

Gigabit Carrier Ethernet DWDM XPonder Card for the Cisco ONS 15454 Multiservice Transport Platform

The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) features a radical new approach to Ethernet over dense wavelength-division multiplexing (DWDM) transport and aggregation. The Cisco ONS 15454 Gigabit Ethernet XPonder card includes DWDM transmission functions and Layer 2 switching functions (Figure 1).

Figure 1. Cisco ONS 15454 Gigabit Ethernet XPonder Card



Background

Metro transport networks must support numerous service demands, from low-rate DS1/T1, DS3/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. As the importance of broadband data services continues to increase and Ethernet becomes an essential protocol, service providers need more integration between Ethernet switching and transport to optimize capital investment and reduce operating costs.

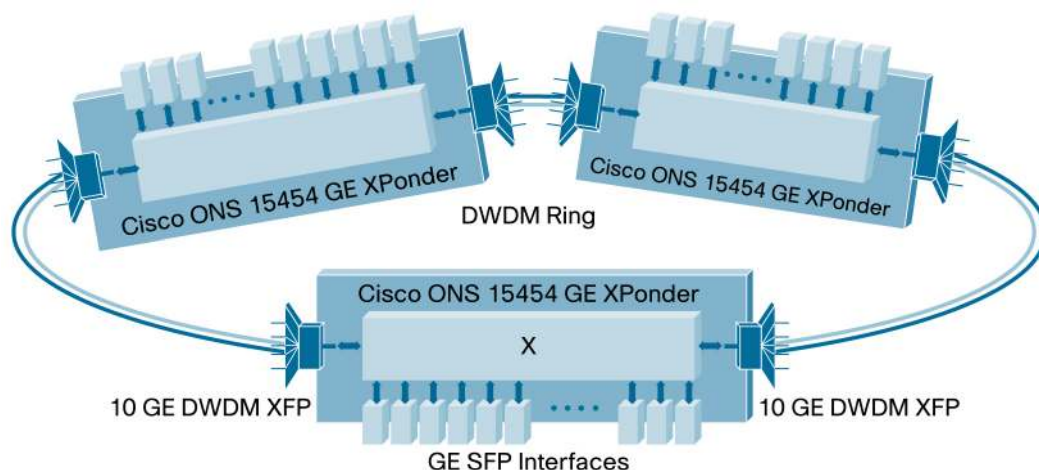
Industry trends indicate that DWDM is the technology being used to transport the huge amount of bandwidth that broadband services are consuming. Thus, DWDM needs to evolve from simply offering management capabilities for Layer 1 (where optical wavelengths are dispatched across the network) to offering Layer 1 and Layer 2 capabilities that provide wavelength connection in addition to VLAN management; quality of service (QoS); and multicast, broadcast, and unicast services – all with reliability comparable to or better than that of older time-division multiplexing (TDM) technology.

Product Overview

The Cisco ONS 15454 Gigabit Ethernet XPonder card portfolio includes two options: an XPonder card and an enhanced XPonder card. The portfolio provides a complete solution with the basic XPonder card optimized for Ethernet access applications, while the enhanced XPonder card provides additional capabilities for Ethernet aggregation rings.

An XPonder card is a dual-slot Cisco ONS 15454 MSTP board providing 20 Small Form-Factor Pluggable (SFP)-based Gigabit Ethernet client ports and two 10 Gigabit SFP (XFP)-based trunk ports supporting G.709 digital wrappers and Enhanced Forward Error Correction (E-FEC) capability. Trunk ports can be equipped with DWDM XFP developed to meet wavelength-division multiplexing (WDM) filter specifications and providing the XPonder card with the DWDM interface. The 20 client ports can be equipped with different Gigabit Ethernet SFPs: SX, LX, ZX, CWDM, DWDM, or electrical (RJ-45). Figure 2 shows a Layer 2 logical scheme, and Figure 3 shows a Layer 1 physical scheme.

Figure 2. Cisco ONS 15454 Gigabit Ethernet XPonder Card Layer 2 Logical Scheme



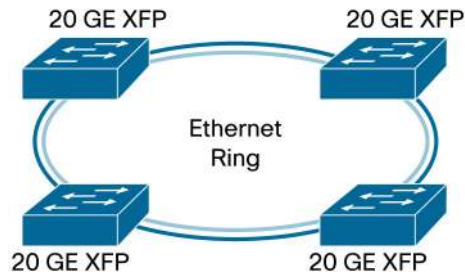
Operating Modes

Boards can be configured to operate in three operating modes:

Layer 2 Switch

In this operating mode, the Cisco ONS 15454 Gigabit Ethernet XPonder card behaves like a Layer 2 switch. The tagged VLAN mechanism makes it possible to build an Ethernet ring over a DWDM wavelength. All Layer 2 packet forwarding as well as multicast replication is performed at wire speed. The two trunk ports equipped with DWDM XFPs are used as Layer 1 substratum Network-to-Network Interface (NNI) ports for an Ethernet distribution ring built by various clients shared on the XPonder cards belonging to that wavelength.

Figure 3. Cisco ONS 15454 Gigabit Ethernet XPonder Layer 1 Physical Scheme



*Marked features require system software release 9.0 or later.

Layer 2 switch support:

- XPonder with MAC address table with up to 16,000 entries
- Enhanced XPonder with MAC address table with up to 32,000 entries*
- 802.1D virtual bridged LANs and VLAN tagging support according to IEEE 802.1Q (up to 4096 VLAN IDs on all ports)
- 801.1AD S-TAG (or outer tag, or Q-in-Q) support
- All Layer 2 packet forwarding and multicast replication performed at wire speed
- Per-VLAN MAC address enable-disable*

QoS ingress policing:

- Ingress port-based rate limiting*
- Per-SVLAN-based ingress rate limiting*
- Flow control available (frame pause)
- Policing-based bandwidth metering per port:
 - Single rate: Three-color marker (RFC 2697)
 - Bandwidth profile based on committed information rate (CIR), committed burst size (CBS), and excess burst size (EBS) parameters
 - Color-blind implementation

Additional QoS functions on the enhanced XPonder include:

- Add double tag and Add+Translation
- Add SVLAN +Translate CVLAN*
- Per-CVLAN to SVLAN ingress CoS

QoS egress policing:

- Class-of-service (CoS)-based
- One Strict Priority and seven Weighted Round Robin (WRR) queues (weight can go from 0 to 15), with tail drop to control congestion; when zero is configured, the queue is managed as a Strict Priority queue
- Bandwidth limitation per queue (bandwidth can also be configured per port)
- For each port, configuration of up to eight queues

Multicast and Video Broadcast

The Cisco ONS 15454 XPonder supports both push and pull models for video broadcast or multicast applications. The SVLAN-based drop-and-continue approach is used for the push model, where all multicast/video broadcast traffic is dropped at each site. With IGMPv2* capability, the XPonder provides a pull model where a multicast stream or a video channel is pulled on to the network via a join from the end customer. Multicast VLAN registration (MVR)* further enhances network flexibility for video applications where a multicast VLAN is reserved for the network independent of the VLAN on which the service is delivered on each port. The translation from multicast VLAN to customer VLAN happens at the client port.

HyperDense Gigabit Ethernet Muxponder

In this operating mode, the Cisco ONS 15454 Gigabit Ethernet XPonder card does not provide any Layer 2 functions. This mode provides a cost-optimized Ethernet transport solution. Equipping the 10 Gigabit Ethernet port with DWDM XFP allows it to support a point-to-point DWDM configuration than can support oversubscription at the 10 Gigabit Ethernet layer. All the ports are configured with a default CIR of 500 Mb, but this value can be reconfigured (at individual port granularity) by the user. Flow control is also available as a selectable option.

Full-Rate 10 Gigabit Ethernet Muxponder

In this operating mode, 10X Gigabit Ethernet ports are mapped to one 10 Gigabit Ethernet port while the other 10X Gigabit Ethernet ports are mapped into the other 10 Gigabit Ethernet Port. All 20X Gigabit Ethernet clients are transparently transmitted at full line speed (the two ports have a throughput of 99.9%). Each of the 10 Gigabit Ethernet Ports can be equipped with DWDM XFP to allow the direct interconnection of the unit with the DWDM layer.

Enhanced FEC Capability

An important feature of the Cisco ONS 15454 Gigabit Ethernet XPonder card is the capability to configure Forward Error correction in three modes: NO FEC, FEC, and E-FEC. The output bit rate varies:

- 10.3125 Gbps for 10 Gigabit Ethernet LAN physical interface (PHY)
- 11.095 Gbps for 10 Gigabit Ethernet LAN PHY (overclocking 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

Flexible Protection Mechanisms

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

- For multiple transponder configurations, the XPonder card supports the following:
 - 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.
- The XPonder also offers redundancy with no single point of failure in a ring configuration:
 - For ring protection, the XPonder provides revolutionary new GR³ Ethernet protection through the G.709 Rapid Resilient Ring Ethernet Protection mechanism, integrating G.709 messaging with an Ethernet VLAN mechanism when configured as Layer 2 switches, to provide reliability comparable to older TDM systems. A recovery time of 50ms (including detection time) can be achieved. The protection mechanism uses a mix of Layer 1 and Layer 2 functions, with fault detection and failure propagation performed through the G.709 bytes (failure propagation is performed at the hardware level) while traffic is flooded, for each protected VLAN on all 10 Gigabit Ethernet WDM rings. One node is identified (through user configuration) as the master node (or port). This node is responsible for opening and closing the Layer 2 VLAN loop in case of failure.
 - XPonder provides client and card redundancy with SONET/SDH-like 1+1 card protection in either same or a different shelf (within the same multishelf management domain)* with following protection models:
 - Active port is enabled while standby port stays disabled
 - Both active and standby ports are enabled; only active port forwards while the standby port drops all ingress-egress traffic
 - GR3 protection mechanism is required
 - The Layer 2 XPonder also supports “Y-cable bidirectional-like” switching where two cards in 1+1 protection are connected through a Y-cable to a single client*.

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 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.

End-to-End Circuit EVC Provisioning*

The XPonder card provides service and network provisioning with Cisco Transport Controller. The XPonder ring and SVLAN-based Ethernet virtual circuits (EVCs) can be provisioned using Cisco Transport Controller. Both point-to-point and multipoint EVC provisioning is supported.

QoS Provisioning*

The Cisco ONS 15454 Ethernet XPonder card provides QoS provisioning with Cisco Transport Controller. Standard system-level QoS profiles can be defined and independently applied on a per-EVC basis.

The XPonder provides remarkable management capabilities for service and QoS provisioning for Carrier Ethernet services.

VLAN Database

The XPonder card provides the capability to provision a VLAN database. The Cisco Transport Controller can retrieve all the VLANs available in the network. VLAN retrieval allows the user to view the WDM ring based on the XPonder card and the EVC or VLAN circuit. This retrieval can be performed on a per-VLAN basis and requires the creation of optical channel (OCH) trails between the XPonder cards. VLAN retrieval results are categorized as follows:

- Green: Selected VLAN is configured on both ends of the link
- Orange: Selected VLAN is configured only on one end of the link
- Gray: Selected VLAN is not configured on either end of the link

VLAN Profiling*

All SVLAN associated parameters can be provisioned using predefined profiles.

Performance Monitoring

The performance monitoring capabilities of the Cisco ONS 15454 Gigabit Ethernet XPonder card support Ethernet signal transport. Standard performance parameters for transmit and receive signals are based on RFC 3635, RFC 2358, RFC 2233, and RFC 1757. Each digital wrapper channel will be monitored according to ITU-T digital wrapper requirements (G.709). Optical parameters on the SFP and XFP interfaces are supported, including laser bias, transmitter optical power, and receiver optical power. Performance monitoring data is calculated and accumulated in 15-minute and 24-hour intervals.

The Cisco ONS 15454 Gigabit Ethernet XPonder cards incorporate faceplate-mounted LEDs to allow a quick visual check of the operating status of the card. An orange circle printed on the faceplate indicates the shelf slots in which the card can be installed.

Link Integrity*

The XPonder supports link integrity using Y.1731 Ethernet OAM-AIS message per SVLAN. Squelching can be enabled or disabled on a per-port basis.

Cisco IOS Software-Like CLI*

The XPonder supports a Cisco IOS Software-like CLI for management purposes. This allows customers with Cisco IOS Software-based networks to manage the XPonder in a familiar fashion.

Application Description

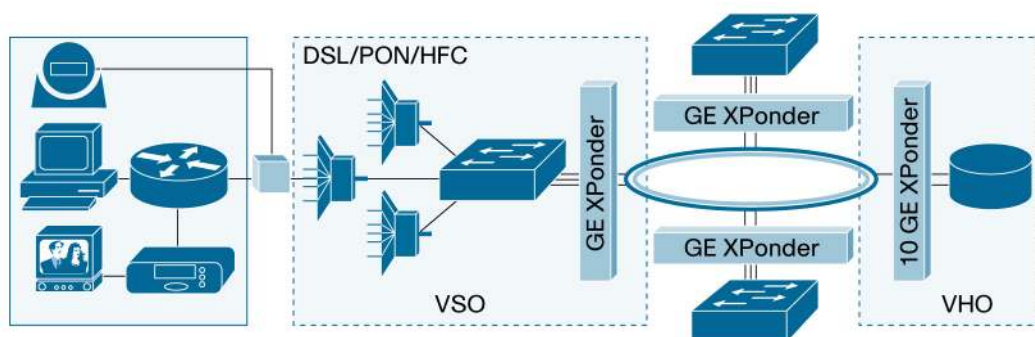
The XPonder card adds several new applications to the already flexible Cisco ONS 15454 MSTP. Cards have been developed to meet the needs of many different network applications, from DWDM point-to-point to Ethernet Virtual Private Network (EVPN) services in Metro Ethernet environments. XPonder cards, when configured as DWDM Ethernet muxponders, meet perfectly the incremental demand for Ethernet bandwidth at ever-lower prices. The availability of pluggable

optics for DWDM also dramatically increases the density of 10 Gigabit Ethernet, reducing the per-port cost.

The Layer 2 switching configuration addresses applications requiring huge bandwidth and high flexibility:

- Video distribution: Video-hub topology fits perfectly in the XPonder architecture (Figure 4). Two approaches are supported:
- Gigabit Ethernet XPonder-only DWDM ring, where the only Ethernet switching units connecting the DWDM ring are the XPonders: Many Gigabit Ethernet XPonders connect to the video switching office (VSO) location, and 10 Gigabit Ethernet XPonders connect to the video hub office (VHO) location. This topology provides a huge advantage in that it supports GR³ Ethernet protection.

Figure 4. Gigabit Ethernet XPonder-Only DWDM Ring

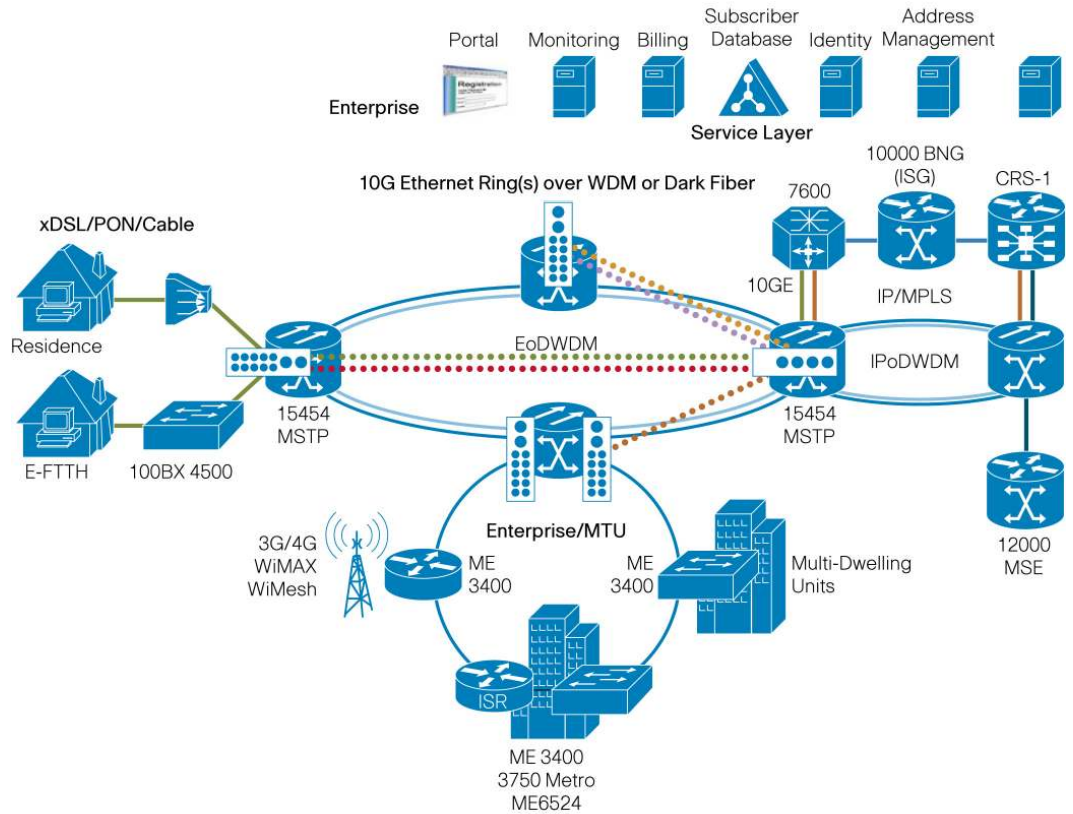


- Access-independent Carrier Ethernet aggregation architecture with IP over DWDM (IPoDWDM) or dark fiber: This solution enables network convergence with Ethernet transport for both business and residential services. Point-to-point and multipoint Metro Ethernet Forum (MEF) standards-based services are supported. In addition, this solution provides SONET-like resiliency for Ethernet transport.

With Ethernet-enabled DWDM, the solution is scalable and provides a “pay as you grow” model. Customers can start with a 10G ring over dark fiber or add a wavelength to an existing DWDM ring. As traffic demand grows, customers can add new 10G wavelengths and scale up to 800G on a pair of fiber strands.

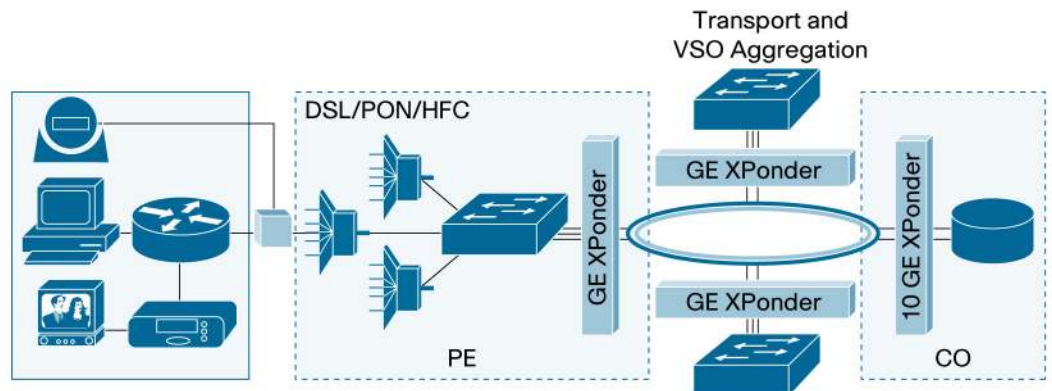
The ring topology allows the XPonder to add and drop Ethernet traffic at a sub-lambda level. Ethernet-enabled DWDM with its ring topology enables an intelligent DWDM network, eliminating the need for unintelligent transponding on a transport network.

Figure 5. IP over DWDM (IPoDWDM) Architecture



- Cost-optimized Ethernet distribution ring for managed services: This architecture provides the flexibility to aggregate Ethernet on a virtual Ethernet ring in place of many point-to-point transponder-based connections, dramatically reducing network CapEx investment (Figure 5).

Figure 6. Cost-Optimized Ethernet Distribution Ring for Managed Services



- Metro Ethernet application: The MEF9 and MEF14 certification environment, with Ethernet virtual private line (EVPL) and ELAN, provides full support for Ethernet carrier applications and support for business services as well as for real video, voice, and data services.

The Cisco Advantage

The Cisco ONS 15454 Gigabit Ethernet XPonder card complements and extends the service capabilities of the Cisco ONS 15454 MSTP. The XPonder card allows carriers to take advantage of their existing fiber plant and installed base of Cisco ONS 15454 systems, while providing a completely new way to transport and manage Ethernet over the same Cisco ONS 15454 platform.

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 120 Gigabit Ethernet interfaces per shelf. When this platform is installed in a typical central office bay frame, a bay can support up to 480 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 Gigabit Ethernet XPonder Card Features and Specifications

Compact Design

- Single-width card slot design for high-density, 10 Gigabit Ethernet solutions
- Up to 6 Cisco ONS 15454 Gigabit Ethernet XPonder cards per shelf assembly (120 Gbps), and up to 18 cards per bay (480 Gbps)

Flexible Restoration Options

- Layer 2 GR³ Ethernet protection: G.709 Rapid Resilient Ring Ethernet Protection mechanism
- Client Y-protection
- Unprotected (0 + 1)
- Protected (1+1)*

Regulatory Compliance

Table 1 lists regulatory compliance information. 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 1. 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 later	Release 9.0 or later
Slot compatibility	1 to 6 and 12 to 17	1 to 6 and 12 to 17

Tables 2 and 3 list client-side specifications. Tables 4 through 7 list additional optical specifications and Table 8 lists card specifications. Table 9 provides ordering information.

Table 2. Supported xWDM SFP Specifications

Product ID	Supported Bit Rates	Operating Mode	Port Number
ONS-SC-2G-xx.X=	OC-48 DWDM / STM-16 DWDM GE DWDM	DWDM	From 13 to 16 From 1 to 8
ONS-SC-Z3-xxxx=	OC-48 CWDM / STM-16 CWDM GE CWDM	CWDM	From 13 to 16 From 1 to 8

Table 3. Supported SFP Specifications

Specification: Client Interface	ONS-SE-ZE-EL= 10/100/1000BASE-T RJ-45 Full Duplex	ONS-SE-G2F-SX= 1000BASE-SX 850 nm LC Multimode	ONS-SE-G2F-LX= 1000BASE-LX 1310 nm LC SM	ONS-SI-GE-ZX= 1000BASE-LX 1550 nm LC SM
Type	SFP	SFP	SFP	SFP
Wavelength, nominal (λ_{nom})	–	850 nanometers (nm)	1310 nm	1550 nm
Spectral range (λ_{Tmin} to λ_{Tmax})	–	770 nm to 860 nm	1270 nm to 1355 nm	1500 nm to 1580 nm
Optical Transmitter				
Output power (P_{Tmin} to P_{Tmax})	–	–9.5 to 0 decibels per milliwatt (dBm)	–9.5 to –3 dBm	0 to +5 dBm
Optical Receiver				

Specification: Client Interface	ONS-SE-ZE-EL=10/100/1000BASE-T RJ-45 Full Duplex	ONS-SE-G2F-SX=1000BASE-SX 850 nm LC Multimode	ONS-SE-G2F-LX=1000BASE-LX 1310 nm LC SM	ONS-SI-GE-ZX=1000BASE-LX 1550 nm LC SM
Sensitivity at bit error rate (BER)	–	–15 dBm	–23.5 dBm	–23 dBm
Connector type (Tx or Rx)	RJ-45	Line card	Line card	Line card

Table 4. Trunk Grey XFP Specifications

Client Interface	SR XFP	IR XFP	MM XFP
Specification <ul style="list-style-type: none"> IEEE 802.3 	10GBASE-LR/LW	10GBASE-ER/EW	10GBASE-SR/SW
Automatic laser shutdown and restart	ITU-T G.664 (06/99)	ITU-T G.664 (06/99)	ITU-T G.664 (06/99)
System reach (SR _{01b})	4 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	40 km	26–300m
Nominal wavelength (λ_{Tnom})	1310 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	840 to 860 nm
Optical transmitter			
Type	Distributed feedback, direct modulation (DFB/DM) ²	Electro absorption (EML)	VCSEL
Output power (P _{Tmin} to P _{Tmax})	–6 to –1 dBm	–1 to +2 dBm	–7dBm to –1 dBm
Minimum required optical return loss <ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	24 dB 12 dB	24 dB 12 dB	12 dB
Minimum extinction ratio (r _{eminx})	6 dB	8.2 dB	3 dB
Laser safety class	1	1	1
Optical receiver			
Type	PIN	PIN	PIN
10 GE/10G FC	–14.4 to +0.5 dBm	–14 to 2 dBm	–9.9 dBm to –1 dBm
Minimum BER (BER _{min})	10E-12	10E-12	10E-12
Maximum receiver reflectance	–14 dB	–14 dB	–12 dB
Input wavelength bandwidth ($\lambda_{c,rx}$)	1290 to 1335 nm ³	1530 to 1565 nm ⁴	840 to 860 nm
Connector type (Tx/Rx)	LC, duplex, shuttered		

1. Fiber distance of $\langle FD_{smf28} \rangle$km in SMF28 of equivalent $\langle SR_{01b} \rangle$dB optical link budget. Assumes $D_{1550} = 17\text{ps/nm/km}$, $D_{1310} = 3.3\text{ps/nm/km}$; 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 $\langle D_{LRIlong-reachmax} \rangle$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 5. DWDM Optical Specifications

Specification	DWDM XFP (ONS-XC-10G-xx.x=)	DWDM SFP (ONS-SC-2G-xx.x=)	CWDM SFP (ONS-SC-Z3-xxxx=)
Automatic Laser Shutdown and Restart	Compliant with ITU-T G.664 (06/99)	Compliant with ITU-T G.664 (06/99)	Compliant with ITU-T G.664 (06/99)
Transmitter Wavelength Range	Single wavelength on 100GHz grid (see Table 6)	Single wavelength on 100GHz grid (see Table 6)	Single wavelength on 100GHz grid (see Table 6)

Specification	DWDM XFP (ONS-XC-10G-xx.x=)	DWDM SFP (ONS-SC-2G-xx.x=)	CWDM SFP (ONS-SC-Z3-xxxx=)
Transmitter Output Power	-1 dBm (Min) / 3 dBm (Max)	0 dBm (Min) / 4 dBm (Max)	0 dBm (Min) / 4 dBm (Max)
Receiver Wavelength Range	1260 nm to 1607 nm	1260 nm to 1607 nm	1460 nm to 1620 nm
Input Power Sensitivity (Power Limited)	-7 dBm to -24 dBm (BER $\leq 7 \times 10^{-4}$) (E-FEC), OSNR ≥ 23 dB (0.5nm RBW), CD Tolerance – 500ps/nm to 1300ps/nm)	-9 dBm to -25 dBm (BER $\leq 10^{-12}$) (No FEC), OSNR ≥ 14 dB (0.5nm RBW), CD Tolerance – 800ps/nm to 2400ps/nm)	-9 dBm to -28 dBm (BER $\leq 10^{-10}$) (No FEC))
Input Power Sensitivity (OSNR Limited)	-7 dBm to -18 dBm (BER $\leq 7 \times 10^{-4}$) (E-FEC), OSNR ≥ 9 dB (0.5nm RBW), CD Tolerance –500ps/nm to 1100ps/nm)	-9 dBm to -19 dBm (BER $\leq 10^{-12}$) (No FEC), OSNR ≥ 9 dB (0.5nm RBW), CD Tolerance –800ps/nm to 2400ps/nm)	–

Note: Support for DWDM and CWDM SFPs requires system software release 8.5 or later.

Table 6. Supported Wavelengths on DWDM Pluggable Units – C Band

xx.x	λ (nm)	ONS-XC-10G-xx.x=	ONS-SC-2G-xx.x=
28.7	1528.77		X
30.3	1530.33	X	X
31.1	1531.12	X	X
31.9	1531.90	X	X
32.6	1532.68	X	X
33.4	1533.46	X	X
34.2	1534.25	X	X
35.0	1535.04	X	X
35.8	1535.82	X	X
36.6	1536.61	X	X
37.4	1537.40	X	X
38.1	1538.19	X	X
38.9	1538.98	X	X
39.7	1539.77	X	X
40.5	1540.56	X	X
41.3	1541.34	X	X
42.1	1542.14	X	X
42.9	1542.94	X	X
43.7	1543.73	X	X
44.5	1544.53	X	X
45.3	1545.32	X	
46.1	1546.12	X	X
46.9	1546.92	X	X
47.7	1547.72	X	X
48.5	1548.51	X	X
49.3	1549.31	X	X
50.1	1550.12	X	X
50.9	1550.92	X	X
51.7	1551.72	X	X
52.5	1552.52	X	X
53.3	1553.32	X	
54.1	1554.13	X	X

xx.x	λ (nm)	ONS-XC-10G-xx.x=	ONS-SC-2G-xx.x=
54.9	1554.94	X	X
55.7	1555.75	X	X
56.5	1556.55	X	X
57.3	1557.36	X	X
58.1	1558.17	X	X
58.9	1558.98	X	X
59.7	1559.79	X	X
60.6	1560.61	X	X
61.4	1561.41	X	

Table 7. Supported Wavelengths on CWDM SFP Units

xxxx	(nm)	ONS-SC-Z3-xxxx=
1470	1470 nm	X
1490	1490 nm	X
1510	1510 nm	X
1530	1530 nm	X
1550	1550 nm	X
1570	1570 nm	X
1590	1590 nm	X
1610	1610 nm	X

Table 8. Card Specifications

Specification	
Management	
Card LEDs <ul style="list-style-type: none"> Failure (FAIL) Active or standby (ACT or STBY) Signal fail (SF) Client port LEDs <ul style="list-style-type: none"> Active input signal DWDM port LEDs <ul style="list-style-type: none"> Active input signal Output wavelength 	Red Green or yellow Yellow Green Green Green
Power	
Card power draw with pluggable optics <ul style="list-style-type: none"> Typical Maximum 	132W 137W
Operating Environment	
Temperature	23 to 131°F (–5 to 55°C)
Humidity	5 to 95 percent noncondensing



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Printed in USA

C78-386486-02 09/08