Extended Performance 4-Port 2.5-Gbps Full-Band Tunable Muxponder Card for the Cisco ONS 15454 Multiservice Transport Platform

The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) supports an Extended Performance 4-Port 2.5-Gbps Full-Band Tunable Muxponder Card, which expands the platform's OC-48/STM-16 interface density. The card facilitates the delivery of transparent 2.5-Gbps-based services for enterprises or service provider optical networks (Figure 1).

Cisco ONS 15454 MSTP Release 9.1 extends the capabilities of this card with an enhanced-performance optical trunk module, which implements an Electronic Dispersion Compensation (EDC) mechanism based on the Maximum Likelihood Sequence Estimation (MLSE) algorithm to improve chromatic dispersion (CD) and polarization-mode dispersion (PMD) robustness.

Figure 1.   Extended Performance 4-Port 2.5-Gbps Full-Band Tunable Muxponder Card

Background

Optical transport networks must support numerous service demands, from low-rate DS-1/T1, DS-3/E3, 10/100BASE-T, and OC-3/STM-1 to higher-rate OC-12/STM-4, Gigabit Ethernet, OC-48/STM-16, OC-192/STM-64, and 10 Gigabit Ethernet services. In the recent past, SONET add-drop multiplexers (ADMs) provided the services platform to aggregate and transport services up to OC-48/STM-16, whereas dense wavelength-division multiplexing (DWDM) platforms were designed for optical signals from OC-3/STM-1 to OC-192/STM-64, including Gigabit and 10 Gigabit Ethernet. Unfortunately, deploying multiple platforms (including DWDM and SONET ADMs) to support multiple services is not cost-effective for many service provider and enterprise networks. The Cisco ONS 15454 MSTP with a muxponder card provides a more cost-effective networking solution to enable the delivery of all services, from lower-speed DS-1/E1, high-density 2.5 Gbps, and high bandwidth OC-192/STM-64.

Product Overview

The Cisco ONS 15454 MSTP Extended Performance 4-Port 2.5-Gbps Full-Band Tunable Muxponder Card can transport four OC-48/STM-16 payloads over a G.709 OTU-2-based, 50-GHz spaced, 50-GHz stabilized, ITU-compliant wavelength with selectable Enhanced Forward Error Correction (E-FEC). The muxponder card is a plug-in module to the Cisco ONS 15454 MSTP, enabling a high-density, cost-effective solution for OC-48/STM-16 services transport over a platform capable of low-rate services down to 1.5 Mbps. The muxponder card architecture contains four client interfaces that are mapped to a single line interface, without accessing the Cisco ONS 15454 shelf cross-connect fabric.

Each client interface provides a 2.488-Mbps (OC-48/STM-16) SONET/SDH interface through a Small Form-Factor Pluggable (SFP) optics module with LC connectors, providing the flexibility to support several optical reaches, including short-reach/intra-office, intermediate-reach/short-haul, and long-reach/long-haul, with support for qualified SFP modules. The muxponder card supports any mixture of SFP reach types and also supports in-service insertion or removal without affecting other active ports, allowing superior networking flexibility and simplified deployment.

The DWDM line interface provides one 10.70923-Gbps G.709 OTU-2 digital wrapper, long-reach/long-haul, ITU-compliant, 50-GHz spaced optical interface using LC connectors supporting G.709 OTU-2 digital wrapper interfaces. The DWDM output line interface is tunable across full optical C band, dramatically reducing inventories for spares. When operating within the outlined specifications, each card will transport each of the 2.5-Gbps signals with a maximum bit error rate (BER) of 10E-15.

The integrated MLSE-based Electronic Dispersion Compensation extends DWDM network performances, providing support to the following applications:

- **High PMD fiber applications:** MLSE technology can monitor and correct errors due to time variant effects
- **Low-latency data center applications:** SAN protocols, such as Server Time Protocol (STP), are extremely sensitive to additional latency introduced by CD optical fiber.
- **Enterprise point-to-point applications:** Installation costs for the dispersion compensation unit (DCU) and fiber can be avoided. This is particularly important in low-end markets, where DCU can comprise up to 10 percent of simple point-to-point systems cost.
- **Ultra-long-haul (ULH) applications:** Improvement in CD and PMD performance can be translated in better ULH performance. Additional OSNR margin can be allocated to compensate for non-linear effects (NLE) impairment, allowing for better system performance.

The muxponder card incorporates the four clients and one DWDM line interface on the same card. The muxponder cards are deployable in the 12 multiservice interface card slots of the Cisco ONS 15454 platform, in systems with or without cross-connect cards. The addition of a cross-connect card enables the platform to support hybrid applications containing transparent 2.5-Gbps services, and allows aggregation of the other services supported by the Cisco ONS 15454 platform. The only other common card required for operation is the timing, communications, and control card (TCC).

The muxponder card provides many carrier-class features and capabilities necessary to deliver 2.5-Gbps services, including selectable protocol transparency, wavelength tunability, flexible protection mechanisms, flexible timing options, and management capabilities.

Enhanced FEC Capability

An important feature of the enhanced muxponder card is the ability to configure the FEC in two modes: FEC and Enhanced FEC (E-FEC). The output bit rate will be always 10.7092 Gbps as defined in G.709 but the error coding performance can be provisioned:

- FEC: standard G.975 Reed-Salomon algorithm
- E-FEC: standard G.975.1 two orthogonally concatenated BCH super FEC codes. 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. E-FEC provides 2 dB of additional reach when compared to standard FEC.

Protocol Transparency

The Full-Band Tunable Muxponder Card provides the capability to deliver transparent 2.5-Gbps wavelength services, OC-48/STM-16 terminated signals, and provides a high-density solution for cost-effective, point-to-point SONET/SDH payload transport for the Cisco ONS 15454 platform. The card can be provisioned to either pass all the SONET/SDH overhead bytes transparently or to terminate the line and section overhead. In transparent mode, client terminal equipment interconnected over a muxponder-card-based circuit can communicate over the section/multiplexer section data communications channel (SDCC/MSDCC), can signal 1+1 and bidirectional line switched ring/multiplex section shared protection ring (BLSR/MS-SPR) protection switching using the K1 and K2 bytes, and can support provisionable section trace capabilities over the J0 byte. In addition, the muxponder circuit, whether provisioned in transparent or terminating mode, can support unidirectional path switched ring/subnetwork connection protection (UPSR/SNCP)-based client circuits. Full transparency is provided by the enhanced multiplex engine, which performs the multiplexing of the incoming 2.5-Gbps signals at the OTN layer that are no longer in the SONET/SDH domain. Each of the 4 x OC-48/STM-16 streams are mapped into a fully standard ODU-1 encapsulation and then the 4 x ODU-1 are multiplexed into an ODU-2 envelope to be transmitted in a fully standard G.709 OTU-2 frame.

The client interfaces can support non-concatenated SONET/SDH payloads on an STS-1, VC-4, VC-12, and VT1.5 basis, as well as concatenated SONET/SDH payloads (STS-Nc, N = 3, 6, 9, 12, 24, or 48; or VC-4-Mc, M = 1, 2, 3, 4, 8, or 16).

Wavelength Tunability

The muxponder cards operate on the 50-GHz ITU grid and are tunable across 82 adjacent 50-GHz channels for the C-band module and across 80 adjacent 50-GHz channels for the L-band module. The incorporation of tunability into the muxponder cards reduces the amount of inventory and spares required to cover all of the wavelengths. Tunability is software-provisionable.

Flexible Protection Mechanism Support

The muxponder card, depending upon the requirement of the network, can be deployed to support the many protection mechanisms found in optical transport networks. Table 1 outlines the supported protection options that help to deliver the service-level agreements (SLAs) required by the application.

Table 1.   Protection Formats

Protection Type	Capabilities	Figure
Unprotected	No client terminal interface, muxponder card, or DWDM line protection. The client signal is transported over a single unprotected muxponder card.	2
1+1 protection or UPSR/SNCP and BLSR/MSP-SPR	Provides protection for the client terminal interface, muxponder card, and DWDM line through client automatic protection switching/linear multiplex section protection (APS/LMSP) signaling transported transparently over the muxponder card.	3
	Similar to unprotected format. Protection is provided through client line or path protection via transparent signal transport through muxponder circuit.	4
Y-cable protection	Provides muxponder card and DWDM line protection without requiring client terminal equipment interface protection. Uses Y-protection device to optically split a single client interface to two muxponder cards. The Cisco ONS 15454 system controls the muxponder card active/standby status to provide a single signal feed to client equipment.	5

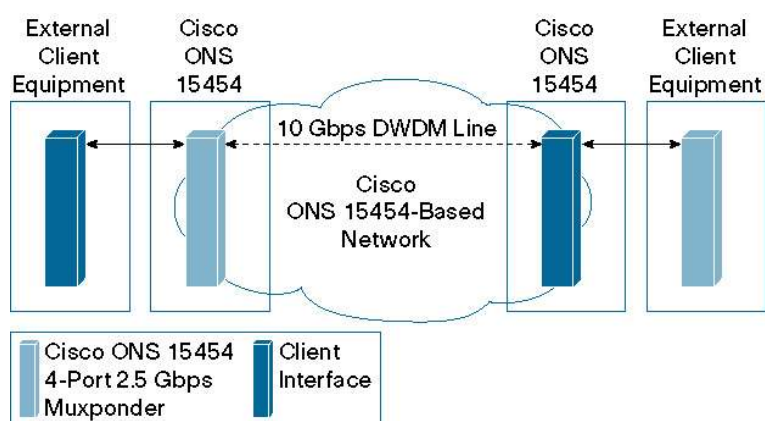**Figure 2.**   Unprotected Configuration

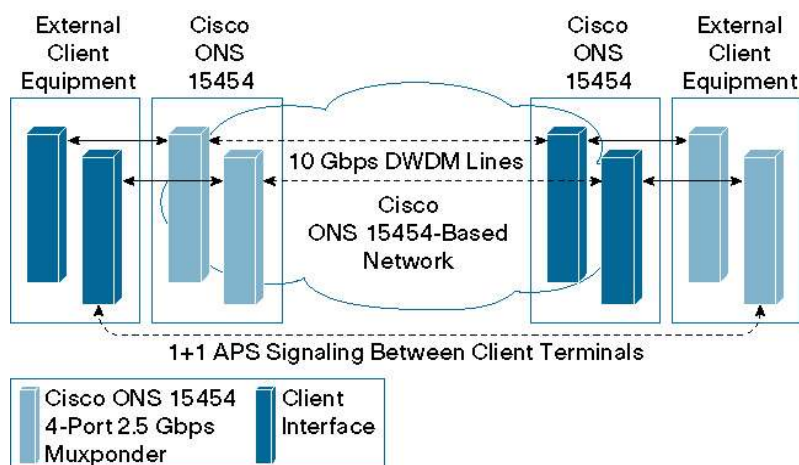**Figure 3.**   1+1 Protection Configuration

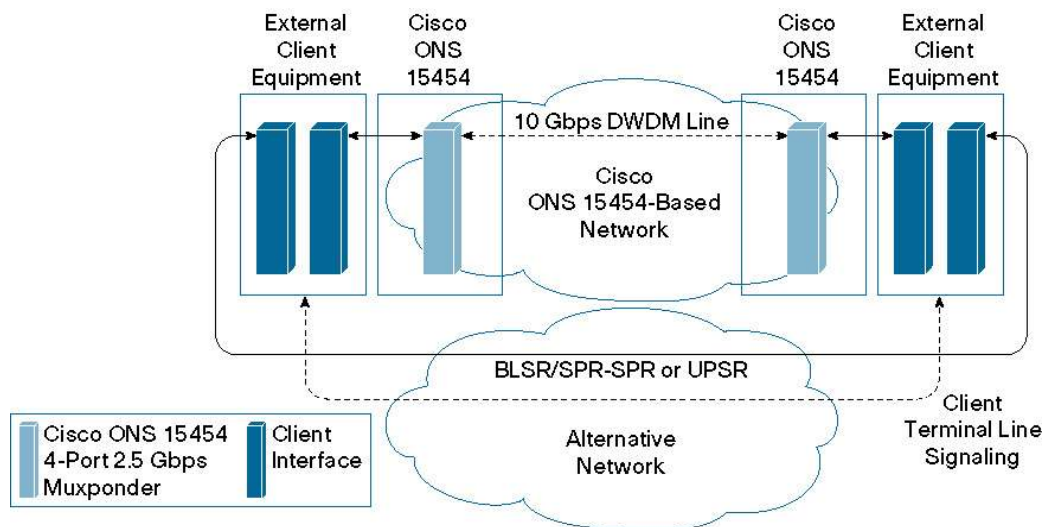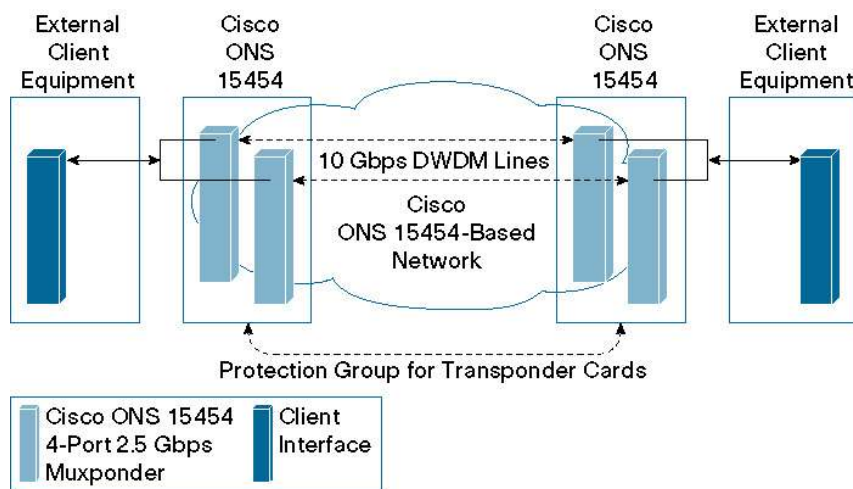**Figure 4.** UPSR/SNCP and BLSR/MSP-SPR Protection Configuration

Figure 5. Y-Cable Configuration

Flexible Timing Options

The Full-Band Tunable Muxponder Card times the client side and the DWDM line optical transmitter port with the clock derivate by the shelf processor. The Cisco ONS 15454 platform provides the option to recover timing signals for node-timing reference, with sync status messaging support, from any of the four client optical interfaces, in addition to the standard options of using an external clock derived from a building integrated timing supply (BITS) clock or another optical interface card on the Cisco ONS 15454 system. The muxponder card can also maintain synchronization from one of the available clients even if both the shelf processors (active and standby) fail.

Management

The Cisco ONS 15454 provides comprehensive management capabilities for operations, administration, monitoring, and provisioning (OAM&P) accessed through the integrated Cisco Transport Controller craft interface with support from the Cisco Transport Manager element management system (EMS). The muxponder card incorporates provisionable digital wrapper (G.709) functions, providing DWDM wavelength performance-

management capabilities, especially for services being transported transparently across the network. Without the digital wrapper function, a carrier transporting a service transparently would be unable to identify network impairments that may degrade the transported signal and exceed SLA requirements. The digital wrapper's general communications channel (GCC) provides a separate communications channel, versus the section data communications channel (DCC)/regenerator SDCC (SDCC/RSDCC) in SONET/SDH signals, to be used by the platform when transparent signals are transported. This GCC enables the Cisco ONS 15454 to extend its advanced network auto-discovery capabilities to DWDM-based services. The integrated Cisco Transport Controller craft manager and the Cisco Transport Manager EMS provide the user with OAM&P access for the system.

Configurable Far-End-Laser-Off Behavior

The Full-Band Tunable Enhanced Muxponder Card offers the capability to provision the Far-End-Laser-Off behavior. You can use Cisco Transport Controller to configure how the remote client interface will behave following a fault condition. It is possible to configure the remote client to squelch or to send an alarm indication signal (AIS).

Performance Monitoring

The performance monitoring capabilities of the muxponder card provide support for both transparent and nontransparent signal transport. For SONET/SDH signals, standard performance monitoring, threshold-crossing conditions, and alarms are supported per Telcordia GR-474 and GR-2918, as well as ITU G.783 and ETS 300 417-1 standards. Each digital wrapper channel will be monitored per G.709 (OTN). Optical parameters on the client and DWDM line interfaces support loss of signal (LOS), laser bias current, transmit optical power, and receive optical power. Calculation and accumulation of the performance monitoring data is in 15-minute and 24-hour intervals as per G.7710.

The muxponder card incorporates faceplate-mounted LEDs to provide a quick visual check of the operational status of the card. An orange circle is printed on the faceplate, indicating the shelf slot in which the card can be installed.

Application Description

The Full-Band Tunable Muxponder Card adds the capability to cost-effectively aggregate 2.5-Gbps services and transport them with or without overhead transparency. Figure 6 displays a typical service provider backbone network application. The muxponder card on the Cisco ONS 15454 network enables the transport of the four services or termination of the SONET/SDH overhead of the four streams, or it is possible to have them transparently pass through service provider A's network.

Figure 6. High-Density OC-48/STM-16 Transport
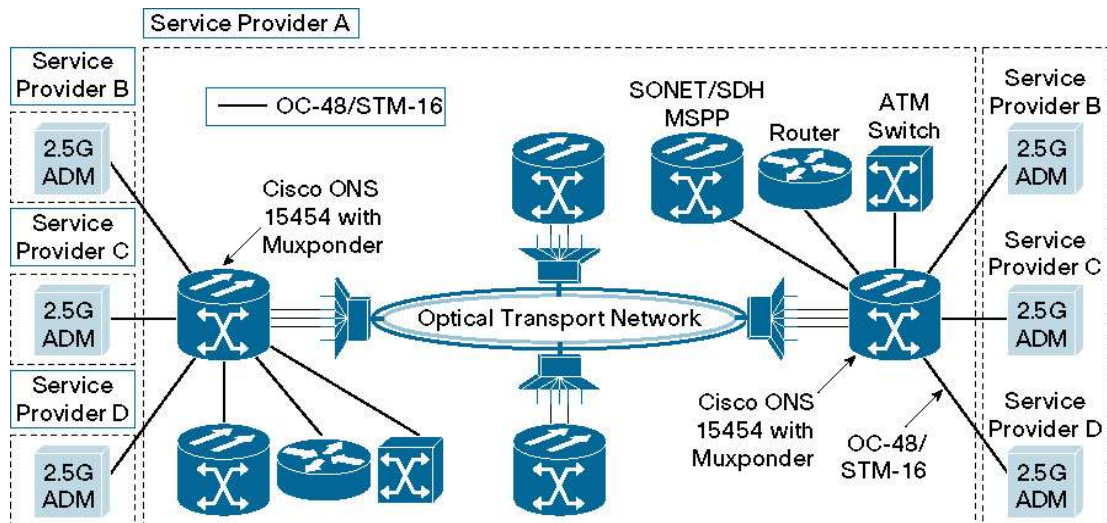
As well as transporting 2.5-Gbps service, the user can deliver a mixture of service types, from DS-1/E1 to 10-Gbps services, using a common Cisco ONS 15454 transport platform. This capability helps reduce system complexity, capital expenditures, and operational expenses related to technician training.

Features and Specifications

Compact Design

- Single-width card slot design for high-density, 4x 2.5-Gbps solutions
- Up to 12 muxponder cards per shelf assembly on the Cisco ONS 15454 platform
- Up to 6 muxponder cards per shelf assembly on the Cisco ONS 15454 M6 platform
- Up to 2 muxponder cards per shelf assembly on the Cisco ONS 15454 M2 platform

Flexible Restoration Options

- Transparent support for UPSR/SNCP, BLSR/MSP, and 1+1 APS/MSP
- Client Y-protection
- Unprotected (0+1)

Tables 2 and 3 list regulatory compliance information and system requirements for the muxponder card. Tables 4 through 7 list product specifications and Table 8 provides ordering information.

Regulatory Compliance

Table 2.   Regulatory Compliance[1]

ANSI System	ETSI System
Countries Supported	
• Canada • United States • Korea • Japan • European Union	• European Union • Africa • CSI • Australia • New Zealand • China • Korea • India • Saudi Arabia • South America
EMC (Class A)	
• ICES-003 (2004) • GR-1089-CORE Issue 4, NEBS EMC and Safety (June 2006) • FCC 47CFR15 (2006)	• EN 300 386 Telecommunications Network Equipment (EMC): 2007 (Note: EMC-1) • CISPR22 (2008) and CISPR24: 2002/ EN55024: 2007: Immunity levels: see EN61000-4-xx • EN55022: 2007 Information Technology Equipment (Emissions)(2006) (EMC-2) • EN55024: 1998/a2: 2003 Information Technology Equipment (Immunity)
Safety	
• UL/CSA 60950-1, 2006 • GR-1089-CORE Issue 4, NEBS EMC and Safety (June 2006)	• UL/CSA 60950-1, 2006 • IEC 60950-1(2005/12), 2nd Edition and National Differences as per CB Bulletin 112A
Laser	
• UL/CSA 60950-1, 2006 • IEC 60950-1(2005/12), 2nd Edition and National Differences as per CB Bulletin 112A • IEC-60825-2 Edition 3.1, 2007/01	• CDRH (accession letter and report) • IEC 60825-1 Consol. Ed. 1.2 (incl. am1+am2) 2001-08
Environmental	
• GR-63-CORE Issue 3, NEBS Physical Protection (Mar 2006) • ETS 300-019-2-1 V2.1.2 (Storage, Class 1.1)	• ETS 300-019-2-2 V2.1.2 (1999-09): Transportation, Class 2.3 • ETS 300-019-2-3 V2.2.2 (2003-04):Operational, Class 3.1E
Optical	
• GR-253-CORE - Issue 04 • ITU-T G.691	• ITU-T G.709 • ITU-T G.975
Quality	
• TR-NWT-000332, Issue 4, Method 1 calculation for 20-year mean time between failure (MTBF)	
Miscellaneous	
• AT&T Network Equipment Development Standards (NEDS) Generic Requirements, AT&T 802-900-260 • SBC TP76200MP	• Verizon SIT.NEBS.NPI.2002.010 • Worldcom ESD requirement

1. All compliance documentation may not be completed at the time of product release. Please check with your Cisco sales representative for countries outside of Canada, the United States, and the European Union.

Table 3. System Requirements

Component	Cisco ONS 15454 ANSI	Cisco ONS 15454 ETSI	Cisco ONS 15454 M6	Cisco ONS 15454 M2
Processor	TCC3[1], TCC2P and TCC2	TCC3[1], TCC2P and TCC2	TNC, TSC, TNC-E[2], or TSC-E[2]	TNC, TSC, TNC-E[2], or TSC-E[2]
Cross-connect	All (not required)	All (not required)	-	-
Shelf assembly	15454-SA-HD or 15454-SA-HD-DDR shelf assembly with CC-FTA or FTA3 version fan-tray assembly	15454-SA-ETSI shelf assembly with CC-FTA or SDH 48V fan-tray assembly	15454-M6-SA shelf assembly	15454-M2-SA shelf assembly
System software	Release 9.1.0 ANSI or later	Release 9.1.0 ETSI or later	Release 9.2 ANSI/ETSI or later	Release 9.2 ANSI/ETSI or later
Slot compatibility	1–6, 12–17	1–6, 12–17	2-7	2-3

1. The TCC3 card is supported on the Cisco ONS 15454 DWDM systems from Rel 9.2 onwards. However, it is backward compatible with software Release 9.1 and earlier releases. In the Release 9.1 and earlier releases, the TCC3 card boots up as the TCC2P card in the Cisco ONS 15454 DWDM systems.

2. The TNC-E and the TSC-E cards are supported on the Cisco ONS 15454 M6 and M2 DWDM systems from Rel 9.3 onwards

Table 4. Client-Side Specifications

Specification	Short Reach/Intra-office	Intermediate Reach/Short Haul	Long Reach/Long Haul
Client Interface (SFP)			
Type	SFP	SFP	SFP
Specification Telcordia GR-253-Core ITU	GR-253-Core SR-1 I-16.1	GR-253-Core IR-1 S-16.1	GR-253-Core LR-2 L-16.2
Optical path attenuation	0 to 7 dB	0 to 12 dB	0 to 7 dB
Wavelength, nominal, (I_{Tnom})	1310 nm	1310 nm	1550 nm
Spectral range (I_{Tmin} to I_{Tmax})	1266 to 1360	1260 to 1360 nm	1500 to 1580
Spectral width @ 20 dB ($\Delta\lambda_{20}$)	—	1 nm	1 nm
Maximum RMS width (σ)	4 nm	—	—
Optical transmitter			
Type	Fabry-Perot	Distributed feedback /Direct Modulation (DFB/DM)	Distributed feedback /Direct Modulation (DFB/DM)
Output power (P_{Tmin} to P_{Tmax})	–10 to –3	–5 to 0 dBm	–3 to +2 dBm
Extinction ratio, minimum (r_{eminx})	8.2 dB	8.2 dB	8.2 dB
Laser safety class	1	1	1
Optical receiver			
Type	PIN	PIN	APD
Sensitivity @ BER (P_{Rmin} to P_{Rmax})	–18 to –3 dBm	–18 to 0 dBm	–28 to –9 dBm
Chromatic dispersion tolerance (D_{SRmax})	12 ps/nm	–	1200 to 1600 ps/nm
Power penalty (P_O)	1	1	2
BER, maximum (BER_{min})	10E-12	10E-12	10E-12
Receiver reflectance (maximum)	–27 dB	–27 dB	–27 dB
Input wavelength bandwidth (I_{c_rx})	1266 to 1580 nm	1260 to 1580 nm	1500 to 1580 nm
Connector type (Tx/Rx)	LC	LC	LC

Table 5.   DWDM Specifications

Specification	DWDM Line Interface
DWDM Line Interface	
Bit Rate	10.7092 ±100 ppm 11.0957 ±100 ppm 11.3168 ±100 ppm
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelengths (λ_{Tnom})	Full Tunable from 1529.55 to 1561.84 (C-Band – 50 GHz)
Spectral width at 20 dB ($\lambda\Delta_{20}$)	≤25 GHz
Optical transmitter	
Type	Lithium-Niobate external modulator
Output power (P_{Tmin} to P_{Tmax})	+3 dBm, +6 dBm
Required optical return loss, minimum (ORL_{min})	27 dB
Extinction ratio, minimum (r_{eminx})	>10.5 dB
Laser safety class	1
Optical receiver	
Type	Avalanche photo diode (APD)
Chromatic dispersion tolerance (DLR_{max})	Up to ±4000 ps/nm
Minimum BER (BERmin) • FEC on • E-FEC on	 10E-15 10E-15
Reflectance between far-end Tx and near-end Rx (maximum)	–27 dB
Receiver reflectance (maximum)	–14 dB
Input wavelength bandwidth (λ_{c_rx})	1290 nm to 1605 nm
Connector type (Tx/Rx)	LC, duplex (shuttered)

Table 6.   DWDM Receive-Side Optical Performances

CD Tolerance	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	PMD[1]	OSNR
Any bit-rate						
0 ps/nm	STD	<10E(–5)	<10E(–15)	–8 to –20 dBm	–	8 dB
+/– 800 ps/nm					–	8.5 dB
+/– 1600 ps/nm					–	9 dB
0 ps/nm	ENH	<7x10E(–4)		–8 to –27 dBm	0 ps	19 dB
+/– 2000 ps/nm				–8 to –26 dBm		
+/– 2000 ps/nm				–8 to –25 dBm	20 ps	
At 11.1 Gbps						
0 ps/nm	STD	<10E(–5)	<10E(–15)	–8 to –20 dBm	0 ps	8.1 dB
0 ps/nm					10 ps	8.9 dB
0 ps/nm					30 ps	14.8 dB
+/– 1500 ps/nm					10 ps	10 dB
–2000 / 2500 ps/nm					10 ps	11.3 dB
0 ps/nm	ENH	<7x10E(–4)			0 ps	5.3 dB
0 ps/nm					10 ps	5.9 dB
0 ps/nm					30 ps	10.3 dB
+/– 1500 ps/nm					10 ps	6.9 dB

CD Tolerance	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	PMD[1]	OSNR
−2000 / 2500 ps/nm					10 ps	8.1 dB
−3000 / 4000 ps/nm					20 ps	12.7 dB
+/− 4000 ps/nm					20 ps	13.3 dB

1. Average PMD

Table 7. Card Specifications

Specification	
Management	
Card LEDs • Failure (FAIL) • Active/standby (ACT/STBY) • Signal fail (SF)	 Red Green/yellow Yellow
Client port LEDs (per port) • Active input signal	 Green
DWDM port LEDs • Active input signal • Output wavelength	 Green Green
Power (including worst-case pluggable)	
Typical Maximum	40W 50W
Physical	
Dimensions	Occupies one slot
Weight	1.4 Kg (3.1 lbs)
Reliability and Availability	
Mean time between failure (MTBF)	236,765 hrs
Latency (End to End)	
G.709 Off / NO FEC: G.709 On – Standard FEC G.709 On – Enhanced FEC	1 microsecond 5 microseconds 150 microseconds
Environment Conditions	
Storage temperature	−40ºC to 70ºC (−40ºF to 158ºF)
Operating temperature • Normal • Short term[1]	 0ºC to 40ºC (32ºF to 104ºF) −5ºC to 55ºC (23ºF to 131ºF)
Relative humidity • Normal • Short term[1]	 5% to 85%, non condensing 5% to 90% but not to exceed 0.024 kg water/kg of dry air

1. Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year. (This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period.)

Table 8.   Ordering Information

Part Number	Description
15454-10MEX-L1-C=	Extended performance 4-port OC-48/STM-16 EFEC muxponder card, 4 SFP-based client interfaces, full C-band tunable on 50-GHz ITU wavelengths, DWDM line with LC connectors
15454-SFP-OC48-IR= **15454E-SFP-L.16.1=**	OC-48/STM-16 SFP, intermediate-reach, 1550-nm, single-mode, LC connectors
ONS-SE-2G-S1=	OC-48/STM-16 SFP optics module, short-reach/intra-office, 1310-nm, single-mode, EXT temperature range, LC connectors
ONS-SE-2G-L2=	OC-48/STM-16 SFP optics module, long-reach/long-haul, 1550-nm, single-mode, EXT temperature range, LC connectors
NOTE: Transponders equipped with LR2 XFP need to be placed in a high-speed slot (5,6,12, or 13) if shelf is equipped with FTA-3 or FTA-48V fan tray. No limitation if the shelf is using CC-FTA fan tray.	

Service and Support

Cisco offers a wide range of services programs to accelerate customer success. These innovative services programs are delivered through a unique combination of people, processes, tools, and partners, resulting in high levels of customer satisfaction. Cisco services help you to protect your network investment, optimize network operations, and prepare your network for new applications to extend network intelligence and the power of your business.

For more information about Cisco Services, refer to Cisco Technical Support Services or Cisco Advanced Services.

For More Information

For more information about the Cisco ONS 15454 Multiservice Transport Platform, contact your local account representative or visit Cisco at: http://www.cisco.com/go/optical or http://www.cisco.com/go/IPoDWDM.

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