

Multirate DWDM OTU2 XPonder Card for the Cisco ONS 15454 Multiservice Transport Platform

The 4-port XFP-based 10 Gigabit Ethernet transponder card (Figure 1) for the Cisco® ONS 15454 Multiservice Transport Platform (MSTP) simplifies the integration and transport of OTU2, 10 Gigabit Ethernet, 10 Gigabit Fibre Channel, and OC-192/STM-64 interfaces and services into enterprises or metropolitan-area (metro) and regional service provider networks.

Figure 1. Cisco ONS 15454 OTU2 XPonder Card



Background

Metro 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, 10 Gigabit Ethernet, 10G Fibre Channel, and OC-768/STM-256 services. The flexibility to support multiple rates brings huge savings in terms of operating and management costs.

Product Overview

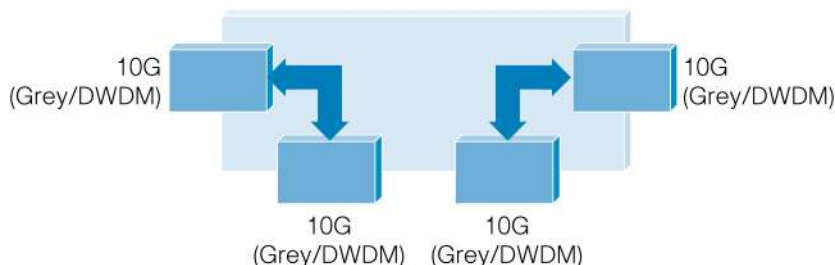
The OTU2 Xponder consists of a 4-port XFP-based 10G transponder that supports multiple bit rate signals over a 100-GHz spaced, ITU-compliant wavelength:

- OC-192/STM-64 (9.95328 Gbps)
- 10GE WAN PHY (9.95328 Gbps)
- 10GE LAN PHY (10.3125 Gbps)
- 10G FC (10.518 Gbps)
- OTU-2
 - Standard G.709 (10.70923 Gbps)
 - G.709 overclocked to transport 10GE as defined by ITU-T G. Sup43 Clause 7.1 (11.0957 Gbps)

- G.709 overclocked to transport 10GE as defined by ITU-T G. Sup43 Clause 7.2 (11.0491 Gbps)
- G.709 proprietary overclocking mode to transport 10G FC (11.3168 Gbps)

The OTU2 Xponder card is a plug-in module to the Cisco ONS 15454 MSTP, enabling a cost-effective architecture for delivering high-rate 10-Gbps services. The OTU2 Xponder card architecture contains a single client interface that is mapped to a single line interface, without accessing the Cisco ONS 15454 shelf cross-connect fabric.

Figure 2. Cisco ONS 15454 OTU2 XPonder Card Logical Scheme



Each of the four interfaces can be independently configured to support OTN wrapper. Combining the XFP and OTN configuration enables multiple configurations. For example, two grey XFPs with no OTN on two port and two DWDM XFPs with OTN wrapper enabled allow this card to act as 2 x 10G transponder in a single board. Using amplification and dispersion compensation, the OTU2 Xponder card is capable of a 1000-km reach. When operated within the outlined specifications, each card will transport the 10-Gbps signal with a maximum bite error rate (BER) of 10E-15.

The OTU2 Xponder 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 only required common card is the appropriate timing, communications, and control card (TCC2P). It is therefore possible to have 24 x 10G transponders on a single Cisco ONS 15454 MSTP shelf.

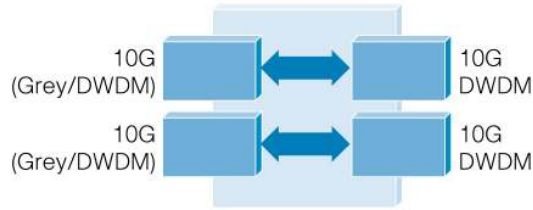
Operating Modes

Boards can be configured to operate in the following modes:

- 2 x 10G transponder
- 2 x 10G regenerator, FEC/EFEC equipping the four ports with DWDM XFP
- 1 x 10G regenerator, EFEC/EFEC equipping two ports with DWDM XFP
- Fiber-switched protected 10G transponder

In the following operating mode, the Cisco ONS 15454 OTU2 XPonder card behaves like two 10G multirate transponders. Port 1 behaves as a client connected with Port 3, which behaves as a trunk. The same applies to Port 2 as a client and Port 4 as a trunk. In this configuration, G.709 on client port is disabled.

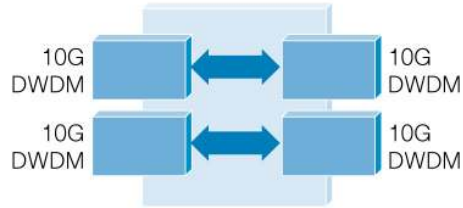
Figure 3. 2 x 10G Transponder



Proper pluggables are inserted in the ports according traffic requirements.

In the following operating mode, the Cisco ONS 15454 Otu2 XPonder card behaves like two 3R regenerators. Port 1 behaves as a trunk connected with Port 3, which behaves as a trunk. The same is true for Port 2 and Port 4. In this configuration G.709 can be enabled on all the ports. Please note that the FEC coding algorithm is asymmetric as Port 1 and Port 2 support Standard FEC (GFEC ITU-T G.975) while Port 3 and Port 4 support EFEC (ITU-T G.975.1).

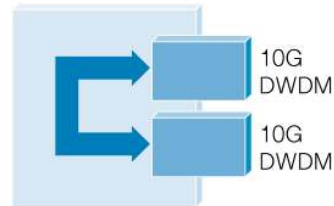
Figure 4. 2 x 10G Regenerator, FEC/EFEC Equipping the Four Ports with DWDM XFP



Proper pluggables are inserted in the ports according to traffic requirements.

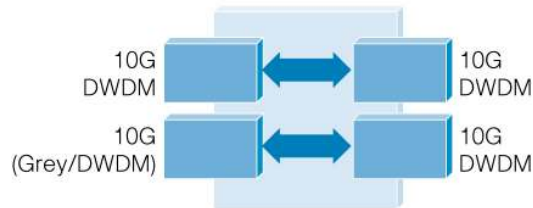
In the following operating mode, the Cisco ONS 15454 OTU2 XPonder card behaves like a single 3R regenerator. Only Port 3 and 4 are enabled as trunks while Port 1 and 2 are deactivated.

Figure 5. 1 x 10G Regenerator, EFEC/EFEC Equipping Two Ports with DWDM XFP



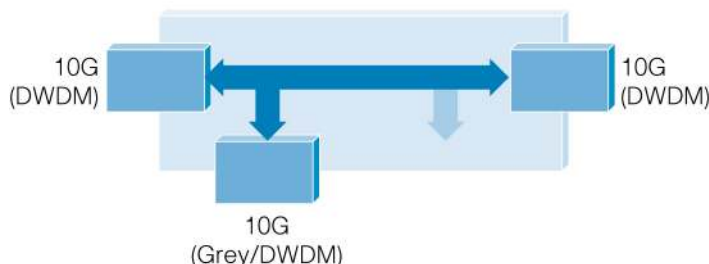
In the following operating mode, the Cisco ONS 15454 OTU2 XPonder card behaves like an MR 10G transponder and an MR 3 regenerator with FEC on one port and EFEC on the other port.

Figure 6. Mixed MR TXP and Regeneration FEC/E-FEC



In the following operating mode, the Cisco ONS 15454 OTU2 Xponder card provides a DWDM trunk protection for a single client input.

Figure 7. Fiber-Switched Protected 10G Transponder



Proper pluggables are inserted in the ports according to traffic requirements.

Pluggable Interfaces

The OTU2 Xponder card is a plug-in module to the Cisco ONS 15454 MSTP, enabling a cost-effective architecture for delivering high-rate 10-Gbps services. The OTU2 Xponder card architecture contains a single client interface that is mapped to a single line interface, without accessing the Cisco ONS 15454 shelf cross-connect fabric. The interfaces are based on 10 Gigabit Small Form-Factor Pluggable (XFP) Multi Source Agreement (MSA). Various types can be used depending on reach and application:

- ONS-XC-10G-S1= (P/N 10-2012-02)
 - 10G-1200-SM-LL-L / 10GE BASE-LR / 10GE BASE-LW / OC-192 SR1 / STM-64 I-64.1 / OTU-2 at 10.7G
- 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-xx.x (xx.x from 30.3 to 61.4 – P/N version 01)
 - DWDM for 10GE LAN PHY, WANPHY, STM-64, OC-192, 10G FC, and OTU2 at 10.7G, 11.05G and 11.09G
- ONS-XC-10G-xx.x (xx.x from 30.3 to 61.4 – P/N version 02)
 - DWDM for 10GE LAN PHY, WANPHY, STM-64, OC192, 10G FC, and OTU2 at 10.7G, 11.05G, 11.09G and 11.3G

Enhanced FEC Capability

An important feature of the OTU2 Xponder card is the ability to configure the Forward Error Correction (FEC) mode. Port 1 and 2 have two modes of operation, NO FEC and FEC, while Port 3 and 4 can also be configured in EFEC mode.

Error-coding performance can be provisioned:

- NO FEC: No Forward Error Correction
- FEC: Standard G.975 Reed-Salomon algorithm
- E-FEC: Standard G.975.1 two orthogonally concatenated BCH super FEC code; this FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved block codes (BCH), with the constructed code decoded iteratively, to achieve the expected performance

Protocol Transparency

The OTU2 Xponder card provides transparent wavelength services on the Cisco ONS 15454 platform.

For SONET- or SDH-based client payloads, when provisioned in transparent operating mode, the card will pass all of the SONET/SDH overhead bytes transparently. The card monitors important SONET/SDH overhead bytes, such as B1 (section BIP-8) and J0 (section trace), to allow fault isolation and performance monitoring capabilities. Termination of the line data communications channel (LDCC) is user-provisionable, to enable the platform processor to route the DCC information for intracarrier networking or to allow the DCC information to be transported untouched, via the digital wrapper's general communications channel (GCC), for intercarrier networking.

For 10 Gigabit Ethernet and OC-192/STM-64 payloads, digital wrapper technology (G.709) is used to add a management wrapper to the service, allowing the OTU2 Xponder card to transparently forward the payload while enabling performance metrics to be derived to help ensure circuit service quality.

For OTU2 clients, the Xponder card can transparently transport OPUk and ODUk terminating OTUk as a fully standard G.709 regenerator.

Flow-Through Timing

The OTU2 Xponder card allows the timing to "flow through" from client to line optical interfaces. Receive timing from one interface (client or line) is used to time the other transmitter interface (line or client). This flow-through timing enables the transported signal to remain independent from the node timing. It is also possible to extract the clock from any of the available ports and pass it to the TCC, but the card does not use the clock coming from the TCC.

Flexible Protection Mechanisms

The Cisco ONS 15454 OTU2 XPonder card provides flexible protection capabilities for both client and DWDM line interfaces, supporting numerous network configurations to uphold the various service-level agreements (SLAs) required by the customer application.

- Unprotected client and line: This configuration has no client terminal interface, transponder card, or DWDM line protection. The client signal is transported over a single unprotected transponder card. This configuration is suitable for transporting client payloads over a DWDM network that is being protected by a Layer 2 or Layer 3 protocol.
- Y-cable client interface: This configuration provides transponder equipment protection without client terminal equipment interface protection. A single client interface is split into two transponder cards using a Y-protection device.

- Fiber switched protection: This configuration provides redundant DWDM trunk interface protection for a single unprotected client interface.

Management

The Cisco ONS 15454 provides comprehensive management capabilities to support operations, administration, maintenance, and provisioning (OAM&P) capabilities through the integrated Cisco transport controller craft interface with support from the Cisco Transport Manager element management system (EMS). The Cisco ONS 15454 OTU2 XPonder card incorporates provisionable digital wrapper (G.709) functions, providing per-wavelength performance management capabilities, especially for services being transported transparently across the network. Without the digital wrapper functions, 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 generic communications channel (GCC) allows a separate communications channel on a per-wavelength basis. This GCC allows the Cisco ONS 15454 MSTP to extend its advanced network autodiscovery capabilities to DWDM-based services. The integrated Cisco ONS 15454 MSTP transport controller craft manager and the Cisco Transport Manager EMS provide the user with OAM&P access for the system.

Performance Monitoring

The performance monitoring capabilities of the Cisco ONS 15454 OTU2 XPonder card provide support for both transparent and nontransparent signal transport. Calculation and accumulation of the performance monitoring data is in 15-minute and 24-hour intervals.

For SONET/SDH signals, standard performance-monitoring and threshold-crossing conditions and alarms are supported per Telcordia GR-474, GR-2918, ITU G.783, and ETS 300 417-1 standards.

Table 1. SONET/SDH Performance Monitoring

SONET PM	Section	Line (Near End)	Line (Far End)
Number of Coding Violations (CV)	CV-S	CV-L	CV-L
Number of Errored Seconds (ES)	ES-S	ES-L	ES-L
Number of Severely Errored Seconds (SES)	SES-S	SES-L	SES-L
Number of Severely Errored Frame Seconds (SEFS)	SEFS-S	–	–
Number of Unavailable Seconds (UAS)	–	UAS-L	UAS-L
Number of Failure Counts (AIS/RFI Detected) (FC)	–	FC-L	FC-L

SDH PM	Regenerator Section	Multiplex Section (Near End)	Multiplex Section (Far End)
Number of Errored Seconds (ES)	RS-ES	MS-ES	MS-ES
Error Seconds Ratio (ESR)	RS-ESR	MS-ESR	MS-ESR
Number of Severely Errored Seconds (SES)	RS-SES	MS-SES	MS-SES
Severely Errored Seconds Ratio (SESR)	RS-SESR	MS-SESR	MS-SESR
Number of Background Block Errors (BBE)	RS-BBE	MS-BBE	MS-BBE
Background Block Errors Ratio (BBER)	RS-BBER	MS-BBER	MS-BBER
Number of Unavailable Seconds (UAS)	RS-UAS	MS-UAS	MS-UAS
Number of Errored Blocks (EB)	RS-EB	MS-EB	MS-EB

For 10 Gigabit Ethernet signals, standard performance parameters for transmit and receive signals are based on RMON Ethernet compliant with RFC-1573, RFC-1757, RFC-2233, RFC-2358, RFC-3273, and RFC3635.

For 10G Fibre Channel the following parameters are available:

txTotalPkts, rxTotalPkts, mediaIndStatsTxFramesBadCRC,
 mediaIndStatsRxFramesTruncated, ifOutOversizePkts, mediaIndStatsRxFramesTooLong,
 mediaIndStatsRxFrameBadCRC, ifOutOctects, ifInOctects, ifInErrors

Each digital wrapper channel will be monitored per ITU-T digital wrapper requirements (G.709).

Table 2. OTN Performance Monitoring

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 Seconds
ESR-SM	ESR-PM	Errored Seconds Ratio
SES-SM	SES-PM	Number of Errored Seconds Ratio
SESR-SM	SESR-PM	Severely Errored Seconds Ratio
UAS-SM	EAS-PM	Number of Unavailable Seconds
FC-SM	FC-PM	Number of Failure Counts

Also FEC/EFEC performance monitoring parameters are available:

Table 3. FEC Performance Monitoring

Counters	Description
Bit Errors	Number of corrected bit errors
Uncorrectable Words	Number of uncorrectable words

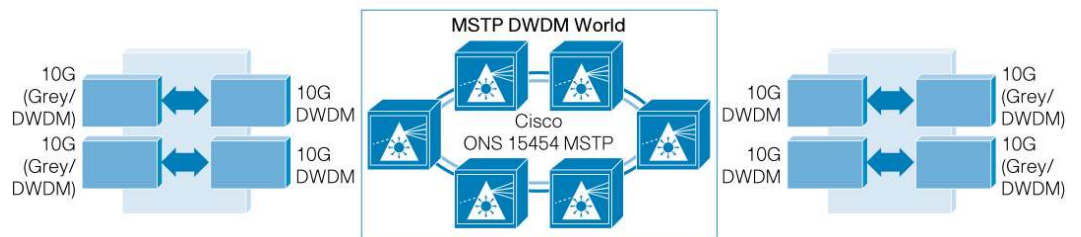
Optical parameters on the DWDM line interface are supported, including laser bias, transmit optical power, and receiver optical power.

The OTU2 Xponder 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 slots where the card can be installed.

Application Description

The Cisco ONS 15454 OTU2 XPonder card provides the capability to support 2 x 10G transponder on a single-slot card, doubling the 10G wavelength density over the Cisco ONS 15454 shelf. Using DWDM XFP capability delays the cost for additional wavelength.

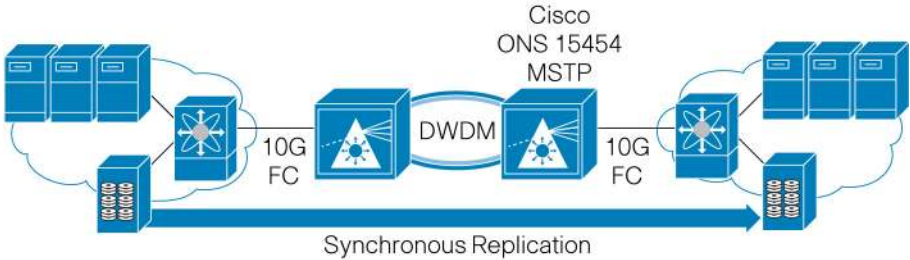
Figure 8. 2 x Transponder Application



The OTU2 XPonder card provides a full set of 10G Fibre Channel Performance Monitoring parameters. Even if it is not equipped with distance extension mechanism, the XPonder easily supports 10G Fibre Channel generated by Cisco MDS 9000 Series interfaces.

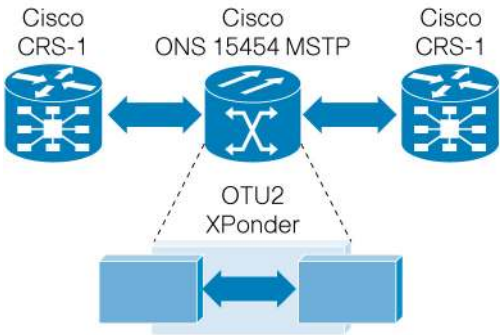
In single shelf up to 18 x 10G Fibre Channel signals terminal system can be accommodated.

Figure 9. Data Center 10G Fibre Channel Application



The OTU2 XPonder card provides the capability to support 3R function in a single card. Because two ports can support EFEC and two ports can support GFEC only, two possible configurations are allowed depending on network topology: single regeneration EFEC/EFEC or double regeneration FEC/EFEC. Regeneration is fully compliant with the G.709 standard, allowing you to transparently transport ODU2 frame and terminate OTU frame. It also can be used as a double regeneration for DWDM XENPAK/X2/XFP optical pluggable interfaces placed on other Cisco routers or switches in IPoWDM scenarios.

Figure 10. Regeneration Application



The Cisco Advantage

The Cisco ONS 15454 optical transport solution offers significant advantages over traditional network elements offering 10-Gbps interfaces, including the following:

Outstanding Service Densities

The Cisco ONS 15454 platform supports up to 240 Gigabit Ethernet interfaces per shelf. When this platform is installed in a typical central office bay frame, a bay can support up to 960 Gigabit Ethernet interfaces.

Common Line Cards and Chassis

Optical line cards are not restoration-type-dependent, which reduces sparing costs and technician confusion. Additionally, as networks and customer interface demands evolve, the user can easily redeploy optical circuit packs as necessary.

Single Software Load

One software load supports all restoration types, eliminating unnecessary guesswork when ordering. All protection configurations are covered by a single right-to-use software license. After the software has been purchased, all features and functions are available to the user.

Common Chassis

A common chassis supporting all optical interface speeds allows the technician to spend time deploying bandwidth and services instead of learning about multiple equipment platforms. Many equipment vendors offer optical-line-speed-specific platforms (for example, OC-3/STM-1 or OC-12/STM-4) and categorize platforms by restoration mechanisms (for example, UPSR/SNCP, 2F-BLSR/MS-SPR, and 4F-BLSR/MS-SPR). This approach not only causes ordering confusion, but brings into question whether the inventoried equipment will accommodate the functions required to support the desired application. The Cisco ONS 15454 platform's line-rate and restoration flexibility makes ordering and deployment quick and easy.

Multiservice Interface Selection

DS1/E1 through OC-192/STM-64, Ethernet, Fast Ethernet, Gigabit Ethernet, and 10 Gigabit Ethernet interfaces are all supported, thus eliminating the "missing interface" problem that occurs with many vendors' bit-rate-specific product offerings.

The Cisco ONS 15454 MSTP, the industry's leading metro optical transport platform, delivers supercharged SONET/SDH transport, integrated optical networking, superior multiservice interfaces, and competitive economic benefits.

Cisco ONS 15454 OTU2 XPonder Card Features and Specifications

Compact Design

- Single-width card slot design for high-density, 10 Gigabit multirate solutions
- Up to 12 Cisco ONS 15454 OTU2 XPonder cards per shelf assembly (240 Gbps), and up to 36 cards per bay (720 Gbps)

Flexible Restoration Options

- Fiber switched
- Client Y-protection
- Unprotected (0 + 1)

Regulatory Compliance¹

Table 4 lists regulatory compliance information.

Table 4. Regulatory Compliance Information

SONET/ANSI System	SDH/ETSI System
Countries Supported	
<ul style="list-style-type: none"> • Canada • United States • Mexico • Korea • Japan • European Union 	<ul style="list-style-type: none"> • European Union • Australia • New Zealand • Singapore • China • Mexico • Hong Kong • Korea
EMC (Class A)	
<ul style="list-style-type: none"> • ICES-003 Issue 4 (2004) • GR-1089-CORE, Issue 4 (Type 2 and Type 4 equipment) • GR-1089-CORE – Issue 03 (Oct 2002) (Objective O3-2 – Section 3.2.1 – Radiated Emissions requirements with all doors open) • FCC 47CFR15, Class A subpart B (2006) 	<ul style="list-style-type: none"> • EN 300 386 v1.3.3 (2005) and v1.4.1 (2007) • CISPR 22 – Fifth edition (2005-04) Class A and the amendment 1 (2005-07) • CISPR 24 – First edition (1997-09) and amendment 1 (2001-07) and amendment 2 (2002-10) • EN 55022:1998 Class A – CENELEC Amendment A2:2003 • EN 55024:1998 – CENELEC Amendment A1:2001 and Amendment A2:2003
Safety	
<ul style="list-style-type: none"> • CAN/CSA-C22.2 No.950-95, 3rd Edition • GR-1089-CORE, Issue 4 (Type 2 and Type 4 equipment) 	<ul style="list-style-type: none"> • UL/CSA 60950 –1 First Edition (2003) • IEC 60950-1 (2001/10)/Amendment 11:2004 to EN 60950-1:2001, 1st Edition (with all country deviations)
Optical Safety	
<ul style="list-style-type: none"> • EN or IEC-60825-2 Third edition (2004-06) • EN or IEC 60825-1 Consol. Ed. 1.2 - incl. am1+am2 (2001-08) • 21CFR1040 (2004/04) (Accession Letter and CDRH Report) • IEC-60825-2 Third edition (2004-06) • ITU-T G.664 (2006) 	
Environmental	
<ul style="list-style-type: none"> • GR-63-CORE, Issue 3 (2006) 	<ul style="list-style-type: none"> • ETS 300-019-2-1 V2.1.2 (Storage, Class 1.1) • ETS 300-019-2-2 V2.1.2 (Transportation, Class 2.3) • ETS 300-019-2-3 V2.1.2 (Operational, Class 3.1E) • EU WEEE regulation • EU RoHS regulation
Optical	
<ul style="list-style-type: none"> • GR-253-CORE - Issue 04 • ITU-T G.691 	<ul style="list-style-type: none"> • ITU-T G.709 • ITU-T G.975
Quality	
<ul style="list-style-type: none"> • TR-NWT-000332, Issue 4, Method 1 calculation for 20-year mean time between failure (MTBF) 	
Miscellaneous	
<ul style="list-style-type: none"> • AT&T Network Equipment Development Standards (NEDS) Generic Requirements, AT&T 802-900-260, Issue 3, December 1999 • SBC TP76200MP, May 2003 	<ul style="list-style-type: none"> • Verizon SIT.NEBS.NPI.2002.010, October 2002 • Worldcom ESD requirement

Table 5. System Requirements

Component	Cisco ONS 15454 ANSI	Cisco ONS 15454 ETSI
Processor	TCC2P and TCC2	TCC2P and TCC2
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 SDH CC-FTA version fan-tray assembly
System software	Release 9.0 or greater	Release 9.0 or greater
Slot compatibility	1 to 6 and 12 to 17	1 to 6 and 12 to 17

Table 6. Client-Side Specifications

Client Interface	SR XFP	LR XFP	IR XFP	MM XFP
Specification <ul style="list-style-type: none"> Telcordia GR-253-Core ITU G.691 IEEE 802.3 10GFC Rev 3.5 T11 ITU G.959 	GR-253-Core SR-1 I-64.1 10GBASE-LR/LW 1200-SM-LL-L	10GBASE-ZR P1L1-2D2	GR-253-Core IR-2 S-64.2 10GBASE-ER/EW P1S1-2D2	10GBASE-SR/SW 1200-MX-SN-I
Automatic laser shutdown and restart	ITU-T G.664	ITU-T G.664	ITU-T G.664	ITU-T G.664
System reach (SR _{01b})	4 dB	22 dB	11 dB	7.3 dB
Unamplified targeted fiber distance, SMF28 ¹ (FD ^{smf28}) <ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	2 km 10 km	80 km 80 km	40 km 40 km	26–300m
Nominal wavelength (λ_{Tnom})	1310 nm	1550 nm	1550 nm	850 nm
Spectral range (λ_{Tmin} to λ_{Tmax}) <ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	1290 to 1330 nm 1260 to 1355 nm	1530 to 1565 nm	1530 to 1565 nm	840 to 860 nm
Optical transmitter				
Type	Distributed feedback, direct modulation (DFB/DM) ²	Electro absorption (EML)	Electro absorption (EML)	VCSEL
Output power (P _{Tmin} to P _{Tmax})	-8.2 to 0.5 dBm	0 to 4 dBm	-1 to 2 dBm	-7.3 to -1dBm
Minimum required optical return loss <ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	24 dB 12 dB	24 dB 12 dB	24 dB 12 dB	12 dB
Minimum extinction ratio (r _{eminx})	6 dB	9 dB	8.2 dB	3 dB
Laser safety class	1	1	1	1
Optical receiver				
Type	PIN	PIN	PIN	PIN
Sensitivity @ BER (P _{Rmin} to P _{Rmax}) <ul style="list-style-type: none"> SONET/SDH 10 GE/10G FC 	-11 to -1 dBm -14.4 to 0.5 dBm	-24 to -7 dBm -24 to -7 dBm	-14 to 2 dBm -15.8 to -1dBm	-9.9 to -1dBm
Chromatic dispersion tolerance (D _{SRmax})	6.6 ps/nm (SONET/SDH)	1600 ps/nm (SONET/SDH)	800 ps/nm (SONET/SDH)	–
Minimum BER (BER _{min})	10E-12	10E-12	10E-12	10E-12
Maximum receiver reflectance	-14 dB	-14 dB	-14 dB	-2 dB
Input wavelength bandwidth (λ_{c_rx})	1290 to 1335 nm ³	1260 to 1565 nm	1530 to 1565 nm ⁴	840 to 860 nm
Connector type (Tx/Rx)	LC-LC, duplex			

1. Fiber distance of $\langle D_{SMF28} \rangle$ km in SMF28 of equivalent $\langle SR_{olb} \rangle$ dB optical link budget. Assumes $D_{1550} = 17$ ps/nm/km, $D_{1310} = 3.3$ ps/nm/km; fiber+splice+connector loss at 1550 nm = 0.275 dB/km and 1310 nm = 0.55 dB/km; including $\langle P^0 \rangle$ dB dispersion penalty at $\langle D_{LRlong-reachmax} \rangle$ ps.
2. DFB/DM is typical but other technologies may be substituted if specifications are met.
3. Acceptable input wavelength range is 1290 to 1605 nm, but receiver sensitivity is guaranteed only for the indicated range.
4. Acceptable input wavelength range is 1260 to 1565 nm, but receiver sensitivity is guaranteed only for the indicated range.

Table 7. DWDM XFP Optical Specifications

Specification	DWDM XFP (ONS-XC-10G-xx.x=)
Automatic Laser Shutdown and Restart	Compliant with ITU-T G.664 (06/99)
Transmitter Wavelength Range	Single wavelength on 100GHz grid (see Table 7)
Transmitter Output Power	-1 dBm (minimum)/3 dBm (maximum)
Receiver Wavelength Range	1260 nm to 1607 nm
Input Power Sensitivity (Power Limited)	-7 dBm to -24 dBm (BER $\leq 7 \times 10^{-4}$) (E-FEC), OSNR ≥ 23 dB (0.5 nm RBW), CD Tolerance -500 ps/nm to 1300 ps/nm)
Input Power Sensitivity (OSNR Limited)	-7 dBm to -18 dBm (BER $\leq 7 \times 10^{-4}$) (E-FEC), OSNR ≥ 9 dB (0.5 nm RBW), CD Tolerance -500 ps/nm to 1100 ps/nm)

Table 8. Supported Wavelengths on DWDM XFP – C Band

xx.x	Nanometers	ONS-XC-10G-xx.x=
30.3	1530.33	X
31.1	1531.12	X
31.9	1531.90	X
32.6	1532.68	X
33.4	1533.46	X
34.2	1534.25	X
35.0	1535.04	X
35.8	1535.82	X
36.6	1536.61	X
37.4	1537.40	X
38.1	1538.19	X
38.9	1538.98	X
39.7	1539.77	X
40.5	1540.56	X
41.3	1541.34	X
42.1	1542.14	X
42.9	1542.94	X
43.7	1543.73	X
44.5	1544.53	X
45.3	1545.32	X
46.1	1546.12	X
46.9	1546.92	X
47.7	1547.72	X
48.5	1548.51	X
49.3	1549.31	X
50.1	1550.12	X
50.9	1550.92	X
51.7	1551.72	X

xx.x	Nanometers	ONS-XC-10G-xx.x=
52.5	1552.52	X
53.3	1553.32	X
54.1	1554.13	X
54.9	1554.94	X
55.7	1555.75	X
56.5	1556.55	X
57.3	1557.36	X
58.1	1558.17	X
58.9	1558.98	X
59.7	1559.79	X
60.6	1560.61	X
61.4	1561.41	X

Table 9. Card Specifications

Specification	
Management	
Card LEDs <ul style="list-style-type: none"> • Failure (FAIL) • Active/standby (ACT/STBY) • Signal fail (SF) 	Red Green/yellow Yellow
Client port LEDs <ul style="list-style-type: none"> • Active input signal 	Green
DWDM port LEDs <ul style="list-style-type: none"> • Active input signal • Output wavelength 	Green Green
Power	
Card power draw <ul style="list-style-type: none"> • Typical • Maximum 	51W (with no pluggables) 70W (fully loaded)
Physical	
Dimensions	Occupies one slot
Weight	1.1 Kg (2.43 lbs)
Reliability and Availability	
Mean Time Between Failures (MTBF)	348,046 hours
Latency TXP mode (End to End)	
G.709 Off / NO FEC:	10.4 microsecond
G.709 On - Standard FEC	14.2 microseconds
G.709 On - Enhanced FEC	147.6 microseconds
Latency Regenerator mode (Unit level)	
G.709 On - Standard FEC	14.2 microseconds
G.709 On - Enhanced FEC	147.6 microseconds
Operating Environment	
Temperature	−5 to 55°C 23 to 131°F
Humidity	5 to 95 percent non condensing
Storage Environment	
Temperature	−5 to 55°C 23 to 131°F
Humidity	5 to 95 percent noncondensing

Table 10. Ordering Information

Part Number	Description
15454-OTU2-XP=	Ethernet 4–10 Gigabit Ethernet Xponder
ONS-XC-10G-xx.x=	OC-192/STM64/10 Gigabit Ethernet, XFP, 15xx.xx (see Table 7), 100 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 – OC192/STM64/10GE – 1550 IR/SH2 – SM LC
ONS-XC-10G-L2=	XFP – OC192/STM64 - 1550 LR2 - SM LC
ONS-XC-10G-SR-MM=	XFP – 10GE/10G FC – 850 SR – MM LC



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