4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card for the Cisco ONS 15454 Multiservice Transport Platform

The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) supports a 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card, which expands the platform's 10-Gbps interface density. The card facilitates the delivery of transparent 10-Gbps-based services for enterprises or service provider optical networks (Figure 1).

Cisco ONS 15454 MSTP Release 9.2 extends the overall data bandwidth that can be transported by the system by a factor of four, supporting transmission of up to 320 channels at 10 Gbps over 80 wavelengths at 40 Gbps.

Figure 1.   4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card

Background

The traffic carried on core and metro DWDM networks is growing exponentially, while operators' revenues are failing to keep pace. The Cisco ONS 15454 40-Gbps solution can dramatically lower the cost to carry this traffic, helping operators to maintain and even increase profitability.

Internet usage is still skyrocketing, primarily due to demand for next-generation services such as quadruple-play, video distribution, IPTV, and an array of high-bandwidth services.

This massive traffic growth is creating bottlenecks in DWDM networks that require a technology leap to support the surge in bandwidth. Scaling from 10 Gbps to 40 Gbps solves this problem by quadrupling the amount of traffic that can be transported over existing fiber.

The Cisco ONS 15454 MSTP 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card allows you to upgrade your existing DWDM system without any additional equipment (such as a DCU). The card meets the following three critical requirements:

- 40-Gbps signals will work on already deployed 10-Gbps systems.
  - 40-Gbps technology will support comparable chromatic dispersion (CD) robustness, polarization-mode dispersion (PMD) robustness, and optical signal-to-noise ratio (OSNR) with existing 10-Gbps transponders.

- 40-Gbps technology will work on 50-GHz system as well as current 10-Gbps wavelengths (with comparable filtering penalty).
- 40-Gbps units will fit mechanically and thermally with existing installed shelf with **no** impact on existing units, allowing full compatibility and **no** restriction on where the units can be placed.

Product Overview

The Cisco 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card can transport four OC-192/STM-64/10GE LAN/10GE WAN/8G FC/10G FC/OTU2 payloads over a G.709 OTU-3-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 10-Gbps 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 multiservice interface (OC-192/STM-64/10GE LAN/10GE WAN/8G FC /10G FC/OTU2) through a 10G Small Form-Factor Pluggable (XFP) optics module with LC connectors, providing the flexibility to support several optical reaches with support for qualified XFP modules. The muxponder card supports any mixture of XFP reach types and also supports in-service insertion or removal without affecting other active ports, allowing superior networking flexibility and reduced pre-planning activities.

Various types can be used depending on reach and application:

- ONS-XC-10G-S1= (P/N 10-2012-03)
  - 10G-1200-SM-LL-L / 10GE BASE-LR / 10GE BASE-WR / OC-192 SR1 / STM-64 I.64 / OTU-2 at 10.7G, 11.05G, and 11.09G
- ONS-XC-10G-I1= (P/N 10-2193-02)
  - 10GE BASE-ER / 10GE BASE-EW / OC-192 IR2 / STM-64 S-64.2
- ONS-XC-10G-L2= (P/N 10-2194-02)
  - 10GE BASE-ZR / OC-192 LR2 / G959.1 P1L1-2D2
- ONS-XC-10G-SR-MM= (P/N 10-2420-01)
  - 1200-MX-SN-I / 10GE BASE-SR / OTU-2 at 10.7G, 11.05G, and 11.09
- ONS-XC-10G-C= (P/N 10-2480-01)
  - Full C Band Tunable DWDM XFP supporting OC-192/STM-64/10GE/10G FC/OTU2 services
- ONS-XC-8G-SM=
  - 800-SMLC-L services
- ONS-XC-10G-xxxx (xxxx from 1470 to 1610)
  - CWDM for 10GE LAN PHY, WANPHY, STM-64, OC-192, 10G FC, and OTU2 at 10.7G, 11.05G, 11.09G, and 11.3G

The DWDM line interface provides a configurable 43.018-Gbps/44.570-Gbps G.709 OTU-3 digital wrapper, long-reach/long-haul, ITU-compliant, 50-GHz spaced optical interface using LC connectors supporting G.709 OTU-3 digital wrapper interfaces. The DWDM output line interface is tunable across full optical C band, dramatically reducing inventories for spares. When operated within the outlined specifications, each card will transport each of the 10-Gbps signals with a maximum bit error rate (BER) of 10E-15.

The muxponder card incorporates the four clients and one DWDM line interface on the same card. The muxponder card is deployable in any of 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 10-Gbps services as well as 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 10-Gbps services, including selectable protocol transparency, wavelength tunability, flexible protection mechanisms, flexible timing options, and management capabilities.

Figure 2. 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card Block Diagram
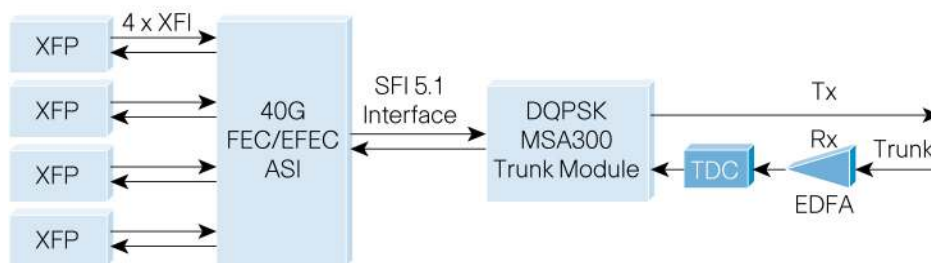
Enhanced FEC Capability

The card supports the Forward Error Correction (FEC) mechanism on trunk and client interfaces.

The trunk port supports FEC and E-FEC and such mechanisms cannot be disabled. The output bit rate will not depend on the selected algorithm but the error coding performance can be provisioned:

- FEC: standard G.975 Reed-Salomon algorithm
- E-FEC: standard G.975.1 (Subclause I.7) 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 respective to standard FEC. This E-FEC algorithm can be enabled in three of the four client ports (Port 1 cannot support E-FEC).

Client ports, pending the support of FEC rate on the pluggable, can support the FEC mechanism which can be disabled.

- FEC: standard G.975 Reed-Salomon algorithm on all four client ports
- E-FEC: standard G.975.1 (Subclause I.7) two orthogonally concatenated BCH super FEC codes.

Advanced Modulation Scheme

The Cisco 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card features an advanced modulation scheme to achieve performance comparable to industry-standard 10-Gbps equivalent units.

Cisco selected an RZ-DQPSK modulation format (Return-to-Zero Differential Quadrature Phase Shift Keying) in order to optimize 40-Gbps transmission in terms of OSNR, CD robustness, and PMD robustness.

RZ-DQPSK is a four-level Phase Modulation scheme where four "signal points" are used. Each "phase" or "signal point" carries two bits. See Figure 3.

Figure 3.   DQPSK Phase Domain Scheme
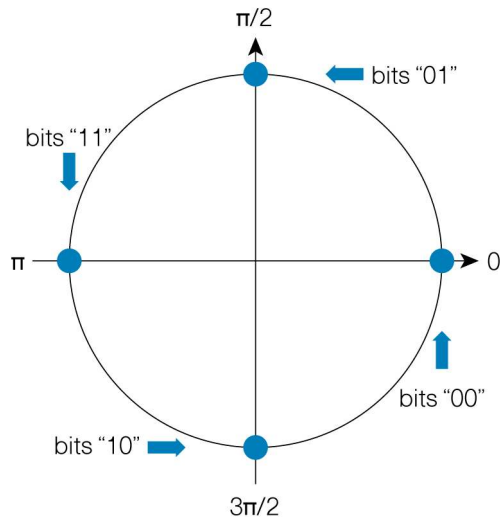
The main advantages of RZ-DQPSK are:

- Good OSNR performance, similar to 10-Gbps units

- Equivalent CD robustness to 10-Gbps units

- Good PMD robustness compatible with existing 10-Gbps units

- Very good spectral density that will allow crossing a long cascade of ROADM with negligible penalty

Protocol Transparency and Card Configuration

The muxponder card enables cost-effective, point-to-point delivery of any combination of 10-Gbps services by the Cisco ONS 15454 MSTP.

The card can be provisioned in two operational modes: OTU3 Trunk or OTU3e Overclocked Trunk.

In the first operational mode card can transparently multiplex any mix of STM-64/OC-192, 10GE LAN, 10GE WAN, OTU2, 8-Gbps Fibre Channel signals while in the second operational mode it is possible to combine any mix of 10-Gbps Fibre Channel and OTU2e (G,Sup43 7.1 and 7.2) signals as indicated in Table 1.

Table 1.   Muxponder Client Configurations and Mapping

Client Format	Freq. [GHz]	Mapping	Trunk Format	Freq. [GHz]
8-Gbps-Fibre Channel	8.500	Enhanced OTN mapping (proprietary)	OTU3	43.018
OC-192/STM-64/10GE WAN-PHY	9.953	ODTU23 multiplexing according to ITU G.709 standard		
10GE LAN-PHY	10.312	GFP-F (G.SUP43 7.3) Or LAN-WAN (G.SUP43 6.1)		
OTU2 (OC-192/STM-64/10GE WAN-PHY)	10.709	ODTU23 multiplexing according to ITU G.709 standard		
10-Gbps -Fibre Channel	10.519	512/513 transcoding + GFP-T	OTU3e	44.570
OTU2e (10GE LAN-PHY)	11.096	ODTU23 multiplexing (G.SUP43 7.1)		

The card is also able to provide provisionable SONET/SDH overhead bytes processing. It is possible to pass them 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 that performs the multiplexing of the incoming 10-Gbps signals at the OTN layer no longer in the SONET/SDH domain. Different mapping schemes are used depending on the payload to help ensure full transparency of the signal, as indicated in Table 1.

LAN-to-WAN Conversion

The Cisco 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card provides the capability to convert incoming 10 Gigabit Ethernet LAN PHY signal into 10 Gigabit Ethernet WAN PHY signal at the far-end egress port.

The 10 Gigabit Ethernet LAN PHY-to-WAN PHY conversion is implemented according to standards defined in IEEE 802.3: WIS (WAN Interface Sublayer). 10 Gigabit Ethernet LAN PHY has an effective line rate of 10.3125 Gbps (10 Gbps of data traffic encoded in a 64B/66B protocol). 10 Gigabit Ethernet WAN PHY interfaces conform to the SONET/SDH standards to achieve 9.95328 Gbps and allow service providers to use their existing SONET/SDH Layer 1 infrastructure.

WAN PHY is used to transport 10 Gigabit Ethernet across SDH/SONET or WDM systems without having to directly map the Ethernet frames into SDH/SONET first. The WAN PHY variants correspond at the physical layer to 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, and 10GBASE-ZR respectively, and hence use the same types of fiber and support the same distances.

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 customer's inventory required to cover all of the wavelengths for deployment and spares. 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 2 outlines the supported protection options that help to deliver the service-level agreements (SLAs) required by the application.

Table 2.   Protection Formats

Protection Type	Capabilities
Unprotected	No client terminal interface, muxponder card, or DWDM line protection. The client signal is transported over a single unprotected muxponder card.
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.
	Similar to unprotected format. Protection is provided through client line or path protection via transparent signal transport through muxponder circuit.
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.
OCH-trail protection	Provide protection for DWDM signal through external optical switch units (PSM).

Flexible Timing Options

The Cisco 4-Port 10-Gbps Full-Band Tunable DQPSK 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 the case of SONET/SDH, Ethernet, and OTN signal, 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 is also able to recover the clock from the trunk when the operational mode is OTU3. The muxponder card can also maintain synchronization from an internal clock even if both the shelf processors (active and standby) fail.

Management

The Cisco ONS 15454 MSTP provides comprehensive management capabilities for operations, administration, maintenance, 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 communication channel (GCC) provides a separate communications channel, versus the section DCC/regenerator section DCC (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.

Far-End-Laser-Off Behavior

The Cisco 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card offers the capability to provision the Far-End-Laser-Off behavior in case of SONET/SDH payloads. The Cisco Transport Controller can be used 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).

In the case of data signals (10 Gigabit Ethernet, 10 Gigabit Fibre Channel, or 8 Gigabit Fibre Channel) the behavior is squelching. In the case of OTN signals, the behavior is standard ODUk-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-253, GR-474, and GR-2918, as well as ITU G.828 and ETS 300 417-1 standards. Each digital wrapper channel will be monitored per G.709 (OTN), G.8021. 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. Ethernet data are monitored using RMON.

Table 8 provides a detailed list of performance monitoring parameters.

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.

Regenerator Configuration

The Cisco 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card also supports the OTU3 Regeneration function. Two cards can be configured to work in unidirectional mode, allowing the OTN O-E-O Regeneration function to perform, as shown in Figure 4.

Figure 4.   Unidirectional Configuration for 40-Gbps Muxponder Card in Regeneration Mode
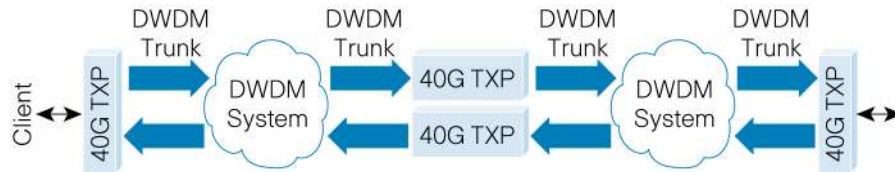
OTU overhead is terminated and ODU is correctly passed through as required by the G.709 standard, and GCC-1 and GCC-2 are properly passed through while GCC0 is not terminated.

Application Description

The Cisco ONS 15454 MSTP 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder adds the capability to cost-effectively aggregate 10-Gbps services and transparently transport them.

Continued proliferation of data-intensive enterprise services (virtual offices with video conferencing, VPNs, etc.) and mass market deployment of high-end consumer applications (HD VoD, IPTV, etc.) are creating bottlenecks in the 10-Gbps-based DWDM transport network. Cisco's 40-Gbps solution can quadruple the available fiber transport bandwidth with performances comparable to the 10-Gbps one.

Fiber relief is one of the key applications for the Cisco 40-Gbps muxponder solution. Bandwidth transport demand increased in the last 3 years consuming existing 10-Gbps Wavelength base DWDM system. With the 40-Gbps muxponder it is possible to significantly increase existing DWDM system capacity. Operators can upgrade an existing 80-channel 10-Gbps network equipped with 64 wavelengths with an additional 16 wavelengths at 40 Gbps that carry an additional 64 10-Gbps signals, thanks to the 40-Gbps muxponder. The Cisco solution was specifically designed to support existing 10-Gbps channels without any need to upgrade the existing optical infrastacture.

Industry trends show that the adoption of 8-Gbps Fibre Channel has become critical in data center environments due to the increase of SAN services (server virtualization, etc.). The 40-Gbps muxponder card offers a hyper-dense 8-Gbps Fibre Channel solution, enabling operators to transmit over a single fiber pair up to 320 8-Gbps Fibre Channel signals over the C-band.

Figure 5. Data Center 8-Gbps Fibre Channel over 40-Gbps Muxponder Card – Architecture
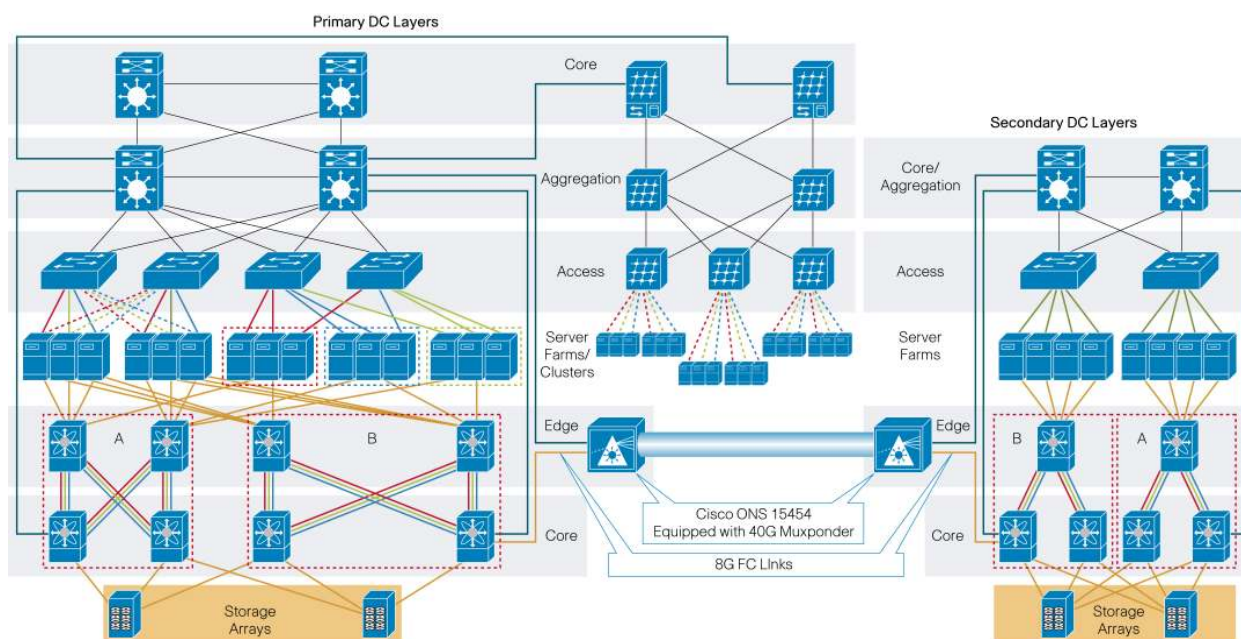
The LAN-WAN conversion on the muxponder card allows the service flexibility to accommodate existing SONET/SDH OC-192/STM-64 facilities that are mapped for 10 Gigabit Ethernet payloads. Key applications are the transport of 10 Gigabit Ethernet over traditional SONET/SDH networks and submarine landing side translation where the vast majority of the systems are TDM-only-based.

Cisco ONS 15454 4-Port 10-Gbps DQPSK Muxponder Card Features and Specifications

Compact Design

- Double-width card slot design for high-density, 4x 10-Gbps solutions
- Up to 6 muxponder cards per shelf assembly enables up to 96 10-Gbps interface per bay frame

Flexible Restoration Options

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

Tables 3 and 4 list the regulatory compliance and system requirements for the muxponder card.

Regulatory Compliance[1]

Table 3. Regulatory Compliance

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 (2007)	• ETSI EN 300 386 V1.4.1 (2008-04) Telecommunication network equipment EMC requirements (Note: EMC-1) • CISPR22:2008 and EN55022:2006/A1:2007 Information Technology Equipment (Emissions) (EMC-2) • CISPR24: 1997/A1:2001/A2:2002 and EN55024:1998/A1:2001/A2:2003: Information Technology Equipment – Immunity characteristics – Limits and Methods of Measurement (test levels)
Safety	
• CSA C22.2 #60950-1 – Edition 7, March 2007 • UL 60950-1 – Edition 2, March 2007 • GR-1089-CORE Issue 4, NEBS EMC and Safety (June 2006)	• UL 60950-1 – Edition 2, March 2007 • IEC 60950-1 – Information technology equipment Safety Part 1: General requirements – Edition 2, 2005 and National Differences as per CB Bulletin 112A • IEC/EN 60950-1 (2006/10) with Amendment 11:2004 to EN 60950-1:2001, 1st Edition and National Differences as per CB Bulletin 112A. • EN 60950-1, Edition 2 (2006) Information technology equipment – Safety – Part 1: General requirements • CE Safety Directive: 2006/95/EC
Laser	
• UL 60950-1 – Edition 2, March 2007 • IEC 60825-1: 2001 Ed.1.2 (incl. am1+am2) Safety of laser products Part 1: Equipment classification, requirements and users guide • IEC60825-2 Ed.3 (2004) Safety of laser products Part 2: Safety of optical fibre communication systems + A1:2006	• IEC 60825-1: 2001 Ed.1.2 (incl. am1+am2) Safety of laser products Part 1: Equipment classification, requirements and users guide • IEC60825-2 Ed.3 (2004) Safety of laser products Part 2: Safety of optical fibre communication systems + A1:2006 • 21CFR1040 (2008/04) (Accession Letter and CDRH Report) Automatic Laser Shutdown and restart (ALS) according to ITU-T G.664 (03/06). Guidance for Industry and FDA Staff (Laser Notice No. 50) 2007, June • Laser Products – Conformance with IEC 60825-1 and IEC 60601-2-22; Guidance for Industry and FDA Staff (Laser Notice No. 50) 2007, June
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)	

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[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.

ANSI System	ETSI System
Miscellaneous	
• GR-1089-CORE Issue 4, NEBS EMC and Safety (June 2006) (Note: NEBS-1) • GR-63-CORE Issue 3, NEBS Physical Protection (Mar 2006) (Note: NEBS-2) • ATT-TP-76200 : 2008 • ANSI T1.315-2001 • GR-499: 2004 Transport Systems Generic Requirements (TSGR): Common Requirements	

Table 4.   System Requirements

Component	Cisco ONS 15454 ANSI	Cisco ONS 15454 ETSI	Cisco ONS15454 M6	Cisco ONS15454 M2
Processor	TCC3/TCC2P/TCC2	TCC3/TCC2P/TCC2	TNC/TSC	TNC/TSC
Cross-connect	All (not required)	All (not required)	–	–
Shelf assembly	15454-SA-HD or 15454-SA-HD-DDR shelf assembly with CC-FTA version fan-tray assembly	15454-SA-ETSI shelf assembly with CC-FTA fan-tray assembly	15454-M6-SA shelf assembly	15454-M2-SA shelf assembly
System software	Release 9.2.0 ANSI or later	Release 9.2.0 ETSI or later	Release 9.2.0 ANSI/ETSI or later	Release 9.2.0 ANSI/ETSI or later
Slot compatibility	1–6, 12–17	1–6, 12–17	2–7	2–3

Table 5.   DWDM Specifications

Specification	DWDM Line Interface
DWDM Line Interface	
Bit rate	43.018 ±100 ppm (OTU-3) 44.570 ±100 ppm (OTU-3e)
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelengths (λ_{Tnom})	Fully tunable from 1529.55 to 1561.83 (C Band – 50 GHz)
Spectral width at 3 dB ($\lambda\Delta_3$)	>25 GHz
Optical Transmitter	
Type	RZ-DQPSK modulation format
Output power (P_{Tmin} to P_{Tmax})	– 2 dBm to +2 dBm
Required optical return loss, minimum (ORL_{min})	30 dB
Laser safety class	1
Optical Receiver	
Type	PIN photo detector
Chromatic dispersion tolerance (DLR_{max})	Up to ±750 ps/nm
Minimum BER (BERmin) • FEC on • E-FEC on	 10E-15 10E-15
Overload	–8 dBm
Receiver reflectance (maximum)	30 dB
Input wavelength bandwidth (λ_{c_rx})	Fully unable from 1529.55 to 1561.83 (C Band – 50 GHz)
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 (0.5nm RWB)
Any Bit Rate						
0 ps/nm	STD	<10E(–5)	<10E(–15)	–8 to –20 dBm	–	12.5 dB
+/– 650 ps/nm					–	12.5 dB
+/– 650 ps/nm					5 ps	13.5 dB
+/– 650 ps/nm					8 ps	14.5 dB
+/– 750 ps/nm					–	14.5 dB
0 ps/nm	ENH	<1x10E(–3)	<10E(–15)	–8 to –24 dBm	–	23 dB
0 ps/nm				–8 to –20 dBm	–	8 dB
+/– 650 ps/nm				–8 to –20 dBm	–	8 dB
+/– 650 ps/nm				–8 to –20 dBm	5 ps	9 dB
+/– 650 ps/nm				–8 to –20 dBm	8 ps	10 dB
+/– 750 ps/nm				–8 to –20 dBm	–	10 dB
+/– 750 ps/nm				–8 to –20 dBm	5 ps	11 dB
+/– 750 ps/nm				–8 to –20 dBm	8 ps	12 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	90W (with no pluggable) 112W (fully loaded)
Physical	
Dimensions	Occupies two slot
Weight	2.58 kg (5.8 lbs)
Reliability and Availability	
Mean Time Between Failures (MTBF)	166,218 hrs
Latency (End to End)	
G.709 On – Standard FEC G.709 On – Enhanced FEC	5 microseconds 50 microseconds
Environment Conditions	
Storage temperature	–40ºC to 70ºC (–40ºF to 158ºF)

Operating temperature
  Normal
  Short term[3]
	
	0ºC to 40ºC (32ºF to 104ºF)
	–5ºC to 55ºC (23ºF to 131ºF)

Specification	
Relative humidity	
Normal	5% to 85%, non condensing
Short term[1]	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.   Performance Monitoring Parameters

Payload	Description		
10 GE	etherStatsOctets and comply with RFC-1757		
	etherStatsPkts and comply with RFC-1757		
	etherStatsBroadcastPkts and comply with RFC-1757		
	etherStatsMulticastPkts and comply with RFC-1757		
	etherStatsUndersizePkts and comply with RFC-1757		
	etherStatsOversizePkts and comply with RFC-1757		
	etherStatsFragments and comply with RFC-1757		
	etherStatsJabbers and comply with RFC-1757		
	etherStatsPkts64Octets and comply with RFC-1757		
	etherStatsPkts65to127Octets and comply with RFC-1757		
	etherStatsPkts128to255Octets and comply with RFC-1757		
	etherStatsPkts256to511Octets and comply with RFC-1757		
	etherStatsPkts512to1023Octets and comply with RFC-1757		
	etherStatsPkts1024to1518Octets and comply with RFC-1757		
	ifInOctets and comply with RFC-2233		
	ifInUcastPkts and comply with RFC-2233		
	ifInErrors and comply with RFC-2233		
	ifInMulticastPkts and comply with RFC-2233.		
	ifInBroadcastPkts and comply with RFC-2233.		
	Ethernet counts include dot3StatsFCSErrors and comply with RFC-2358		
OTN	OTUk SM counters	ODUk PM counters	Description
	BBE-SM	BBE-PM	Number of Background Block Errors
	BBER-SM	BBER-PM	Background Block Errors Ratio
	ES-SM	ES-PM	Number of Errored Second
	ESR-SM	ESR-PM	Errored Seconds Ratio
	SES-SM	SES-PM	Number o Severely Errored Seconds
	SESR-SM	SESR-PM	Severely Errored Seconds Ratio
	UAS-SM	UAS-PM	Number o Unavailable Seconds
	FC-SM	FC-PM	Number of Failure Counts
OC-192	CV-L: Line Coding Violation (CV-L)		
	CV-S: Section Coding Violation (CV-S)		
	ES-L: Line Errored Seconds (ES-L)		
	ES-S: Section Errored Seconds (ES-S)		
	FC-L: Line Failure Count (FC-L)		
	SEF-S: Severely Errored Framing Seconds (SEFS-S)		
	SES-L: Line Severely Errored Seconds (SES-L)		
	SES-S: Section Severely Errored Seconds (SES-S)		
	UAS-L: Line Unavailable Seconds (UAS-L)		

Payload	Description
STM-64	MS-BBE: Multiplex Section Background Block Error (MS-BBE)
	MS-BBER : Multiplex Section Background Block Error Ratio (MS-BBER)
	MS-EB : Multiplex Section Errored Block (MS-EB)
	MS-ES: Multiplex Section Errored Second (MS-ES)
	MS-ESR: Multiplex Section Errored Second Ratio (MS-ESR
	MS-SES: Multiplex Section Severely Errored Second (MS-SES)
	MS-SESR: Multiplex Section Severely Errored Second ratio (MS-SESR)
	MS-UAS: Multiplex Section Unavailable Seconds (MS-UAS)
	RS-BBE: Regenerator Section Background Block Error (RS-BBE)
	RS-BBER: Regenerator Section Background Block Error Ratio (RS-BBER)
	RS-EB: Regenerator Section Errored Block (RS-EB)
	RS-ES: Regenerator Section Errored Second (RS-ES
	RS-ESR: Regenerator Section Errored Second Ratio (RS-ESR)
	RS-SES: Regenerator Section Severely Errored Second (RS-SES)
	RS-SESR: Regenerator Section Severely Errored Second Ratio (RS-SESR)
	RS-UAS: Regenerator Section Unavailable Second (RS-UAS)
FEC	Bit Errors: Number of corrected bit errors
	Uncorrectable Words: Number of uncorrectable words
10G Fibre Channel and 8-Gbps Fibre Channel	rxTotalPkts: Client RX – Receive frame counter
	mediaIndStatsRxFramesTruncated: Client RX –
	mediaIndStatsRxFramesTooLong: Client RX – Receive oversize frame counter
	mediaIndStatsRxFrameBadCRC: Client RX – Receive frame CRC error counter
	ifInOctects: Client RX – Receive (frame) octets counter
	ifInErros: Client RX – Receive Total Errored Frame counter
Trunk Optical PM	Transmit optical power (OPT) PM
	Transmitter laser bias current (LBC)
	Receiver optical power (OPR)

Table 9.   Ordering Information

Part Number	Description
15454-40G-MXP-C=	4x10GE/OC-192/STM-64/OTU2 Muxponder DQPSK
ONS-XC-10G-C=	10G Multi-Rate Full C Band Tuneable DWDM XFP, 50 GHz, LC
ONS-XC-10G-S1=	10 Gigabit SFP OC-192/STM-64/10 GE/10-Gbps Fibre Channel, 1310 SR-SM LC connectors
ONS-XC-10G-I2=	XFP – OC-192/STM-64/10GE – 1550 IR/SH2 – SM LC
ONS-XC-10G-L2=	XFP – OC-192/STM-64 – 1550 LR2 – SM LC
ONS-XC-10G-SR-MM=	XFP – 10GE/10G FC – 850 SR – MM LC
ONS-XC-8G-SM=	8G FC XFP SM
ONS-XC-10G-1470=	OC192/10GE/OTU2, CWDM, 1470 nm, XFP C-Temp, 40km range
ONS-XC-10G-1490=	OC192/10GE/OTU2, CWDM, 1490 nm, XFP C-Temp, 40km range
ONS-XC-10G-1510=	OC192/10GE/OTU2, CWDM, 1510 nm, XFP C-Temp, 40km range
ONS-XC-10G-1530=	OC192/10GE/OTU2, CWDM, 1530 nm, XFP C-Temp, 40km range
ONS-XC-10G-1550=	OC192/10GE/OTU2, CWDM, 1550 nm, XFP C-Temp, 40km range
ONS-XC-10G-1570=	OC192/10GE/OTU2, CWDM, 1570 nm, XFP C-Temp, 40km range
ONS-XC-10G-1570=	OC192/10GE/OTU2, CWDM, 1590 nm, XFP C-Temp, 40km range
ONS-XC-10G-1610=	OC192/10GE/OTU2, CWDM, 1610 nm, XFP C-Temp, 40km range

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For More Information

For more information about the 4-Port 10-Gbps Full-Band Tunable DQPSK Muxponder Card for the Cisco ONS 15454 MSTP, visit www.cisco.com/en/US/products/hw/optical/ps2006/ps5320/index.html or contact your local account representative

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