cont.)		(8)	cerent454AlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.
		(9)	snmpTrapAddress	The address of the SNMP trap.

18.8 SNMP Community Names

Community names are used to group SNMP trap destinations. All ONS 15454 trap destinations can be provisioned as part of SNMP communities in CTC. When community names are assigned to traps, the ONS 15454 treats the request as valid if the community name matches one that is provisioned in CTC. In this case, all agent-managed MIB variables are accessible to that request. If the community name does not match the provisioned list, SNMP drops the request.

18.9 SNMP in Multishelf Management

When using the dense wavelength division multiplexing (DWDM) multishelf management feature to subtend shelves from a node controller shelf, SNMP for the subtended shelves must be specially provisioned. All shelves within a multishelf configuration share the node controller's ID and IP address. Thus, the only way to route SNMP messages to or from subtended shelves is by using proxy ARP.

The cerent454MultishelfEnabled object ID (OID) can be used to determine whether the node is single shelf or multishelf.

To view the OID, use the **snmpwalk** *node IP address* **ifDescr** SNMP command in global configuration mode. This command output displays the OID as

```
<interface_name>_x/y/z
```

where

x = Shelf number (for a multishelf node)

y = Card slot number

z = Card port number.

The following example shows how to obtain the OID using the **snmpwalk** *node IP address* **ifDescr** SNMP command.

```
Router(config)# snmpwalk 192.0.2.1 ifDescr
RFC1213-MIB::ifDescr.1 = STRING: "motfcc0"
RFC1213-MIB::ifDescr.6 = STRING: "pdcc0"
RFC1213-MIB::ifDescr.7 = STRING: "pdcc1"
RFC1213-MIB::ifDescr.8 = STRING: "pdcc2"
RFC1213-MIB::ifDescr.9 = STRING: "pdcc3"
RFC1213-MIB::ifDescr.10 = STRING: "pdcc4"
RFC1213-MIB::ifDescr.11 = STRING: "pdcc5"
RFC1213-MIB::ifDescr.12 = STRING: "pdcc6"
RFC1213-MIB::ifDescr.13 = STRING: "pdcc7"
RFC1213-MIB::ifDescr.14 = STRING: "pdcc8"
RFC1213-MIB::ifDescr.15 = STRING: "pdcc9"
RFC1213-MIB::ifDescr.16 = STRING: "pdcc10"
```

```
RFC1213-MIB::ifDescr.17 = STRING: "pdcc11"
RFC1213-MIB::ifDescr.18 = STRING: "pdcc12"
RFC1213-MIB::ifDescr.19 = STRING: "pdcc13"
RFC1213-MIB::ifDescr.20 = STRING: "pdcc14"
RFC1213-MIB::ifDescr.21 = STRING: "pdcc15"
RFC1213-MIB::ifDescr.22 = STRING: "pdcc16"
RFC1213-MIB::ifDescr.23 = STRING: "pdcc17"
RFC1213-MIB::ifDescr.24 = STRING: "pdcc18"
RFC1213-MIB::ifDescr.25 = STRING: "pdcc19"
RFC1213-MIB::ifDescr.26 = STRING: "pdcc20"
RFC1213-MIB::ifDescr.27 = STRING: "pdcc21"
RFC1213-MIB::ifDescr.28 = STRING: "pdcc22"
RFC1213-MIB::ifDescr.29 = STRING: "pdcc23"
RFC1213-MIB::ifDescr.30 = STRING: "pdcc24"
RFC1213-MIB::ifDescr.31 = STRING: "pdcc25"
RFC1213-MIB::ifDescr.32 = STRING: "pdcc26"
RFC1213-MIB::ifDescr.33 = STRING: "pdcc27"
RFC1213-MIB::ifDescr.34 = STRING: "pdcc28"
RFC1213-MIB::ifDescr.35 = STRING: "pdcc29"
RFC1213-MIB::ifDescr.36 = STRING: "pdcc30"
RFC1213-MIB::ifDescr.37 = STRING: "pdcc31"
RFC1213-MIB::ifDescr.38 = STRING: "pdcc32"
RFC1213-MIB::ifDescr.39 = STRING: "pdcc33"
RFC1213-MIB::ifDescr.40 = STRING: "pdcc34"
RFC1213-MIB::ifDescr.41 = STRING: "pdcc35"
RFC1213-MIB::ifDescr.42 = STRING: "pdcc36"
RFC1213-MIB::ifDescr.43 = STRING: "pdcc37"
RFC1213-MIB::ifDescr.44 = STRING: "pdcc38"
RFC1213-MIB::ifDescr.45 = STRING: "pdcc39"
RFC1213-MIB::ifDescr.46 = STRING: "pdcc40"
RFC1213-MIB::ifDescr.47 = STRING: "pdcc41"
RFC1213-MIB::ifDescr.48 = STRING: "pdcc42"
RFC1213-MIB::ifDescr.49 = STRING: "pdcc43"
RFC1213-MIB::ifDescr.50 = STRING: "pdcc44"
RFC1213-MIB::ifDescr.51 = STRING: "pdcc45"
RFC1213-MIB::ifDescr.52 = STRING: "pdcc46"
RFC1213-MIB::ifDescr.53 = STRING: "pdcc47"
RFC1213-MIB::ifDescr.54 = STRING: "pdcc48"
RFC1213-MIB::ifDescr.55 = STRING: "pdcc49"
RFC1213-MIB::ifDescr.56 = STRING: "pdcc50"
RFC1213-MIB::ifDescr.57 = STRING: "pdcc51"
RFC1213-MIB::ifDescr.58 = STRING: "pdcc52"
RFC1213-MIB::ifDescr.59 = STRING: "pdcc53"
RFC1213-MIB::ifDescr.60 = STRING: "pdcc54"
RFC1213-MIB::ifDescr.61 = STRING: "pdcc55"
RFC1213-MIB::ifDescr.62 = STRING: "pdcc56"
RFC1213-MIB::ifDescr.63 = STRING: "pdcc57"
RFC1213-MIB::ifDescr.64 = STRING: "pdcc58"
RFC1213-MIB::ifDescr.65 = STRING: "pdcc59"
RFC1213-MIB::ifDescr.66 = STRING: "pdcc60"
RFC1213-MIB::ifDescr.67 = STRING: "pdcc61"
RFC1213-MIB::ifDescr.68 = STRING: "pdcc62"
RFC1213-MIB::ifDescr.69 = STRING: "pdcc63"
RFC1213-MIB::ifDescr.70 = STRING: "pdcc64"
RFC1213-MIB::ifDescr.71 = STRING: "pdcc65"
RFC1213-MIB::ifDescr.72 = STRING: "pdcc66"
RFC1213-MIB::ifDescr.73 = STRING: "pdcc67"
RFC1213-MIB::ifDescr.74 = STRING: "pdcc68"
RFC1213-MIB::ifDescr.75 = STRING: "pdcc69"
RFC1213-MIB::ifDescr.76 = STRING: "pdcc70"
RFC1213-MIB::ifDescr.77 = STRING: "pdcc71"
RFC1213-MIB::ifDescr.78 = STRING: "pdcc72"
RFC1213-MIB::ifDescr.79 = STRING: "pdcc73"
RFC1213-MIB::ifDescr.80 = STRING: "pdcc74"
```

```
RFC1213-MIB::ifDescr.81 = STRING: "pdcc75"
RFC1213-MIB::ifDescr.82 = STRING: "pdcc76"
RFC1213-MIB::ifDescr.83 = STRING: "pdcc77"
RFC1213-MIB::ifDescr.84 = STRING: "pdcc78"
RFC1213-MIB::ifDescr.85 = STRING: "pdcc79"
RFC1213-MIB::ifDescr.86 = STRING: "pdcc80"
RFC1213-MIB::ifDescr.257 = STRING: "fog_1_36"
RFC1213-MIB::ifDescr.8194 = STRING: "TenGigabitEthernet2/1"
RFC1213-MIB::ifDescr.8195 = STRING: "TenGigabitEthernet2/2"
RFC1213-MIB::ifDescr.8196 = STRING: "TenGigabitEthernet2/3"
RFC1213-MIB::ifDescr.8197 = STRING: "TenGigabitEthernet2/4"
RFC1213-MIB::ifDescr.12290 = STRING: "dwdm-cli_2/3/1"
RFC1213-MIB::ifDescr.12291 = STRING: "dwdm-cli_2/3/2"
RFC1213-MIB::ifDescr.12292 = STRING: "dwdm-trk_2/3/3"
RFC1213-MIB::ifDescr.12293 = STRING: "dwdm-trk_2/3/4"
RFC1213-MIB::ifDescr.12294 = STRING: "TenGigabitEthernet3/1"
RFC1213-MIB::ifDescr.12295 = STRING: "TenGigabitEthernet3/2"
RFC1213-MIB::ifDescr.12296 = STRING: "TenGigabitEthernet3/3"
RFC1213-MIB::ifDescr.12297 = STRING: "TenGigabitEthernet3/4"
RFC1213-MIB::ifDescr.147458 = STRING: "GigabitEthernet36/1"
RFC1213-MIB::ifDescr.147459 = STRING: "GigabitEthernet36/2"
RFC1213-MIB::ifDescr.147502 = STRING: "TenGigabitEthernet36/45"
RFC1213-MIB::ifDescr.147503 = STRING: "TenGigabitEthernet36/46"
RFC1213-MIB::ifDescr.147504 = STRING: "TenGigabitEthernet36/47"
RFC1213-MIB::ifDescr.147505 = STRING: "TenGigabitEthernet36/48"
RFC1213-MIB::ifDescr.147554 = STRING: "ds1_36/1"
RFC1213-MIB::ifDescr.147555 = STRING: "ds1_36/2"
```

LAN-connected network elements (LNEs) can be set up as gateway network elements (GNEs) or as SOCKS proxies, depending upon network security requirements. If the GNE/ENE firewall feature is required, the LNE must be set up as a GNE. If the design does not require the firewall feature but does require all-IP networking, the LNE must be set up as a SOCKS proxy.

In a GNE/ENE firewall configuration, nonconnected network elements must be set up as end network elements (ENEs). With a SOCKS configuration, subtended nodes communicate with the proxy server by IP. For procedures to provision a node or shelf as a GNE, ENE or SOCKS proxy, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

18.10 Proxy Over Firewalls

SNMP and NMS applications have traditionally been unable to cross firewalls used for isolating security risks inside or from outside networks. CTC enables network operations centers (NOCs) to access performance monitoring data such as RMON statistics or autonomous messages across firewalls by using an SMP proxy element installed on a firewall.

The application-level proxy transports SNMP protocol data units (PDU) between the NMS and NEs, allowing requests and responses between the NMS and NEs and forwarding NE autonomous messages to the NMS. The proxy agent requires little provisioning at the NOC and no additional provisioning at the NEs.

The firewall proxy is intended for use in a gateway network element-end network element (GNE-ENE) topology with many NEs through a single NE gateway. Up to 64 SNMP requests (such as get, getnext, or getbulk) are supported at any time behind single or multiple firewalls. The proxy interoperates with common NMS such as HP OpenView.

For security reasons, the SNMP proxy feature must be enabled at all receiving and transmitting NEs to function. For instructions to do this, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

18.11 Remote Monitoring

The ONS 15454 incorporates RMON to allow network operators to monitor Ethernet card performance and events. The RMON thresholds are user-provisionable in CTC. Refer to the *Cisco ONS 15454 DWDM Procedure Guide* for instructions.

Note Typical RMON operations, other than threshold provisioning, are invisible to the CTC user.

ONS 15454 system RMON is based on the IETF-standard MIB RFC 2819 and includes the following five groups from the standard MIB: Ethernet Statistics, History Control, Ethernet History, Alarm, and Event.

18.11.1 64-Bit RMON Monitoring over DCC

The ONS 15454 DCC is implemented over the IP protocol, which is not compatible with Ethernet. The system builds Ethernet equipment History and Statistics tables using HDLC statistics that are gathered over the DCC (running point-topoint protocol, or PPP). RMON DCC monitoring (for both IP and Ethernet) monitors the health of remote DCC connections.

RMON DCC contains two MIBs for DCC interfaces. They are:

- cMediaIndependentTable—standard, rfc3273; the proprietary extension of the HC-RMON MIB used for reporting statistics
- cMediaIndependentHistoryTable—proprietary MIB used to support history

18.11.1.1 Row Creation in MediaIndependentTable

The SetRequest PDU for creating a row in the mediaIndependentTable should contain all the values required to activate a row in a single set operation along with an assignment of the status variable to createRequest (2). The SetRequest PDU for entry creation must have all the object IDs (OIDs) carrying an instance value of 0. That is, all the OIDs should be of the type OID.0.

In order to create a row, the SetRequest PDU should contain the following:

- mediaIndependentDataSource and its desired value
- mediaIndependentOwner and its desired value (The size of mediaIndependentOwner is limited to 32 characters.)
- mediaIndependentStatus with a value of createRequest (2)

The mediaIndependentTable creates a row if the SetRequest PDU is valid according to the above rules. When the row is created, the SNMP agent decides the value of mediaIndependentIndex. This value is not sequentially allotted or contiguously numbered. It changes when an Ethernet interface is added or deleted. The newly created row will have mediaIndependentTable value of valid (1). If the row already exists, or if the SetRequest PDU values are insufficient or do not make sense, the SNMP agent returns an error code.

Note mediaIndependentTable entries are not preserved if the SNMP agent is restarted.

The mediaIndependentTable deletes a row if the SetRequest PDU contains a mediaIndependentStatus with a value of invalid (4). The varbind's OID instance value identifies the row for deletion. You can recreate a deleted row in the table if desired.

18.11.1.2 Row Creation in cMediaIndependentHistoryControlTable

SNMP row creation and deletion for the cMediaIndependentHistoryControlTable follows the same processes as for the MediaIndependentTable; only the variables differ.

In order to create a row, the SetRequest PDU should contain the following:

- cMediaIndependentHistoryControlDataSource and its desired value
- cMediaIndependentHistoryControlOwner and its desired value
- cMediaIndependentHistoryControlStatus with a value of createRequest (2)

18.11.2 HC-RMON-MIB Support

For the ONS 15454, the implementation of the high-capacity remote monitoring information base (HC-RMON-MIB, or RFC 3273) enables 64-bit support of existing RMON tables. This support is provided with the etherStatsHighCapacityTable and the etherHistoryHighCapacityTable. An additional table, the mediaIndependentTable, and an additional object, hcRMONCapabilities, are also added for this support. All of these elements are accessible by any third-party SNMP client should have the ability to upload RFC 3273 SNMP MIB variables in the etherStatsHighCapacityTable, etherHistoryHighCapacityTable, or mediaIndependentTable.

18.11.3 Ethernet Statistics RMON Group

The Ethernet Statistics group contains the basic statistics monitored for each subnetwork in a single table called the etherStatsTable.

18.11.3.1 Row Creation in etherStatsTable

The SetRequest PDU for creating a row in this table should contain all the values needed to activate a row in a single set operation, and an assigned status variable to createRequest. The SetRequest PDU object ID (OID) entries must all carry an instance value, or type OID, of 0.

In order to create a row, the SetRequest PDU should contain the following:

- The etherStatsDataSource and its desired value
- The etherStatsOwner and its desired value (size of this value is limited to 32 characters)
- The etherStatsStatus with a value of createRequest (2)

The etherStatsTable creates a row if the SetRequest PDU is valid according to the above rules. When the row is created, the SNMP agent decides the value of etherStatsIndex. This value is not sequentially allotted or contiguously numbered. It changes when an Ethernet interface is added or deleted. The newly created row will have etherStatsStatus value of valid (1).

If the etherStatsTable row already exists, or if the SetRequest PDU values are insufficient or do not make sense, the SNMP agent returns an error code.

Note EtherStatsTable entries are not preserved if the SNMP agent is restarted.

18.11.3.2 Get Requests and GetNext Requests

Get requests and getNext requests for the etherStatsMulticastPkts and etherStatsBroadcastPkts columns return a value of zero because the variables are not supported by ONS 15454 Ethernet cards.

18.11.3.3 Row Deletion in etherStatsTable

To delete a row in the etherStatsTable, the SetRequest PDU should contain an etherStatsStatus "invalid" value (4). The OID marks the row for deletion. If required, a deleted row can be recreated.

18.11.3.4 64-Bit etherStatsHighCapacity Table

The Ethernet statistics group contains 64-bit statistics in the etherStatsHighCapacityTable, which provides 64-bit RMON support for the HC-RMON-MIB. The etherStatsHighCapacityTable is an extension of the etherStatsTable that adds 16 new columns for performance monitoring data in 64-bit format. There is a one-to-one relationship between the etherStatsTable and etherStatsHighCapacityTable when rows are created or deleted in either table.

18.11.4 History Control RMON Group

The History Control group defines sampling functions for one or more monitor interfaces in the historyControlTable. The values in this table, as specified in RFC 2819, are derived from the historyControlTable and etherHistoryTable.

18.11.4.1 History Control Table

The RMON is sampled at one of four possible intervals. Each interval or period contains specific history values (also called buckets). Table 18-9 lists the four sampling periods and corresponding buckets.

The historyControlTable maximum row size is determined by multiplying the number of ports on a card by the number of sampling periods. For example, a card that contains 24 ports when multiplied by periods allows 96 rows in the table. A card that contains 14 ports when multiplied by four periods allows 56 table rows.

Table 18-9 RMON History Control Periods and History Categories

Sampling Periods (historyControlValue Variable)	Total Values or Buckets (historyControl Variable)
15 minutes	32
24 hours	7
1 minute	60
60 minutes	24

18.11.4.2 Row Creation in historyControlTable

The SetRequest PDU must be able to activate a historyControlTable row in one single-set operation. In order to do this, the PDU must contain all needed values and have a status variable value of 2 (createRequest). All OIDs in the SetRequest PDU should be type OID.0 type for entry creation.

To create a SetRequest PDU for the historyControlTable, the following values are required:

- The historyControlDataSource and its desired value
- The historyControlBucketsRequested and it desired value
- The historyControlInterval and its desired value
- The historyControlOwner and its desired value
- The historyControlStatus with a value of createRequest (2)

The historyControlBucketsRequested OID value is ignored because the number of buckets allowed for each sampling period, based upon the historyControlInterval value, is already fixed. Table 18-9 lists these variables.

The historyControlInterval value cannot be changed from the four allowed choices. If you use another value, the SNMP agent selects the closest smaller time period from the set buckets. For example, if the set request specifies a 25-minute interval, this falls between the 15-minute (32 bucket) variable and the 60-minute (24 bucket) variable. The SNMP agent automatically selects the lower, closer value, which is 15 minutes, so it allows 32 buckets.

If the SetRequest PDU is valid, a historyControlTable row is created. If the row already exists, or if the SetRequest PDU values do not make sense or are insufficient, the SNMP agent does not create the row and returns an error code.

18.11.4.3 Get Requests and GetNext Requests

These PDUs are not restricted.

18.11.4.4 Row Deletion in historyControl Table

To delete a row from the table, the SetRequest PDU should contain a historyControlStatus value of 4 (invalid). A deleted row can be recreated.

18.11.5 Ethernet History RMON Group

The ONS 15454 implements the etherHistoryTable as defined in RFC 2819. The group is created within the bounds of the historyControlTable and does not deviate from the RFC in its design.

18.11.5.1 64-Bit etherHistoryHighCapacityTable

64-bit Ethernet history for the HC-RMON-MIB is implemented in the etherHistoryHighCapacityTable, which is an extension of the etherHistoryTable. The etherHistoryHighCapacityTable adds four columns for 64-bit performance monitoring data. These two tables have a one-to-one relationship. Adding or deleting a row in one table will also change the other.

18.11.6 Alarm RMON Group

The Alarm group consists of the alarmTable, which periodically compares sampled values with configured thresholds and raises an event if a threshold is crossed. This group requires the implementation of the event group, which follows this section.

18.11.6.1 Alarm Table

The NMS uses the alarmTable to determine and provision network performance alarmable thresholds.

18.11.6.2 Row Creation in alarmTable

To create a row in the alarmTable, the SetRequest PDU must be able to create the row in one single-set operation. All OIDs in the SetRequest PDU should be type OID.0 type for entry creation. The table has a maximum number of 256 rows.

To create a SetRequest PDU for the alarmTable, the following values are required:

- The alarmInterval and its desired value
- The alarmVariable and its desired value
- The alarmSampleType and its desired value
- The alarmStartupAlarm and its desired value
- The alarmOwner and its desired value
- The alarmStatus with a value of createRequest (2)

If the SetRequest PDU is valid, a historyControlTable row is created. If the row already exists, or if the SetRequest PDU values do not make sense or are insufficient, the SNMP agent does not create the row and returns an error code.

In addition to the required values, the following restrictions must be met in the SetRequest PDU:

- The alarmOwner is a string of length 32 characters.
- The alarmRisingEventIndex always takes value 1.
- The alarmFallingEventIndex always takes value 2.
- The alarmStatus has only two values supported in SETs: createRequest (2) and invalid (4).
- The AlarmVariable is of the type OID.ifIndex, where ifIndex gives the interface this alarm is created on and OID is one of the OIDs supported in Table 18-10.

Table 18-10 OIDs Supported in the AlarmTable

No.	Column Name	OID	Status
1	ifInOctets	{1.3.6.1.2.1.2.2.1.10}	—
2	IfInUcastPkts	{1.3.6.1.2.1.2.2.1.11}	—
3	ifInMulticastPkts	{1.3.6.1.2.1.31.1.1.1.2}	Unsupported in E100/E1000
4	ifInBroadcastPkts	{1.3.6.1.2.1.31.1.1.1.3}	Unsupported in E100/E1000
5	ifInDiscards	{1.3.6.1.2.1.2.2.1.13}	Unsupported in E100/E1000
6	ifInErrors	{1.3.6.1.2.1.2.2.1.14}	—
7	ifOutOctets	{1.3.6.1.2.1.2.2.1.16}	—

Table 18-10 OIDs Supported in the AlarmTable (continued)

No.	Column Name	OID	Status
8	ifOutUcastPkts	{1.3.6.1.2.1.2.2.1.17}	—
9	ifOutMulticastPkts	{1.3.6.1.2.1.31.1.1.1.4}	Unsupported in E100/E1000
10	ifOutBroadcastPkts	{1.3.6.1.2.1.31.1.1.1.5}	Unsupported in E100/E1000
11	ifOutDiscards	{1.3.6.1.2.1.2.2.1.19}	Unsupported in E100/E1000
12	Dot3StatsAlignmentErrors	{1.3.6.1.2.1.10.7.2.1.2}	—
13	Dot3StatsFCSErrors	{1.3.6.1.2.1.10.7.2.1.3}	—
14	Dot3StatsSingleCollisionFrames	{1.3.6.1.2.1.10.7.2.1.4}	—
15	Dot3StatsMultipleCollisionFrames	{1.3.6.1.2.1.10.7.2.1.5}	—
16	Dot3StatsDeferredTransmissions	{1.3.6.1.2.1.10.7.2.1.7}	—
17	Dot3StatsLateCollisions	{1.3.6.1.2.1.10.7.2.1.8}	—
18	Dot3StatsExcessiveCollisions	{13.6.1.2.1.10.7.2.1.9}	—
19	Dot3StatsFrameTooLong	{1.3.6.1.2.1.10.7.2.1.13}	—
20	Dot3StatsCarrierSenseErrors	{1.3.6.1.2.1.10.7.2.1.11}	Unsupported in E100/E1000
21	Dot3StatsSQETestErrors	{1.3.6.1.2.1.10.7.2.1.6}	Unsupported in E100/E1000
22	etherStatsUndersizePkts	{1.3.6.1.2.1.16.1.1.1.9}	—
23	etherStatsFragments	{1.3.6.1.2.1.16.1.1.1.11}	—
24	etherStatsPkts64Octets	{1.3.6.1.2.1.16.1.1.1.14}	—
25	etherStatsPkts65to127Octets	{1.3.6.1.2.1.16.1.1.1.15}	—
26	etherStatsPkts128to255Octets	{1.3.6.1.2.1.16.1.1.1.16}	—
27	etherStatsPkts256to511Octets	{1.3.6.1.2.1.16.1.1.1.17}	—
28	etherStatsPkts512to1023Octets	{1.3.6.1.2.1.16.1.1.1.18}	—
29	etherStatsPkts1024to1518Octets	{1.3.6.1.2.1.16.1.1.1.19}	—
30	EtherStatsBroadcastPkts	{1.3.6.1.2.1.16.1.1.1.6}	—
31	EtherStatsMulticastPkts	{1.3.6.1.2.1.16.1.1.1.7}	—
32	EtherStatsOversizePkts	{1.3.6.1.2.1.16.1.1.1.10}	—
33	EtherStatsJabbers	{1.3.6.1.2.1.16.1.1.1.12}	—
34	EtherStatsOctets	{1.3.6.1.2.1.16.1.1.1.4}	—
35	EtherStatsCollisions	{1.3.6.1.2.1.16.1.1.1.13}	—
36	EtherStatsCollisions	{1.3.6.1.2.1.16.1.1.1.8}	—
37	EtherStatsDropEvents	{1.3.6.1.2.1.16.1.1.1.3}	Unsupported in E100/E1000 and G1000

18.11.6.3 Get Requests and GetNext Requests

These PDUs are not restricted.

18.11.6.4 Row Deletion in alarmTable

To delete a row from the table, the SetRequest PDU should contain an alarmStatus value of 4 (invalid). A deleted row can be recreated. Entries in this table are preserved if the SNMP agent is restarted.

18.11.7 Event RMON Group

The Event group controls event generation and notification. It consists of two tables: the eventTable, which is a read-only list of events to be generated, and the logTable, which is a writable set of data describing a logged event. The ONS 15454 implements the logTable as specified in RFC 2819.

18.11.7.1 Event Table

The eventTable is read-only and unprovisionable. The table contains one row for rising alarms and another for falling ones. This table has the following restrictions:

- The eventType is always log-and-trap (4).
- The eventCommunity value is always a zero-length string, indicating that this event causes the trap to be despatched to all provisioned destinations.
- The eventOwner column value is always “monitor.”
- The eventStatus column value is always valid(1).

18.11.7.2 Log Table

The logTable is implemented exactly as specified in RFC 2819. The logTable is based upon data that is locally cached in a controller card. If there is a controller card protection switch, the existing logTable is cleared and a new one is started on the newly active controller card. The table contains as many rows as provided by the alarm controller.

APPENDIX A

Hardware Specifications

This appendix contains hardware and software specifications for the ONS 15454 ANSI and ETSI shelf assemblies and cards.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

The following sections are included:

- A.1 Shelf Specifications, page A-1
- A.2 General Card Specifications, page A-5
- A.3 Common Control Card Specifications, page A-7
- A.4 Optical Service Channel Cards, page A-12
- A.5 Optical Amplifier Cards, page A-14
- A.6 Multiplexer and Demultiplexer Cards, page A-19
- A.7 Reconfigurable Optical Add/Drop Cards, page A-21
- A.8 Optical Add/Drop Cards, page A-38
- A.9 Transponder and Muxponder Card Specifications, page A-48
- A.10 Mesh Patch Panel Specifications, page A-81
- A.11 SFP and XFP Specifications, page A-83

A.1 Shelf Specifications

This section provides specifications for shelf bandwidth; a list of topologies; Cisco Transport Controller (CTC) specifications; the LAN, Transaction Language One (TL1), modem, and alarm specifications; timing, power, and environmental specifications; and shelf dimensions.

A.1.1 Bandwidth

The ONS 15454 has the following bandwidth specifications:

- Total bandwidth: 240 Gbps
- Data plane bandwidth: 160 Gbps

- SONET/SDH plane bandwidth: 80 Gbps

A.1.2 Configurations

The ONS 15454 can be configured for the following dense wavelength division multiplexing (DWDM) topologies:

- Hubbed rings
- Multihubbed rings
- Point-to-point
- Linear
- Linear with optical add/drop multiplexing (OADM)
- Hybrid terminal node
- Hybrid OADM node
- Hybrid line amplifier node

A.1.3 Cisco Transport Controller

CTC, the ONS 15454 craft interface software, has the following specifications:

- 10BaseT Ethernet
- TCC2/TCC2P card access: RJ-45 connector
- Backplane access: LAN pin field (ANSI only)
- Front Mount Electrical Connection (FMEC) access: LAN connector on MIC-C/T/P faceplate (ETSI only)

A.1.4 External LAN Interface

The ONS 15454 external LAN interface has the following specifications:

- 10BaseT Ethernet
- Backplane access: LAN pin field (ANSI only)
- FMEC access: LAN connector on MIC-C/T/P faceplate (ETSI only)

A.1.5 TL1 Craft Interface

The ONS 15454 TL1 craft interface has the following specifications:

- Speed: 9600 bps
- TCC2/TCC2P access: EIA/TIA-232 DB-9 type connector
- Backplane access: CRAFT pin field (ANSI only)

A.1.6 Modem Interface

The ONS 15454 modem interface has the following specifications:

- Hardware flow control
- TCC2/TCC2P: EIA/TIA-232 DB-9 type connector

A.1.7 Alarm Interface

The ONS 15454 alarm interface has the following specifications:

- ETSI
  - Visual: Critical, Major, Minor, Remote
  - Audible: Critical, Major, Minor, Remote
  - FMEC access: 62-Pin DB connector on MIC-A/P faceplate
  - Alarm inputs: Common 32-VDC output for all alarm-inputs, closed contact limited to 2 mA
  - Control outputs: Open contact maximum 60 VDC, closed contact maximum 100 mA
- ANSI
  - Visual: Critical, Major, Minor, Remote
  - Audible: Critical, Major, Minor, Remote
  - Backplane access: Alarm pin fields
  - Alarm contacts: 0.045 mm, –48 V, 50 mA

A.1.8 EIA Interface (ANSI only)

The ONS 15454 electrical interface assembly (EIA) interface has the following specifications:

- SMB: AMP #415504-3 75-ohm, 4-leg connectors
- BNC: Trompeter #UCBJ224 75-ohm 4 leg connector (King or ITT are also compatible)
- AMP Champ: AMP#552246-1 with #552562-2 bail locks

A.1.9 BITS Interface (ANSI only)

The ONS 15454 building integrated timing supply (BITS) interface has the following specifications:

- 2 DS-1 BITS inputs
- 2 derived DS-1 outputs
- Backplane access: BITS pin field

A.1.10 System Timing

The ONS 15454 ANSI has the following system timing specifications:

- Stratum 3 per Telcordia GR-253-CORE

- Free running accuracy: +/– 4.6 ppm
- Holdover stability: 3.7 x 10^{-7} per day, including temperature (< 255 slips in first 24 hours)
- Reference: External BITS, line, internal

The ONS 15454 ETSI has the following system timing specifications:

- Stratum 3E, per ITU-T G.813
- Free running accuracy: +/– 4.6 ppm
- Holdover stability: 3.7 exp –7 per day, including temperature (< 255 slips in first 24 hours)
- Reference: External BITS, line, internal

A.1.11 System Power

The ONS 15454 ANSI has the following power specifications:

- Nominal Input Voltage: –48 VDC
- Power consumption: Configuration dependent; 55 W (fan tray only)
- Power requirements:
  - Nominal: –48 VDC
  - Input Voltage Range: –40.5 to –57.0 VDC
- Power terminals: #6 Lug
- ANSI shelf fusing: 100–A fuse panel (minimum 30 A fuse per shelf)
  HD shelf fusing: 100–A fuse panel (minimum 30 A fuse per shelf)

The ONS 15454 ETSI has the following power specifications:

- Nominal Input Voltage: –48 VDC
- Power consumption: Configuration dependent; 53 W (fan tray only)
- Power requirements:
  - Nominal: –48 VDC
  - Input Voltage Range: –40.5 to –57.0 VDC
- Power terminals: 3WK3 Combo-D power cable connector (MIC-A/P and MIC-C/T/P faceplates)
- Fusing: 100 A fuse panel; minimum 30 A fuse per shelf

A.1.12 Fan Tray

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

Table A-1 Fan Tray Assembly Power Requirements

Fan Tray Assembly	Watts	Amps	BTU/Hr
FTA2	53	1.21	198
FTA3 -T	86.4	1.8	295
15454E-CC-FTA/15454-CC-FTA	115	2.4	393

A.1.13 System Environmental Specifications

The ONS 15454 ANSI has the following environmental specifications:

- Operating temperature:

  C-Temp: 32 to +131 degrees Farenheit (0 to +55 degrees Celsius)

  I-Temp: –40 to +139 degrees Farenheit (–40 to +65 degrees Celsius)
- Operating humidity: 5 to 95 percent, noncondensing

The ONS 15454 ETSI has the following environmental specifications:

- Operating temperature: 32 to 104 degrees Fahrenheit (0 to +40 degrees Celsius)
- Operating humidity: 5 to 95 percent, noncondensing

A.1.14 Dimensions

The ONS 15454 ANSI shelf assembly has the following dimensions:

- Height: 18.5 in. (40.7 cm)
- Width: 19 or 23 in. (41.8 or 50.6 cm) with mounting ears attached
- Depth: 12 in. (26.4 cm) (5 in. or 12.7 cm projection from rack)
- Weight: 55 lb (24.947 kg) empty

The ONS 15454 ETSI shelf assembly has the following dimensions:

- Height: 616.5 mm (24.27 in.)
- Width: 535 mm (17 in.) without mounting ears attached
- Depth: 280 mm (11.02 in.)
- Weight: 26 kg empty (57.3 lb)

A.2 General Card Specifications

This section provides power specifications and temperature ranges for all ONS 15454 cards.

A.2.1 Power

Table A-2 provides power consumption information for the ONS 15454 cards.

Table A-2 Individual Card Power Requirements (Typical Values at 25 degrees C)

Card Type	Card Name	(Power in Watts)	Amperes at –48 V	BTU/Hr.
Common Control Cards	TCC2/TCC2P	26	0.54	89
	AIC-I	8	0.17	28
	AEP	3	(from +5 VDC from AIC-I)	10
	MIC-A/P	0.13	via TCC2/TCC2P/TCC3	0.44
	MIC-C/T/P	0.38	via TCC2/TCC2P/TCC3	1.29
	MS-ISC-100T	53	1.10	181.0
Optical Service Channel Cards	OSCM	23	0.48	79
	OSC-CSM	24	0.5	82
Optical Amplifier Cards	OPT-PRE	30	0.63	103
	OPT-BST	30	0.63	103
	OPT-BST-E	30	0.63	103
	OPT-BST-L	25	0.52	86
	OPT-AMP-L	32	0.67	110
	OPT-AMP-17-C	40	0.83	137
	OPT-AMP-C	40	0.83	137
Multiplexer and Demultiplexer Cards	32MUX-O	16	0.33	55
	32DMX-O	16	0.33	55
	4MD-xx.x	17	0.35	58.0
ROADM Cards	32DMX	15	0.31	52
	32DMX-L	15	0.31	52
	32WSS	50	1.04	171
	32WSS-L	43	0.90	147
	40-MUX-C	35	0.73	120
	40-DMX-C	35	0.73	120
	40-DMX-CE	35	0.73	120
	40-WSS-C	73	1.53	250
	40-WSS-CE	73	1.53	250
	40-WXC-C	30	0.63	103
	MMU	7	0.15	24

Table A-2 Individual Card Power Requirements (continued)(Typical Values at 25 degrees C)

Card Type	Card Name	(Power in Watts)	Amperes at –48 V	BTU/Hr.
Optical Add/Drop Cards	AD-1C-xx.x	17	0.35	58.0
	AD-2C-xx.x	17	0.35	58.0
	AD-4C-xx.x	17	0.35	58.0
	AD-1B-xx.x	17	0.35	58.0
	AD-4B-xx.x	17	0.35	58.0
Transponder and Muxponder Cards	TXP_MR_10G	35	0.73	120
	TXP_MR_10E	50	1.05	171
	TXP_MR_10E_C	50	1.05	171
	TXP_MR_10E_L	50	1.05	171
	TXP_MR_2.5G	35	0.73	120
	TXPP_MR_2.5G	50	1.05	171
	MXP_2.5G_10G	50	1.05	171
	MXP_2.5G_10E	50	1.05	171
	MXP_2.5G_10E_C	50	1.05	171
	MXP_2.5G_10E_L	50	1.05	171
	MXP_MR_2.5G	50	1.05	171
	MXPP_MR_2.5G	50	1.05	171
Transponder and Muxponder Cards	MXP_MR_10DME_C	60	1.25	205
	MXP_MR_10DME_L	60	1.25	205
	ADM-10G	135	2.81	461

A.2.2 Temperature

- Operating temperature:
  - Long term: 0 to 40 degrees Celsius (32 to 104 degrees Fahrenheit)
  - Short term: Functionality is guaranteed at -5 to 55 degrees Celsius (23 to 131 degrees Fahrenheit), according to GR-63 Issue 3

The indicated temperatures are the ambient ones in which the shelf can be placed.

A.3 Common Control Card Specifications

This section provides specifications for the TCC2, TCC2P, AIC, and AIC-I cards, the alarm expansion panel (AEP), the MIC-A/P and MIC-C/T/P FMECs, and the MS-ISC-100T card.

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

A.3.1 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 (through the backplane)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/– 4.6 ppm
  - Holdover stability: 3.7 x 10^{-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
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.3.2 TCC2P Card Specifications

The TCC2P card has the following specifications:

- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TCC2P faceplate)
  - Interface: 10BaseT LAN (on TCC2P faceplate)
  - Interface: 10BaseT LAN (through the 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 (in –48 VDC systems)
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 1.5 lb (0.7 kg)

A.3.3 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
- Express orderwire/local orderwire (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 (A-law/mu-law) configuration, the orderwire is not ITU-T G.712 compliant.

  - Orderwire party line
  - Dual tone, multifrequency (DTMF) signaling
- User data channel (UDC)
  - Bit rate: 64 kbps, codirectional

  - ITU-T G.703
  - Input/output impedance: 120 ohm
  - Termination: RJ-11 connectors
- Data communications channel (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)
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Weight: 1.8 lb (0.82 kg)

A.3.4 AEP Specifications (ANSI only)

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
  - 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
- 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)

A.3.5 MIC-A/P FMEC Specifications (ETSI only)

The MIC-A/P FMEC card has the following specifications:

- Power supply input BATTERY B
  - System supply voltage: Nominal –48 VDC
    Tolerance limits: –40.5 to –57.0 VDC
  - Connector: 3WK3 Combo-D power cable connector
- Alarm outputs
  - Voltage (open contact): Maximum 60 VDC
  - Current (closed contact): Maximum 250 mA
  - Connector: 62-pin DB connector (common for inputs/outputs)
- Alarm inputs
  - Voltage (open contact): Maximum 60 VDC
  - Current (closed contact): Maximum 2 mA
  - Connector: 62-pin DB connector (common for inputs/outputs)
- Dimensions
  - Height: 182 mm (7.165 in.)
  - Width: 31.88 mm (1.255 in.)
  - Depth: 92 mm (3.62 in.)
  - Depth with backplane connector: 98 mm (3.87 in.)
  - Weight not including clam shell: 0.2 kg (0.5 lb)

A.3.6 MIC-C/T/P FMEC Specifications (ETSI only)

The MIC-C/T/P FMEC card has the following specifications:

- Power supply input BATTERY A
  - System supply voltage: Nominal –48 VDC
    Tolerance limits: –40.5 to –57.0 VDC
  - Connector: 3WK3 Combo-D power cable connector
- Timing connector
  - Frequency: 2.048 MHz +/–10 ppm

  - Signal level: 0.75 to 1.5 V
  - Impedance: 75 ohms +/–5 percent (switchable by jumper to high impedance > 3 kohms)

Note 120 ohms balanced impedance is possible with external matching cable.

  - Cable attenuation: Up to 6 dB at 2 MHz
  - Connectors: 1.0/2.3 miniature coax connector
- System management serial port:
  - System management serial port craft interface
  - Modem port (for future use)
  - Connectors: 8-pin RJ-45
- System management LAN port connectors:
  - Signal: IEEE 802.3 10BaseT
  - Connectors: 8-pin RJ-45
- Dimensions
  - Height: 182 mm (7.165 in.)
  - Width: 31.88 mm (1.255 in.)
  - Depth: 92 mm (3.62 in.)
  - Depth with backplane connector: 98 mm (3.87 in.)
  - Weight not including clam shell: 0.2 kg (0.5 lb)

A.3.7 MS-ISC-100T Card Specifications

The MS-ISC-100T card has the following specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.3 lb (1.0 kg)

A.4 Optical Service Channel Cards

This section provides specifications for the OSCM and OSC-CSM cards.

A.4.1 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
- Transmitter optical service channel (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} bit error rate (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
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.4.2 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
- 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
  - 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
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.5 Optical Amplifier Cards

This section provides specifications for the OPT-PRE amplifier, OPT-BST amplifier, OPT-BST-E amplifier, OPT-BST-L amplifier, OPT-AMP-L preamplifier (configurable as a preamplifier or booster amplifier), OPT-AMP-C amplifier (configurable as a preamplifier or booster amplifier, and OPT-AMP-17-C amplifier cards.

A.5.1 OPT-PRE Amplifier Card Specifications

The OPT-PRE amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Mid-access loss (MAL) range (for dispersion compensation unit [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

- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.2 OPT-BST Amplifier Card Specifications

The OPT-BST amplifier card 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
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.3 OPT-BST-E Amplifier Card Specifications

The OPT-BST-E amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm
  - Gain ripple (peak to valley): 1.8 dB
  - Gain range: 8 to 23 dB with programmable gain tilt
  - Extended gain range: 23 to 26 dB with gain tilt uncontrolled
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 20.5 dBm

  - Maximum output power (with full channel load): 20 dB
  - Minimum output power (with one channel): –0 dBm
  - Input power (Pin) range at full channel load: –6 to 12 dBm
  - Input power (Pin) range at single channel load: –26 to –8 dBm
  - Noise figure at G^3 23 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
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.4 OPT-BST-L Amplifier Card Specifications

The OPT-BST-L amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1570.0 to 1605.0 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Gain range: 8 to 20 dB with programmable gain tilt
  - Extended gain range: 20 to 27 dB with gain tilt uncontrolled
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 10 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: –10 to 9 dBm
  - Input power (Pin) range at single channel load: –37 to –18 dBm
  - Noise figure at G^3 20 dB = 7.5 dB
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.5 OPT-AMP-L Preamplifier Card Specifications

The OPT-AMP-L card has the following specifications:

- Optical characteristics:
  - DWDM channel wavelength plan, 100 GHz, 4 skip 1, ITU-T wavelength grid channels 71 (1602.3 nm) to 90 (1570.4 nm)
  - DWDM channel wavelength plan, 50 GHz, 8 skip 2, ITU-T wavelength grid channels 70.5 (1602.7 nm) to 90 (1570.4 nm)
  - Channel spacing: 100 and 50 GHz
  - Total operating wavelength range 1570.0 - 1605.0 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Standard gain range: 12 to 24 dB
  - Extended gain range (uncontrolled gain tilt): 24 to 35 dB
  - Gain and power regulation over/undershoot: 0.5 dB
  - Minimum output power (with one channel): +2 dBm
  - Maximum power output (standard or extended gain range): 20 dB
  - Input power range (full channel load): –15 to 8 dB
  - Input power range (single channel load): –40 to –17
  - Noise figure at G^3 20 dB = 8.9 dB
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.6 OPT-AMP-17-C Amplifier Card Specifications

The OPT-AMP-17-C card has the following specifications:

- Optical characteristics:
  - DWDM channel wavelength plan: 80 channels at 50 GHz spacing, 1530.33 nm to 1561.83 nm
  - Channel spacing: 50 GHz
  - Total operating wavelength range 1529.0 to 1562.5 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Gain range: 14 to 23 dB
  - Optimal gain (gain tilt = 0): 17 dB
  - Gain and power regulation over/undershoot: 0.5 dB

  - Minimum output power (with one channel): –2 dBm
  - Maximum power output (standard or extended gain range): 17.5 dBm
  - Input power range (full channel load): –6 to 3 dBm
  - Input power range (single channel load): –28 to –19 dBm
  - Noise figure at G=17dB = 6 dB maximum
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.5.7 OPT-AMP-C Amplifier Card Specifications

The OPT-AMP-C amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1529.0 to 1562.5 nm
  - Gain ripple (peak to valley): 1.2 dB
  - Gain range: 12 to 24 dB with programmable gain tilt
  - Extended gain range: 24 to 35 dB with gain tilt uncontrolled
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 20.5 dBm
  - Maximum output power (with full channel load): 20 dBm
  - Minimum output power (with one channel): –2 dBm
  - Input power (Pin) at full channel load: –15 dBm minimum
  - Input power (Pin) range at single channel load: –40 to –17 dBm
  - Noise figure at G^3 20 dB = 7.6 dB
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 8.66 in. (220.1 mm)

A.6 Multiplexer and Demultiplexer Cards

This section provides specifications for the 32MUX-O, 32DMX-O, and 4MD-xx.x cards.

A.6.1 32MUX-O Card Specifications

The 32MUX-O card optical specifications are listed in Table A-3.

Note For power specifications, see Table A-2 on page A-6.

Table A-3 32MUX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Transmit (Tx) filter shape (–1 dB bandwidth)	All standard operating procedures (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	+/–300	pm
Insertion loss	All SOP and within whole operating temperature range	In 1/32—Out BOL	4	8.0	dB
		In 1/32—Out EOL	4	8.5	dB
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 32MUX-O card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.6.2 32DMX-O Card Specifications

The 32DMX-O card optical specifications are listed in Table A-4.

Note For power specifications, see Table A-2 on page A-6.

Table A-4 32DMX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Receive (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	+/–300	pm
Insertion loss	All SOP and within whole operating temperature range	In 1/32—Out BOL	4	8.0	dB
		In 1/32—Out EOL	4	8.5	dB
VOA dynamic range	—	—	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 32DMX-O card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.6.3 4MD-xx.x Card Specifications

The 4MD-xx.x card optical specifications are listed in Table A-5.

Note For power specifications, see Table A-2 on page A-6.

Table A-5 4MD-xx.x 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

Table A-5 4MD-xx.x Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
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:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7 Reconfigurable Optical Add/Drop Cards

This section provides specifications for the 32DMX, 32DMX-L, 40-MUX-C, 40-DMX-C, 40-DMX-CE, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 32WSS, 32WSS-L, and MMU cards.

A.7.1 32DMX Card Specifications

The 32DMX card optical specifications are listed in Table A-6.

Note For power specifications, see Table A-2 on page A-6.

Table A-6 32DMX Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–1 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	COM RX => TX 1, 32 (OUT)	+/–110	—	—	pm
–3 dB bandwidth			+/–200	—	—	pm
Insertion loss	All SOP, and within whole operating temperature range, connectors included.	COM RX => TX 1, 32	—	—	5.5	dB

Table A-6 32DMX Optical Specifications (continued)

Parameter	Note	Condition	Min	Typical	Max	Units
VOA dynamic range	—	COM RX => TX 1, 32	25	—	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32DMX channel plan is shown in Table A-7. All 32DMX client interfaces must comply with this plan.

Table A-7 32DMX Channel Plan

Channel Number	Band	Channel ID	Frequency (GHz)	Wavelength (nm)
1	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	2	34.2	195.4	1534.25
6		35.0	195.3	1535.04
7		35.8	195.2	1535.82
8		36.6	195.1	1536.61
9	3	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	4	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	5	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	6	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

Table A-7 32DMX Channel Plan (continued)

Channel Number	Band	Channel ID	Frequency (GHz)	Wavelength (nm)
25	7	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	8	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

The 32DMX card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.2 32DMX-L Card Specifications

The 32DMX-L card optical specifications are listed in Table A-6.

Note For power specifications, see Table A-2 on page A-6.

Table A-8 32DMX -L Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–1 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	COM RX => TX 1, 32 (OUT)	+/–100	—	—	pm
–3 dB bandwidth			+/–199	—	—	pm
Insertion loss	All SOP, and within whole operating temperature range, connectors included.	COM RX => TX 1, 32	—	—	5.8	dB
VOA dynamic range	—	COM RX => TX 1, 32	25	—	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32DMX-L channel plan is shown in Table A-9. All 32DMX-L client interfaces must comply with this plan.

Table A-9 32DMX-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	1591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

The 32DMX-L card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.3 32WSS Card Specifications

The 32WSS card optical specifications are listed in Table A-10.

Note For power specifications, see Table A-2 on page A-6.

Table A-10 32WSS Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–0.25 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	EXP RX => COM TX	+/–/95	—	—	pm
–0.5 dB bandwidth			+/–115	—	—	pm
–1.0 dB bandwidth			+/–135	—	—	pm
–0.25 dB bandwidth		Add 1, 32 => COM TX	+/–115	—	—	pm
–0.5 dB bandwidth			+/–135	—	—	pm
–1.0 dB bandwidth			+/–160	—	—	pm
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => COM TX	—	—	11.3	dB
	—	COM RX => EXP TX	—	—	1.5	dB
	—	Add 1, 32 => COM TX	—	—	7.6	dB
	—	COM RX => DROP TX	6	—	8.5	dB
VOA dynamic range	—	EXP RX => COM TX	20	—	—	dB
	—	Add 1, 32 => COM TX	25	—	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32WSS channel plan is shown in Table A-11. All 32WSS client interfaces must comply with this plan.

Table A-11 32WSS Channel Plan

Channel Number	Band	Channel ID	Frequency (GHz)	Wavelength (nm)
1	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	2	34.2	195.4	1534.25
6		35.0	195.3	1535.04
7		35.8	195.2	1535.82
8		36.6	195.1	1536.61
9	3	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	4	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	5	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	6	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	7	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	8	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

The 32WSS card has the following additional specifications:

- Dimensions

- Height: 12.65 in. (321.3 mm)
- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (228.6 mm)

A.7.4 32WSS-L Card Specifications

The 32WSS-L card optical specifications are listed in Table A-12.

Note For power specifications, see Table A-2 on page A-6.

Table A-12 32WSS-L Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–0.1 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	EXP RX => COM TX	—	+/–/57	—	pm
–0.25 dB bandwidth			+/–/61	+/–/89	—	
–0.5 dB bandwidth			+/–91	+/–/116	—	
–1.0 dB bandwidth			+/–135	+/–/149	—	
–0.1 dB bandwidth		Add 1, 32 => COM TX	+/–32	+/–/69	—	
–0.25 dB bandwidth			+/–98	+/–/129	—	
–0.5 dB bandwidth			+/–135	+/–/161	—	
–1.0 dB bandwidth			+/–160	+/–/201	—	
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => COM TX	—	9.7	11.3	dB
		COM RX => EXP TX	—	1.4	1.6	dB
		Add 1, 32 => COM TX	—	6.2	8.0	dB
		COM RX => DROP TX	6.0	8.0	8.5	dB
VOA dynamic range	—	EXP RX => COM TX	20	25	—	dB
	—	Add 1, 32 => COM TX	25	25	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32WSS-L channel plan is shown in Table A-13. All 32WSS-L client interfaces must comply with this plan.

Table A-13 32WSS-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	1591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

The 32WSS-L card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)

- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (228.6 mm)

A.7.5 40-MUX-C Card Specifications

The 40-MUX-C card optical specifications are listed in Table A-14.

Note For power specifications, see Table A-2 on page A-6.

Table A-14 40-MUX-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Transmit (Tx) filter shape	All standard operating procedures (SOP) and within whole operating temperature range	–1 dB bandwidth, RX 1, 40 => COM TX	+/–100	—	pm
		–3 dB bandwidth, RX 1, 40 => COM TX	+/–199	—	pm
Insertion loss	All SOP and within whole operating temperature range	RX 1, 40 => COM TX		5.8	dB
VOA dynamic range	—	RX 1, 40 => COM TX	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-MUX-C card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.6 40-DMX-C Card Specifications

The 40-DMX-C card optical specifications are listed in Table A-15.

Note For power specifications, see Table A-2 on page A-6.

Table A-15 40-DMX-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Receive (Rx) filter shape	All SOP and within whole operating temperature range	–1 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–100	—	pm
		–3 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–199	—	pm
Insertion loss	All SOP and within whole operating temperature range	COM RX => TX 1, 40	—	5.8	dB
VOA dynamic range	—	COM RX => TX 1, 40	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-DMX-C card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.7 40-DMX-CE Card Specifications

The 40-DMX-CE card optical specifications are listed in Table A-16.

Note For power specifications, see Table A-2 on page A-6.

Table A-16 40-DMX-CE Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Receive (Rx) filter shape	All SOP and within whole operating temperature range	–1 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–100	—	pm
		–3 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–199	—	pm
Insertion loss	All SOP and within whole operating temperature range	COM RX => TX 1, 40	—	5.8	dB

Table A-16 40-DMX-CE Card Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
VOA dynamic range	—	COM RX => TX 1, 40	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-DMX-CE card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.8 40-WSS-C Card Specifications

The 40-WSS-C card optical specifications are listed in Table A-17.

Note For power specifications, see Table A-2 on page A-6.

Table A-17 40-WSS-C Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	EXP_RX to COM_TX	—	—	pm
Channel grid: –0.25 dB			+/– 61	—	pm
Channel grid: –0.5 dB			+/– 91	—	pm
Channel grid: –1.0 dB			+/– 135	—	pm
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	EXP_RX to COM_TX	+/– 32	—	pm
Channel grid: –0.25 dB			+/– 98	—	pm
Channel grid: –0.5 dB			+/– 135	—	pm
Channel grid: –1.0 dB			+/– 160	—	pm

Table A-17 40-WSS-C Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
Insertion loss	All SOP and within whole operating temperature range	EXP_RX to COM_TX	—	7.5	dB
		EXP_RX to COM_TX	—	2.3	dB
		EXP_RX to COM_TX	—	6.0	dB
		EXP_RX to COM_TX	—	6.8	dB
VOA dynamic range	—	EXP_RX to COM_TX	20	—	dB
		EXP_RX to COM_TX	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-WSS-C card channel grid is listed in Table A-18.

Table A-18 40-WSS-C Channel Grid

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195.0	1537.4
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35

Table A-18 40-WSS-C Channel Grid (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194.0	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193.0	1553.33
54.1	54.1	192.9	1544.13
	54.9	192.8	1544.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192.0	1561.42

The 40-WSS-C card has the following additional specifications:

- Dimensions
  - Height: 8.66 in. (220 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 1.42 in. (36 mm)

A.7.9 40-WSS-CE Card Specifications

The 40-WSS-CE card optical specifications are listed in Table A-19.

Note For power specifications, see Table A-2 on page A-6.

Table A-19 40-WSS-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	EXP RX greater than or equal to COM TX	—	—	pm
Channel grid: –0.25 dB			+/– 61	—	pm
Channel grid: –0.5 dB			+/– 91	—	pm
Channel grid: –1.0 dB			+/– 135	—	pm
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	Add 1, 40 greater than or equal to COM TX	+/– 32	—	pm
Channel grid: –0.25 dB			+/– 98	—	pm
Channel grid: –0.5 dB			+/– 135	—	pm
Channel grid: –1.0 dB			+/– 160	—	pm
Insertion loss	All SOP and within whole operating temperature range	EXP RX greater than or equal to COM TX	—	7.5	dB
		COM RX greater than or equal to EXP TX	—	2.3	dB
		Add 1, 40 greater than or equal to COM TX	—	6.0	dB
		COM RX greater than or equal to DROP TX	—	6.8	dB
VOA dynamic range	—	EXP RX greater than COM TX	20	—	dB
		Add 1, 40 greater than or equal to COM TX	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-WSS-CE card channel grid is listed in Table A-20.

Table A-20 40-WSS-C Card Channel Grid

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.7	30.7	195.85	1530.72
	31.5	195.75	1531.51
	32.3	195.65	1532.29
	33.1	195.55	1533.07
	33.9	195.45	1533.86
B34.6	34.6	195.35	1534.64
	35.4	195.25	1535.43
	36.2	195.15	1536.22
	37.0	195.05	1537.00
	37.8	194.95	1537.79
B38.6	38.6	194.85	1538.58
	39.4	194.75	1539.37
	40.1	194.65	1540.16
	40.9	194.55	1540.95
	41.8	194.45	1541.75
B42.5	42.5	194.35	1542.54
	43.3	194.25	1543.33
	44.1	194.15	1544.13
	44.9	194.05	1544.92
	45.7	193.95	1545.72
B46.5	46.5	193.85	1546.52
	47.3	193.75	1547.32
	48.1	193.65	1548.11
	48.9	193.55	1548.91
	49.7	193.45	1549.72
B50.5	50.5	193.35	1550.52
	51.3	193.25	1551.32
	52.1	193.15	1552.12
	52.9	193.05	1552.93
	53.7	192.95	1553.73
B54.4	54.4	192.85	1554.54
	55.3	192.75	1555.34
	56.1	192.65	1556.15
	56.9	192.55	1556.96
	57.8	192.45	1557.77

Table A-20 40-WSS-C Card Channel Grid (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B58.6	58.6	192.35	1558.58
	59.4	192.25	1559.39
	60.2	192.15	1560.20
	61.0	192.05	1561.01
	61.8	191.95	1561.83

The 40-WSS-CE card has the following additional specifications:

- Dimensions
  - Height: 8.66 in. (220 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 1.42 in. (36 mm)

A.7.10 40-WXC-C Card Specifications

The 40-WXC-C card optical specifications are listed in Table A-21.

Note For power specifications, see Table A-2 on page A-6.

Table A-21 40-WXC-C Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel bandwidth: –0.25 dB	All SOP and within whole operating temperature range	All paths	—	—	GHz
Channel bandwidth: –0.5 dB			+/- 20.5	—	GHz
Channel bandwidth: –1.5 dB			—	—	GHz
Channel bandwidth: –03.0 dB			+/- 37.5	—	GHz
Insertion loss	All SOP and within whole operating temperature range	All paths	—	8.5	dB
VOA dynamic range	—	All paths	20	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-WXC-C card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm) for a standard DWDM unit

- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (228.6 mm) for a standard DWDM unit

A.7.11 MMU Card Specifications

The MMU card optical specifications are listed in Table A-22.

Note For power specifications, see Table A-2 on page A-6.

Table A-22 MMU Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
Operating bandwidth	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	All paths	1500	—	1605	nm
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => COM TX	—	—	7.0	dB
		EXP A RX => COM TX	—	—	2.3	dB
		COM RX => EXP TX	—	—	0.8	dB
		COM RX => EXP A TX	—	—	14.8	dB
Wavelength dependent losses	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	C-band only	—	—	0.3	dB
		L-band only	—	—	0.3	dB
		C and L bands	—	—	0.5	dB
Polarization dependent loss (PDL)	—	C-band only	—	—	0.2	dB
	—	L-band only	—	—	0.2	dB
	—	C and L bands	—	—	0.3	dB
Chromatic dispersion		All paths	–20	—	+20	ps/nm
Polarization mode dispersion (PMD)	—	All paths	—	—	0.1	ps
Optical power reading resolution	—	All photodiodes (both real and virtual)	—	—	0.1	dB
Optical power reading precision	—		–0.1	—	0.1	dB

Table A-22 MMU Optical Specifications (continued)

Parameter	Note	Condition	Min	Typical	Max	Units
Directivity	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => EXP A RX	40	—	—	dB
		EXP RX => EXP B RX	40	—	—	dB
		EXP A RX => EXP B RX	40	—	—	dB
Return loss	—	—	40	—	—	dB
Maximum optical input power	Maximum handling power	—	500	—	—	mW

The MMU card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 8.66 in. (220.1 mm)

A.8 Optical Add/Drop Cards

This section provides specifications for the AD-IC-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, and AD-4B-xx.x cards.

A.8.1 AD-1C-xx.x Card Specifications

Table A-23 lists the AD-1C-xx.x optical specifications.

Table A-23 AD-1C-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 xx.xx Rx—COM Tx	+/–180	—	pm
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
Insertion loss (express section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	COM Rx—Exp Tx Exp Rx—COM Tx	—	2.4 or 1.2	dB

Table A-23 AD-1C-xx.x Card Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
Insertion loss (add section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	2.6	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

The AD-1C-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 6-3 on page 6-3 through Table 6-6 on page 6-5 for this information.

The AD-1C-xx.x card has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.8.2 AD-2C-xx.x Card Specifications

Table A-24 lists the AD-2C-xx.x optical specifications.

Table A-24 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	+/–180	—	
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	dB
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	dB
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	dB

Table A-24 AD-2C-xx.x Card Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

The AD-2C-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 6-3 on page 6-3 through Table 6-6 on page 6-5 for this information.

The AD-2C-xx.x has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.8.3 AD-4C-xx.x Card Specifications

Table A-25 lists the AD-4C-xx.x optical specifications.

Table A-25 AD-4C-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid	See Table A-26. The channel plan for the AD-4C-xx.x card is identical to the channel plan for the AD-1B-xx.x card.	—	—	—	—
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	+/–180	—	pm
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	dB
		COM Rx—zz.zz Tx	—	4.5	dB
		COM Rx—kk.kk Tx	—	4.1	dB
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	dB

Table A-25 AD-4C-xx.x Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
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	dB
		zz.zz Rx—COM Tx	—	4.5	dB
		kk.kk Rx—COM Tx	—	4.9	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

The AD-4C-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 6-3 on page 6-3 through Table 6-6 on page 6-5 for this information.

The AD-4C-xx.x has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.8.4 AD-1B-xx.x Card Specifications

Table A-26 lists the unit names, band IDs, channel IDs, frequencies, and wavelengths assigned to the eight versions of the AD-1B-xx.x card.

Table A-26 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

Table A-26 AD-1B-xx.x Channel Allocation Plan by Band (continued)

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
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
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

Table A-26 AD-1B-xx.x Channel Allocation Plan by Band (continued)

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
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 A-27 lists AD-1B-xx.x optical specifications.

Table A-27 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	See Table A-28.		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

Table A-27 AD-1B-xx.x Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
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	dB
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 A-28 lists the range of wavelengths for the receive (express) band.

Table A-28 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	—

The AD-1B-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 6-3 on page 6-3 through Table 6-6 on page 6-5 for this information.

The AD-1B-xx.x card has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.8.5 AD-4B-xx.x Card Specifications

Table A-29 lists the unit names, band IDs, channel IDs, frequencies, and wavelengths assigned to the two versions of the card.

Table A-29 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 A-29 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 A-30 lists AD-4B-xx.x optical specifications.

Table A-30 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 A-31.		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	dB
		COM Rx—Band Tx 38.1/54.1	—	3.8	dB
		COM Rx—Band Tx 42.1/58.1	—	4.5	dB
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	dB
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	dB
		Band Rx 38.1/54.1—COM Tx	—	2.3	dB
		Band Rx 42.1/58.1—COM Tx	—	1.8	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

Table A-31 lists the range of wavelengths for the receive (express) band.

Table A-31 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	—	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
B42.1	Wavelengths 1541.275 or lower	Wavelengths 1545.695 or higher

Table A-31 AD-4B-xx.x Transmit and Receive Dropped Band Wavelength Ranges (continued)

	Rx (Express) Band	
Tx (Dropped) Band	**Left Side (nm)**	**Right Side (nm)**
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	—

The AD-4B-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 6-3 on page 6-3 through Table 6-6 on page 6-5 for this information.

The AD-4B-xx.x has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.9 Transponder and Muxponder Card Specifications

This section provides specifications for the TXP_MR_10G, MXP_2.5G_10G, TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, MXPP_MR_2.5G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, MXP_MR_10DME_C, MXP_MR_10DME_L cards, and ADM-10G cards.

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

A.9.1 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

    10.70923 Gbps with ITU-T G.709 Digital Wrapper/forward error correction (FEC)

    10.3125 Gbps for 10 Gigabit Ethernet (GE)

    11.095 Gbps with ITU-T G.709 Digital Wrapper/FEC over 10 GE
  - 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.691
- Transmitter (trunk side)
  - Maximum transmitter output power: +3.5 dBm
  - Minimum transmitter output power: +2.5 dBm
  - Transmitter: Lithium Niobate (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 (16 card versions, each covering two wavelengths):
  - 1530.33 to 1531.12 nm (two wavelengths)
  - 1531.90 to 1532.68 nm (two wavelengths)
  - 1534.25 to 1535.04 nm (two wavelengths)
  - 1535.82 to 1536.61 nm (two wavelengths)
  - 1538.19 to 1538.98 nm (two wavelengths)
  - 1539.77 to 1540.56 nm (two wavelengths)
  - 1542.14 to 1542.94 nm (two wavelengths)
  - 1543.73 to 1544.53 nm (two wavelengths)
  - 1546.12 to 1546.92 nm (two wavelengths)
  - 1547.72 to 1548.51 nm (two wavelengths)
  - 1550.12 to 1550.92 nm (two wavelengths)
  - 1551.72 to 1552.52 nm (two wavelengths)
  - 1554.13 to 1554.94 nm (two wavelengths)
  - 1555.75 to 1556.55 nm (two wavelengths)
  - 1558.17 to 1558.98 nm (two wavelengths)
  - 1559.79 to 1560.61 nm (two wavelengths)
- Receiver (trunk side):
  - Receiver input power (no FEC, unamplified, 23 dB optical signal-to-noise ratio [OSNR], BER 1 * 10 exp – 12): –8 to –21 dBm
  - Receiver input power (no FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12): –8 to –19 dBm
  - Receiver input power (no FEC, amplified, 19 dB OSNR, BER 1 * 10 exp – 12): –8 to –20 dBm

  - Receiver input power (no FEC, amplified, 19 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12):–8 to –18 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, BER 8 * 10 exp – 5): –8 to –24 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm, BER 8 * 10 exp – 5): –8 to –22 dBm
  - Receiver input power (FEC, amplified, 9 dB OSNR, BER 8 * 10 exp – 5): –8 to –18 dBm
  - Receiver input power (FEC, unamplified, 11 dB OSNR, at +/– 800 ps/nm, BER 8 * 10 exp – 5): –8 to –18 dBm
- Line (client side)
  - Bit rate: 9.95328 Gbps or 10.3125 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: Compliant with SR-1 specification for OC-192. In the case of 10 GE, the allowance is up to 10 km of single-mode fiber (SMF) dispersion.
  - Loopback modes: Terminal and facility
  - Connectors: LC
- 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: Distributed feedback (DFB) laser
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: avalanche photodiode (APD)
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.2 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

    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
- Transmitter (trunk side)
  - Maximum transmitter output power: +3.5 dBm
  - Minimum transmitter output power: +2.5 dBm
  - 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 (16 card versions, each covering two wavelengths):
  - 1530.33 to 1531.12 nm (two wavelengths)
  - 1531.90 to 1532.68 nm (two wavelengths)
  - 1534.25 to 1535.04 nm (two wavelengths)
  - 1535.82 to 1536.61 nm (two wavelengths)
  - 1538.19 to 1538.98 nm (two wavelengths)
  - 1539.77 to 1540.56 nm (two wavelengths)
  - 1542.14 to 1542.94 nm (two wavelengths)
  - 1543.73 to 1544.53 nm (two wavelengths)
  - 1546.12 to 1546.92 nm (two wavelengths)
  - 1547.72 to 1548.51 nm (two wavelengths)
  - 1550.12 to 1550.92 nm (two wavelengths)
  - 1551.72 to 1552.52 nm (two wavelengths)
  - 1554.13 to 1554.94 nm (two wavelengths)
  - 1555.75 to 1556.55 nm (two wavelengths)
  - 1558.17 to 1558.98 nm (two wavelengths)

  - 1559.79 to 1560.61 nm (two wavelengths)
- Receiver (trunk side)
  - Receiver input power (no FEC, unamplified, 23 dB OSNR, BER 1 * 10 exp – 12): –8 to –21 dBm
  - Receiver input power (no FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12): –8 to –19 dBm
  - Receiver input power (no FEC, amplified, 19 dB OSNR, BER 1 * 10 exp – 12): –8 to –20 dBm
  - Receiver input power (no FEC, amplified, 19 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12): –8 to –18 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, BER 8 * 10 exp – 5): –8 to –24 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm, BER 8 * 10 exp – 5): –8 to –22 dBm
  - Receiver input power (FEC, amplified, 9 dB OSNR, BER 8 * 10 exp – 5): –8 to –18 dBm
  - Receiver input power (FEC, unamplified, 11 dB OSNR, at +/– 800 ps/nm, BER 8 * 10 exp – 5): –8 to –18 dBm
- Line (client side)
  - Bit rate: 2.48832 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: Compliant with SR-1 specification for OC-192. In the case of 10 GE, allowance is up to 10 km of SMF fiber of dispersion.
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side): Depends on the Small Form-factor Pluggable (SFP) that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.3 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

    2.66 Gbps with ITU-T G.709 Digital Wrapper/FEC
  - Code: Scrambled NRZ

- Fiber: 1550-nm single-mode
- Maximum chromatic dispersion allowance: 5400 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

- 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 (eight card versions):

  ITU grid blue band: 1530.334 to 1544.526 nm (four card versions covering four wavelengths each)

  ITU grid red band: 1546.119 to 1560.606 nm (four card versions covering four wavelengths each)
- Receiver (trunk side, see Table A-32)

Table A-32 TXP_MR_2.5G/TXPP_MR_2.5G Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance
22 dB	Off - 2R	< 10 exp – 12	N/A	– 9 to – 24 dBm	—
22 dB	Off - 2R	< 10 exp – 12	N/A	– 9 to – 21 dBm	+/– 3300ps/nm
21 dB	Off - 3R	< 10 exp – 12	N/A	– 9 to – 30 dBm	—
22 dB	Off - 3R	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 1800ps/nm
23 dB	Off - 3R	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 5400ps/nm
12 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 25 dBm	—
12 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 24 dBm	+/– 1800ps/nm
12 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 23 dBm	+/– 5400ps/nm
21 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 31 dBm	—

1. OSNR defined with 0.1 nm resolution bandwidth (RBW)

  - 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

- Line (client side)
  - Bit rate: 8 Mbps to 2.488 Gbps
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 850nm to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.4 MXP_MR_2.5G and MXPP_MR_2.5G Card Specifications

The MXP_MR_2.5G and MXPP_MR_2.5G cards have the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - ESCON—Enterprise System Connection 200 Mbps
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps

  - Mixed configurations up to maximum line rate of 2.5 Gbps (for example, if you have a port configured for FC2G, you cannot use another port at the same time). See the "8.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards" section on page 8-44 for more information on mixed-mode operation.

- Client ports: 8x SFP
- Performance monitoring (PM) for all interfaces
- Buffer-to-buffer credit management for distance extension
- Line (trunk side)
  - Bit rate: 2.488 Gbps for OC-48/STM-16
  - 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 MXP_MR_2.5G and MXPP_MR_2.5G cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_2.5G and MXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_2.5G and MXPP_MR_2.5G cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Transmit power: +3 +/– 1 dBm with MXP_MR_2.5G card, and +/– 1 dBm with MXPP_MR_2.5G card
  - 50-GHz DWDM migration ready (the wavelength deviation is less than +/– 0.040 nm through wavelocker deployment)
  - Four-channel wavelength tunability at 100-GHz spacing
  - Transmitter maximum return reflectance: –27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - Transmitter is a 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 the TXP_MR_2.5G and TXPP_MR_2.5G cards (eight card versions):
  - ITU grid blue band: 1530.334 to 1544.526 nm (four card versions, four wavelengths each)
  - ITU grid red band: 1546.119 to 1560.606 nm (four card versions, four wavelengths each)
- Receiver (trunk side, see Table A-33)

Table A-33 MXP_MR_2.5G/MXPP_MR_2.5G Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance
17 dB	N/A	< 10 exp – 12	N/A	– 9 to – 23 dBm	—
17 dB	N/A	< 10 exp – 12	N/A	– 9 to – 22 dBm	+/– 1800 ps/nm
17 dB	N/A	< 10 exp – 12	N/A	– 9 to – 21 dBm	+/– 5400 ps/nm
18 dB	N/A	< 10 exp – 12	N/A	– 9 to – 23 dBm	+/– 1800 ps/nm
19 dB	N/A	< 10 exp – 12	N/A	– 9 to – 23 dBm	+/– 5400 ps/nm
21 dB	N/A	< 10 exp – 12	N/A	– 9 to – 30 dBm	—
21 dB	N/A	< 10 exp – 12	N/A	– 9 to – 29 dBm	+/– 1800 ps/nm
21 dB	N/A	< 10 exp – 12	N/A	– 9 to – 28 dBm	+/– 5400 ps/nm
22 dB	N/A	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 1800 ps/nm
23 dB	N/A	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 5400 ps/nm

1. OSNR defined with 0.1 nm RBW

  - Receiver sensitivity –28 dBm, BER 1 * 10 exp – 12
  - Receiver overload is equal to or exceeds –8 dBm
  - Receiver maximum reflectance of –27 dB
- Line (client side)
  - Bit rate: 200Mbps or 1.06 Gbps to 2.125 Gbps per client
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)

  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.25 lb (1.02 kg)

A.9.5 MXP_2.5G_10E Card Specifications

The MXP_2.5G_10E card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - 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_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10E card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - 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_10E (eight card versions):

  ITU grid blue band:
  - 1530.33 to 1533.07 nm (four channels)
  - 1534.25 to 1537.00 nm (four channels)
  - 1538.19 to 1540.95 nm (four channels)
  - 1542.14 to 1544.92 nm (four channels)

  ITU grid red band:
  - 1546.12 to 1548.92 nm (four channels)
  - 1550.12 to 1552.93 nm (four channels)
  - 1554.13 to 1556.96 nm (four channels)
  - 1558.17 to 1561.01 nm (four channels)

- Receiver (trunk side, see Table A-34)
  - 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

Table A-34 MXP_2.5G_10E Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.6 MXP_2.5G_10E_C Card Specifications

The MXP_2.5G_10E_C card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)

  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - 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_10E_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E_C card. Using direct fiber loopbacks causes irreparable damage to the card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - 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_10E_C card:

  There is a single version of the MXP_2.5G_10E_C card. It is tunable across 82 wavelengths in the C-band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-35.

Table A-35 MXP_2.5G_10E_C Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918

Table A-35 MXP_2.5G_10E_C Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

- Receiver (trunk side, see Table A-36)

Table A-36 MXP_2.5G_10E_C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—

Table A-36 MXP_2.5G_10E_C Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm

Table A-36 MXP_2.5G_10E_C Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
12 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 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: 1529 to 1562 nm
- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.7 MXP_2.5G_10E_L Card Specifications

The MXP_2.5G_10E_L card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - 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_10E_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E_L card. Using direct fiber loopbacks causes irreparable damage to the card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - 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_10E_L card:

  There is a single version of the MXP_2.5G_10E_L card. It is tunable across 80 wavelengths in the L band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-37.

Table A-37 MXP_2.5G_10E_L Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64

Table A-37 MXP_2.5G_10E_L Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

- Receiver (trunk side, see Table A-38)

Table A-38 MXP_2.5G_10E_L Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm

Table A-38 MXP_2.5G_10E_L Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
13 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 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: 1570 to 1604 nm
- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.8 MXP_MR_10DME_C Card Specifications

The MXP_MR_10DME_C card has the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps
  - FC4G—Fibre Channel 4.25 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - FICON4G—Fiber connectivity 4.25 Gbps (IBM signal)
  - ISC compatability
  - ISC peer 1G

  - ISC peer 2G
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps
  - Mixed configurations up to maximum line rate of 10.0 Gbps. See the "8.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards" section on page 8-51 for more information on mixed-mode operation.
- Client ports: 8x SFP
- Line (trunk side)
  - Bit rate: 9.952 Gbps for OC-192/STM-64
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_10DME_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_10DME_C cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DME_C cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Minimum output power: +3 dBm
  - Maximum output power: +6 dBm
  - Minimum Single-Mode Suppression Ratio (SMSR): 30 dB
  - Minimum optical extinction ratio: 10 dB
  - 41 wavelength tunability at 100-GHz spacing
  - Receiver maximum return reflectance (Rx return loss): –27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - 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.

  - For available wavelengths for the MXP_MR_10DME_C card, see Table 8-29 on page 8-56.
- For the receiver trunk side, see Table A-39:

Table A-39 MXP_MR_10DME_C Card Receiver Trunk Side Specifications

FEC Applications	OSNR[1]	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance	Power Penalty	OSNR Penalty
None	23 dB	< 10 exp – 12	—	–8 to –20 dBm	+/– 1200 ps/nm	2 dBm	—
	19 dB	< 10 exp – 12	—	–9 to –22 dBm	+/– 1000 ps/nm	2 dBm	—
FEC	10 dB	< 10 exp – 5	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	—	1.5 dB

Table A-39 MXP_MR_10DME_C Card Receiver Trunk Side Specifications (continued)

FEC Applications	OSNR[1]	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance	Power Penalty	OSNR Penalty
Enhanced FEC	19 dB	< 10 exp – 4	< 10 exp – 15	–8 to –26 dBm	+/– 800 ps/nm	2 dBm	2 dB
	8 dB	< 10 exp – 4	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	2 dBm	1.5 dB

1. OSNR defined with 0.5 nm RBW

  - 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: 1529 to 1562 nm
- Line (client side)
  - Bit rate: 1.06 Gbps to 4.25 Gbps per client
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.25 lb (1.02 kg)

A.9.9 MXP_MR_10DME_L Card Specifications

The MXP_MR_10DME_L card has the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps
  - FC4G—Fibre Channel 4.25 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - FICON4G—Fiber connectivity 4.25 Gbps (IBM signal)
  - ISC compatability
  - ISC peer 1G
  - ISC peer 2G
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps
  - Mixed configurations up to maximum line rate of 10.0 Gbps. See the "8.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards" section on page 8-51 for more information on mixed-mode operation.
- Client ports: 8x SFP
- Line (trunk side)
  - Bit rate: 9.952 Gbps for OC-192/STM-64
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_10DME_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_10DME_L cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DME_L cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Minimum output power: +3 dBm
  - Maximum output power: +6 dBm
  - Minimum SMSR: 30 dB
  - Minimum optical extinction ratio: 10.5 dB
  - 40 wavelength tunability at 100-GHz spacing, 80 wavelength tunability at 50-GHz spacing
  - Receiver maximum return reflectance (Rx return loss): –27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - 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.

  - For the currently available wavelengths for the MXP_MR_10DME_L card, see Table 8-30 on page 8-57.

- Table A-40 provides the receiver trunk side specifications:

Table A-40 MXP_MR_10DME_L Card Receiver Trunk Side Specifications

FEC Applications	OSNR[1]	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance	Power Penalty	OSNR Penalty
None	23 dB	< 10 exp – 12	—	–8 to –19 dBm	+/– 1200 ps/nm	2 dBm	—
	19 dB	< 10 exp – 12	—	–9 to –19 dBm	+/– 1000 ps/nm	2 dBm	—
FEC	10 dB	< 10 exp – 5	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	—	1.5 dB
Enhanced FEC	19 dB	< 10 exp – 4	< 10 exp – 15	–8 to –26 dBm	+/– 800 ps/nm	—	2 dB
	8 dB	< 10 exp – 4	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	—	1.5 dB

1. OSNR defined with 0.5 nm RBW

  - 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: 1570 to 1604 nm
- Line (client side)
  - Bit rate: 1.06 Gbps to 4.25 Gbps per client
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12

  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.25 lb (1.02 kg)

A.9.10 TXP_MR_10E Card Specifications

The TXP_MR_10E card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm for C band and +2 dBm for L band
  - 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_10E:

  C-band frequency plan (eight card versions, each with four tunable channels on the ITU 100-GHz grid):
  - 1530.33 to 1533.07 nm (four channels)
  - 1534.25 to 1537.00 nm (four channels)
  - 1538.19 to 1540.95 nm (four channels)

- 1542.14 to 1544.92 nm (four channels)
- 1546.12 to 1548.92 nm (four channels)
- 1550.12 to 1552.93 nm (four channels)
- 1554.13 to 1556.96 nm (four channels)
- 1558.17 to 1561.01 nm (four channels)

L-band frequency plan (five card versions, each with eight tunable channels on the ITU 50-GHz grid):

- 1577.44 to 1580.35 nm (eight channels)
- 1580.77 to 1583.69 nm (eight channels)
- 1584.11 to 1587.04 nm (eight channels)
- 1587.46 to 1590.41 nm (eight channels)
- 1590.83 to 1593.79 nm (eight channels)

- Receiver (trunk side, see Table A-41)

Table A-41 TXP_MR_10E Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+ – 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 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

- Line (client side):
  - 10-Gigabit Small Form-factor Pluggable (XFP)-based SR
  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, ITU-T G.691

- 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)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.11 TXP_MR_10E_C Card Specifications

The TXP_MR_10E_C card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E_C card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E_C card.

  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, and ITU-T G.709
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm

- Minimum transmitter output power: +3 dBm
- 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_10E_C card:

  There is a single version of the TXP_MR_10E_C card. It is tunable across 82 wavelengths in the C-band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-42.

Table A-42 TXP_MR_10E_C Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747

Table A-42 TXP_MR_10E_C Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

- Receiver (trunk side, see Table A-43)

Table A-43 TXP_MR_10E _C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+ – 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
12 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 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: 1529 to 1562 nm
- Line (client side):
  - XFP-based SR

  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
- 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)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.12 TXP_MR_10E_L Card Specifications

The TXP_MR_10E_L card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E_L card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E_L card.

  - Connectors: LC

- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +2 dBm
  - 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_10E_L card:

  There is a single version of the TXP_MR_10E_L card. It is tunable across 80 wavelengths in the L band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-44.

Table A-44 TXP_MR_10E_L Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64

Table A-44 TXP_MR_10E_L Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

- Receiver (trunk side, see Table A-45)

Table A-45 TXP_MR_10E Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+ – 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
13 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW

2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 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: 1570 to 1604 nm
- Line (client side):
  - XFP-based SR
  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
- 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)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - 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)

A.9.13 ADM-10G Card Specifications

The ADM-10G card has the following specifications:

- Line
  - Bit rate: OC-3/STM-1 (155.520 Mb/s); OC-12/STM-3 (622.08 Mb/s); OC-48/STM-16 (2488.32 Mb/s); OC-192/STM-64 (9.95328 Gbps)

  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode for ONS-XC-10GS1 XFP or 1530.33 to 1554.94-nm single-mode for ONS-XC-10G-xx.x XFP
  - Maximum chromatic dispersion allowance: up to 3600 ps/nm
  - Loopback modes: Terminal, facility, and cross-connect
  - Connectors: LC
- Transmitter (trunk side)
  - Transmitter: LN external modulator transmitter
  - Maximum transmitter output power: Depends on XFP that is used
  - Minimum transmitter output power: Depends on XFP that is used
  - Wavelength stability (drift): +/– 25 picometers (pm)
- Receiver (trunk side)
  - Receiver: APD
  - Receiver input wavelength range: Depends on XFP that is used
  - Receiver sensitivity: depends on XFP that is used
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 5.07 lb (2.3 kg)

A.9.14 GE_XP and 10GE_XP Card Specifications

The GE_XP and 10GE-XP cards have the following specifications:

- Line (trunk side)
  - Bit rate: 11.1 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode) or 10.3125 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode disabled)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: – 500 to 1600 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the GE_XP card in a loopback on the trunk port. Do not use direct fiber loopbacks with the GE_XP card. Using direct fiber loopbacks causes irreparable damage to the GE_XP card.

  - Connectors: LC

- Transmitter (trunk side)
  - Maximum transmitter output power: +3 dBm
  - Minimum transmitter output power: -1 dBm
  - Transmitter: EML laser
  - Wavelength stability (drift): +/– 100 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 GE_XP and 10GE_XP: C Band, 100 GHz spacing.
- Receiver (trunk side, see Table A-46)
  - 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

Table A-46 GE_XP Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	1.00E – 12	N/A	– 7 to – 23 dBm	—
30 dB	Off	1.00E – 12	N/A	– 7 to – 20 dBm	– 500 to 1600 ps/nm
24 dB	Off	1.00E – 12	N/A	– 7 to – 18 dBm	—
27 dB	Off	1.00E – 12	N/A	– 7 to – 18 dBm	– 500 to 1600 ps/nm
18 dB	Standard	1.00E – 05	1.00E – 15	– 7 to – 18 dBm	—
19 dB	Standard	1.00E – 05	1.00E – 15	– 7 to – 18 dBm	– 500 to 1600 ps/nm
30 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 27 dBm	—
30 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 24 dBm	– 500 to 1600 ps/nm
15 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 18 dBm	—
15 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 18 dBm	– 500 to 1600 ps/nm

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

- Line (client side)
  - Bit rate: 1.125Gbps (GE) or 10.3125Gbps (10GE)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode or 850-nm multimode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.

- Environmental
  - Power consumption: 50.00 W (maximum), 1.11 A at –48 V, 136.6 BTU/hr
- Dimensions
  - Height: 12.992 in. (330 mm)
  - Width: 10GE_XP and 10GE_XPE: 0.921 in. (23.4 mm)
    GE_XP and GE_XPE: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.448 in. (240 mm)
  - Depth with backplane connector: tbd in. (tbd mm)
  - Weight not including clam shell: 10GE-XP, 1.04 kg; GE-XP, 1.36 kg.

A.10 Mesh Patch Panel Specifications

This section provides specifications for the PP-MESH-4 and PP-MESH-8 patch panels.

A.10.1 PP-MESH-4 Patch Panel Specifications

The PP-MESH-4 patch panel optical specifications are listed in Table A-47.

Table A-47 PP-MESH-4 Patch Panel Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Wavelength range	—	—	1530	1570	nm
Insertion loss [1] [2]	—	In all the wavelength ranges (local ADD or test access RX to EXP TX, COM RX to EXP TX, COM RX to test access TX)	—	7.5	dB
Insertion Loss Uniformity [1] [2]	—	In all the wavelength ranges	—	0.9	dB
Polarization dispersion loss (PDL) [1]	—	—	—	0.3	dB
Polarization mode dispersion (PMD) [1]	—	—	—	0.1	dB
Optical Return Loss [1]	—	—	50	—	dB
Directivity [1]	—	—	50	—	dB

1. Under all SOPs and all operating environmental conditions
2. Values are referenced with connector loss (LC=0.3 dB, MPO=0.5dB)

The PP-MESH-4 patch panel has the following additional specifications:

- Environmental

  - Operating temperature: +23 to +149 degrees Fahrenheit (–5 to +65 degrees Celsius)
  - Operating humidity: 5 to 95 percent, noncondensing
- Dimensions
  - Height: 17.42 in. (442.5 mm)
  - Width: 3.457 in. (87.8 mm)
  - Depth: 11.025 in. (280 mm)

A.10.2 PP-MESH-8 Patch Panel Specifications

The PP-MESH-8 patch panel optical specifications are listed in Table A-48.

Table A-48 PP-MESH-8 Patch Panel Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Wavelength range	—	—	1530	1570	nm
Insertion loss [1] [2]	—	In all the wavelength ranges (local ADD or test access RX to EXP TX, COM RX to EXP TX, COM RX to test access TX)	—	10.6	dB
Insertion loss uniformity [1] [2]	—	In all the wavelength ranges	—	1.3	dB
PDL [1]	—	—	—	0.5	dB
PMD [1]	—	—	—	0.1	dB
Optical Return Loss [1]	—	—	50	—	dB
Directivity [1]	—	—	50	—	dB

1. Under all SOPs and all operating environmental conditions
2. Values are referenced with connector loss (LC=0.3 dB, MPO=0.5dB)

The PP-MESH-8 patch panel has the following additonal specifications:

- Environmental
  - Operating temperature: +23 to +149 degrees Fahrenheit (–5 to +65 degrees Celsius)
  - Operating humidity: 5 to 95 percent, noncondensing
- Dimensions
  - Height: 17.42 in. (442.5 mm)
  - Width: 3.457 in. (87.8 mm)
  - Depth: 11.025 in. (280 mm)

A.11 SFP and XFP Specifications

Note The CC-FTA fan tray is mandatory if CWDM SFPs and DWDM SFPs are used on MSTP units.

Note Use hardware version 2.0 DWDM SFP for MSTP units.

See the Installing the GBIC, SFP, and XFP Optics Modules in Cisco ONS Platforms for SFP and XFP specifications.

APPENDIX B

Administrative and Service States

This appendix describes the administrative and service states for Cisco ONS 15454 dense wavelength division multiplexing (DWDM) cards, optical payload ports, out-of-band optical service channel (OSC) ports, optical channel network connections (OCHNCs), and transponder/muxponder cards and ports. States for Software Release 5.0 and later are based on the generic state model defined in Telcordia GR-1093-Core, Issue 2 and ITU-T X.731.

B.1 Service States

Service states include a Primary State (PST), a Primary State Qualifier (PSTQ), and one or more Secondary States (SST). Table B-1 lists the ANSI and ETSI service state PSTs and PSTQs supported by the ONS 15454.

Table B-1 ONS 15454 Service State Primary States and Primary State Qualifiers

ANSI Primary State, Primary State Qualifier	ETSI Primary State, Primary State Qualifier	Definition
IS-NR (In-Service and Normal)	Unlocked-enabled	The entity is fully operational and will perform as provisioned.
OOS-AU (Out-of-Service and Autonomous)	Unlocked-disabled	The entity is not operational because of an autonomous event.
OOS-AUMA (Out-of-Service and Autonomous Management)	Locked-disabled	The entity is not operational because of an autonomous event and has also been manually removed from service.
OOS-MA (Out-of-Service and Management)	Locked-enabled	The entity has been manually removed from service.

Table B-2 defines the ANSI and ETSI SSTs supported by the ONS 15454.

Table B-2 ONS 15454 Secondary States

ANSI Secondary State	ETSI Secondary State	Definition
AINS	automaticInService	The entity is delayed before transitioning to the IS-NR (ANSI)/Unlocked-enabled (ETSI) service state. The transition to IS-NR/Unlocked-enabled depends on correction of conditions. Alarm reporting is suppressed, but traffic is carried. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the Cisco Transport Controller (CTC) Conditions tab or by using the TL1 RTRV-COND command.
DSBLD	disabled	The entity was manually removed from service and does not provide its provisioned functions. All services are disrupted; unable to carry traffic.
FLT	failed	The entity has a raised alarm or condition.
MEA	mismatchOfEquipment	An improper card is installed. For example, an installed card is not compatible with the card preprovisioning or the slot. This SST applies only to cards.
MT	maintenance	The entity has been manually removed from service for a maintenance activity but still performs its provisioned functions. Alarm reporting is suppressed, but traffic is carried. 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.
SWDL	softwareDownload	The card is involved in a software and database download. This SST applies only to cards.
UAS	unassigned	The card is not provisioned in the database. This SST applies only to cards.
UEQ (Unequipped)	notInstalled	The card is not physically present (that is, an empty slot). This SST applies only to cards.

B.2 Administrative States

Administrative states are used to manage service states. Administrative states consist of a PST and an SST. Table B-3 lists the ANSI and ETSI administrative states supported by the ONS 15454. See Table B-2 for SST definitions.

Note A change in the administrative state of an entity does not change the service state of supporting or supported entities.

Table B-3 ONS 15454 Administrative States

ANSI Administrative State (PST,SST)	ETSI Administrative State (PST,SST)	Definition
IS	Unlocked	Puts the entity in service.
IS,AINS	Unlocked,automaticInService	Puts the entity in automatic in-service.

Table B-3 ONS 15454 Administrative States (continued)

ANSI Administrative State (PST,SST)	ETSI Administrative State (PST,SST)	Definition
OOS,DSBLD	Locked,disabled	Removes the entity from service and disables it.
OOS,MT	Locked,maintenance	Removes the entity from service for maintenance.

B.3 Service State Transitions

This section describes the transition from one service state to the next state for DWDM shelves, cards, optical payload ports, OSC ports, OCHNCs, and transponder/muxponder cards and ports. A service state transition is based on the action performed on the entity and any autonomous activity.

Note When an entity is put in the OOS,MT administrative state, the ONS node suppresses all standing alarms on that entity. All alarms and events appear on the Conditions tab. You can change this behavior for the LPBKFACILITY and LPBKTERMINAL alarms. To display these alarms on the Alarms tab, set the NODE.general.ReportLoopbackConditionsOnOOS-MTPorts (ANSI) or NODE.general.ReportLoopbackConditionsOnPortsInLocked,Maintenance (ETSI) to TRUE on the NE Defaults tab.

B.3.1 DWDM Shelf Service State Transitions

Table B-4 lists ANSI and ETSI service state transitions for shelf entities.

Table B-4 ONS 15454 Shelf Service State Transitions

Current Service State	Action	Next Service State
OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)	Connect a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Connect an invalid shelf.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Add a shelf.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)	Disconnect a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Add a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)

Table B-4 ONS 15454 Shelf Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)	Connect a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Connect an invalid shelf.	OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Delete a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)	Connect a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Connect an invalid shelf.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Delete a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
IS-NR (ANSI) Unlocked-enabled (ETSI)	Delete a shelf.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Disconnect a shelf.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)	Disconnect a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
OOS-AUMA,AINS & MEA (ANSI) Locked-disabled,automaticInService & mismatchOfEquipment (ETSI)	Disconnect a shelf.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)	Disconnect a shelf.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Delete a shelf.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)

B.3.2 DWDM Card Service State Transitions

Table B-5 lists ANSI and ETSI service state transitions for AD-1B-xx.x, AD-4B-xx.x, AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, OSC-CSM, OSCM, OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-PRE, OPT-AMP-17-C, OPT-AMP-17-C, 4MD-xx.x, 32WSS, 32WSS-L, 32MUX-O, 32DMX, 32DMX-L, 32DMX-O, 40-MUX-C, 40-DMX-C, 40-DMX-CE, 40-WSS-C, 40-WSS-CE, and 40-WXC-C cards.

Table B-5 ONS 15454 Optical Unit Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
		OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)	Insert a valid card.	OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)

Table B-5 ONS 15454 Optical Unit Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,unequipped (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
		OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)

Table B-5 ONS 15454 Optical Unit Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Reset the card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision the card.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)	Restart completed.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
		OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision an invalid card.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Provision a valid card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Preprovision a card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)

B.3.3 Optical Payload Port Service State Transitions

Table B-6 lists the ANSI and ETSI optical payload port service state transitions.

Table B-6 ONS 15454 Optical Payload Port Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	The OCHNC end-to-end path no longer exists.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	All required OCHNC connections exist.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port or cross-connect in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port or cross-connect in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port or cross-connect in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

Table B-6 ONS 15454 Optical Payload Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port or cross-connect in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port or cross-connect in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port or cross-connect in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)	Release the loopback.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Alarm/condition is cleared.	OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port or cross-connect in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port or cross-connect in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port or cross-connect in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port or cross-connect in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)

Table B-6 ONS 15454 Optical Payload Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

B.3.4 OSC Port Service State Transitions

Table B-7 lists the ANSI and ETSI OSC port service state transitions.

Table B-7 ONS 15454 OSC Port Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Delete the OSC.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	Create the OSC.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)

Table B-7 ONS 15454 OSC Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)

Table B-7 ONS 15454 OSC Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

B.3.5 OCHNC, OCHCC, and OCH-Trail Service State Transitions

Table B-8 lists the ANSI and ETSI OCHNC, OCHCC, and OCH-Trail service state transitions.

Table B-8 ONS 15454 OCHNC Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Put the connection in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	Put the connection in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

Table B-8 ONS 15454 OCHNC Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)	Release the loopback.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Alarm/condition is cleared.	OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)
OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)	Put the connection in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)

B.3.6 Transponder/Muxponder Card Service State Transitions

Table B-9 lists ANSI and ETSI transponder and muxponder card service state transitions.

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)
	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)	Insert a valid card.	OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,unequipped (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Locked-disabled,notInstalled (ETSI)
OOS-AU,UEQ (ANSI) Locked-disabled,notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Reset the card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision the card.	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)	Restart completed.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,UEQ (ANSI) Locked-disabled,notInstalled (ETSI)
	Insert a valid card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Insert an invalid card.	OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision an invalid card.	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
	Provision a valid card.	OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)
OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Preprovision a card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Reset the card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

B.3.7 Transponder/Muxponder Port Service State Transitions

Table B-10 lists the ANSI and ETSI transponder and muxponder port service state transitions.

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR[1] (ANSI) Unlocked-enabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)	Release the loopback.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Alarm/condition is cleared.	OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR[1] (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)	Release the loopback.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR[1] Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in loopback.	OOS-MA,LPBK & MT[2] [3] (ANSI) Locked-enabled,loopback & maintenance (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

1. The transponder and muxponder cards have both client and trunk ports. To bring up service, it is not necessary for both the client side and trunk side to be in the IS-NR (ANSI)/Unlocked-enabled (ETSI) service state.
2. In a client-side facility loopback, the client port is in the OOS-MA,LPBK & MT (ANSI)/Locked-enabled,loopback and maintenance (ETSI) service state and the remaining client and trunk ports can be in any other service state. In a client-side terminal loopback on transponder cards, the client port is in the OOS-MA,LPBK & MT service state and the trunk ports are in IS-NR (ANSI)/Unlocked-enabled (ETSI). For client-side terminal loopbacks on muxponder cards, the client port is in the OOS-MA,LPBK & MT service state and the remaining client and trunk ports can be in any service state.
3. In a trunk-side facility loopback, the trunk port is in the OOS-MA,LPBK & MT (ANSI)/Locked-enabled,loopback and maintenance (ETSI) service state and the remaining client and trunk ports can be in any other service state. In a trunk-side terminal loopback, the trunk port is in the OOS-MA,LPBK & MT (ANSI)/Locked-enabled,loopback and maintenance (ETSI) service state and the client ports are in IS-NR (ANSI)/Unlocked-enabled (ETSI) for complete loopback functionality. This type of loopback affects all client ports because it is performed on the aggregate signal.

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10DME_L card. *See* MXP_MR_10DME_L card

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