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Cisco QSFP-DD Pluggable Open Line System (QSFP-DD OLS)

Contents

The QSFP-DD OLS is a pluggable open line system solution that can be directly hosted on a Cisco router.

Product overview

The Cisco® QSFP-DD Open Line System (QSFP-DD OLS) is a pluggable optical amplifier module that, together with the channel breakout options (described later), provides a simple yet powerful open line system solution in a pluggable form factor that can be directly hosted on a Cisco router.

Cisco offers a comprehensive range of pluggable optical modules in the Cisco pluggables portfolio. The wide variety of modules gives customers flexible and cost-effective options for all types of interfaces. Thanks to the miniaturization of the technology with a 7-nm manufacturing procedure and innovation in silicon photonic technology, it was possible to squeeze a 400G-capable Digital Coherent WDM interface within a QSFP-DD form factor.

This innovation first lead to the release of Cisco QSFP-DD ZR and QSFP-DD ZR+ interfaces in late CY 2021. While these were industry-leading Coherent DWDM interfaces at the time of their launch, the transmit power of −10dBm on these interfaces left customers needing additional amplification at the sources to launch at a healthy power into the transmission fiber. The distances were thus restricted to 40 km, and a limited set of add/drop configurations compliant with that low transmit power could be used in the line system configuration.

In parallel, Cisco's Routed Optical Networking (RON) strategy was born, which envisioned an architecture that was all router to router. Routed Optical Networking, part of the Converged SDN Transport solution, is an architecture that delivers improved operational efficiencies and simplicity. The solution works by merging IP and private line services onto a single layer where all the switching is done at Layer 3. Routers are connected with standardized 400G ZR/ZR+ coherent pluggable optics. The Cisco vision for this new solution is to leverage the fundamental lifecycle changes happening in routers and optics and utilize those technologies in a different architecture. These technological advancements result in massive scalability in the Cisco 8000, NCS 5000, and NCS 500 routers, a smaller footprint and higher functioning 400G ZR/ZR+ coherent optics, and simpler DWDM line systems, telemetry software, and automation, all leading to a new network paradigm. The QSFP-DD ZR, ZR+ and Bright ZR+ interfaces formed an integral part of the Cisco Routed Optical Networking solution.

The low transmit power of the QSFP-DD ZR, ZR+ necessitated customers to add an amplifier at the beginning and end of a link/fiber span connecting both the routers in the Cisco RON solution to achieve a longer span reach than 40 km. At this point, one might as well consider a line system instead of just an amplifier as the inclusion of the line system in this Cisco RON solution also allows more channels to be packed into a single fiber, allowing mass expansion of capacity. Among the Cisco optical networking solutions, the NCS 1001, NCS 2000, and NCS 1010 were good candidates to meet this end. But this solution still required an entire line system additional to the existing Cisco RON router-to-router simplified architecture.

At this juncture, Cisco designed an ingenious solution to collapse the line system ability into a pluggable form factor and that is the most prevalently used QSFP-DD. Thus, the QSFP-DD open line system (QSFP-DD OLS) was thus born. It could be put directly on a router alongside other QSFP-DD optics on any QSFP-DD port. This latest offering from Cisco, the QSFP-DD OLS, is a "pluggable open line system" solution that perfectly integrates into the Cisco Routed Optical Networking architecture by hosting line system abilities directly on a router.

The arrival of the latest 400G Bright QSFP-DD optics early this year ensured the interface itself is now able to launch at a much higher +1dBm power, allowing a span reach of 80 km and longer. But the QSFP-DD OLS still adds value to this solution by further extending the reach of the 400G Bright QSFP-DD optics link beyond the 80 to 120 km mark and more importantly brings in a multichannel line system ability directly on the router. The ability to extend the reach and capacity of a single fiber span in a Cisco Routed Optical Networking architecture is the standout value of this QSFP-DD OLS solution, immaterial of which interface is being used.
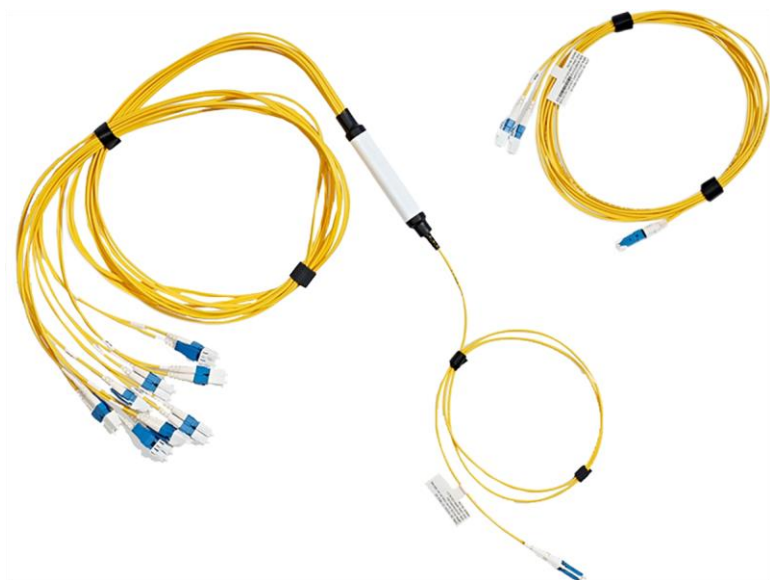

Figure 1.
The QSFP-DD pluggable open line system

Figure 2.
1x8 breakout cable (left), CS-LC cable (right)

Features and benefits

The QSFP-DD OLS itself is a pluggable module that integrates in itself two variable-gain amplifiers: a pre-amplifier and a booster amplifier to amplify both the up and down fiber streams. Various channel breakout options are available to combine or separate each channel from a coherent DWDM optical source. The TX-EDFA acting as a Booster amplifier recovers the loss of the optical Multiplexer units, and it provides an optical power boost before the link. The RX-EDFA acting as Preamp recovers the link loss, bringing the optical signal to a power level above the sensitivity of the receivers after the Demultiplexer unit.

The QSFP-DD OLS can extend the reach of a 400G QSFP-DD ZR/ZR+ link from 40 to 130 km or longer depending on fiber specification, the channel count, and the line rate of the signal.

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To be able to integrate a pair of ingress and egress ports on the QSFP-DD OLS pluggable faceplate, industry-standard CS connectors are used. The QSFP-DD-OLS has two bidirectional optical ports: the COM-RX/TX that shall be connected to the Mux/DMX unit, and the LINE-TX/RX that shall be connected to the fiber link. The optical connectors are 2x CS-UPC. The CS connector provides the characteristics and simplicity of the duplex LC connector into a smaller footprint to allow two pairs of CS connectors to fit within the physical constraints of the QSFP-DD form factor. Since the other optical units like Coherent Interfaces modules, DWDM Add/Drop multiplexers, and fiber patch panels have normally LC connectors, a hybrid adaptation patch cord with a CS dual connector on one side and 2x LC connector on the other side is available to interconnect the QSFP-DD-OLS modules with other optical equipment.

Optical safety is enabled by default to:

- Switch off each section independently in case Optical LOS is detected at its input
- Set the TX-EDFA in Automatic Power Reduction (APR) at 8dBm in case a LOS is cleared at the COM-RX port, but LOS is still present at LINE-RX (this prevents the launch of high optical power on an open line)

One can build an N-channel line system using the QSFP-DD OLS and its associated components:

A single channel system

It requires no special components to add and drop. A special CS-LC cable (ONS-CAB-CS-LC-5) has been made available to interconnect LC ports of the QSFP-DD coherent source or the network with the CS ports of the QSFP-DD OLS. Just one pair of these cables is sufficient to make a single channel system. All the gain of the amplifier is available for the single channel in focus.

A 4-channel system

To achieve a 4-channel combine and split, an FLD-4 (fixed 4 channel OADM) can be used. This is a passive optical Add/Drop unit belonging to the ONS-15216 platform that is able to multiplex/demultiplex 4 channels over the 100GHz ITU grid. There are 10 different Cisco FLD-4s (each managing 4 channels) that are orderable today, identified by the xy.x numbers and covering the whole C-band. But 6 out of the 10 FLD-4 PIDs are compatible with the QSFP-DD-OLS optical operating bandwidth as listed in Table 1. A special CS-LC cable (ONS-CAB-CS-LC-5) has been made available to interconnect LC ports of the A/D or the network with the CS ports of the QSFP-DD OLS.

An 8-channel system

To achieve an 8-channel combine and split, a 1x8 channel breakout cable can be used. This new breakout cable (ONS-BRK-CS-8LC) is a dual fanout 1x8 cable with an embedded passive splitter and coupler. The cable has one dual CS/UPC connector on the common port that can be connected to the COM port of the QSFP-DD-OLS and 8 dual LC/UPC (labelled CHi-RX/TX) that can be connected to a Coherent Optical Interface modules port. **The cable is grid-less so any port can be fed with any optical frequency without any constraints of frequency value or spacing between the channels**.

A 16-channel system

To achieve a 16-channel combine and split, a 1x16 channel breakout cable can be used. This new breakout cable (ONS-BRK-CS-16LC) is a dual fanout 1x16 cable with an embedded passive splitter and coupler. The cable has one dual CS/UPC connector on the common port that can be connected to the COM port of the QSFP-DD-OLS and 16 dual LC/UPC (labelled CHi-RX/TX) that can be connected to a Coherent Optical Interface modules port. The cable is grid-less so any port can be fed with any optical frequency without any constraints of frequency value or spacing between the channels.

A 32-channel system

To achieve a 32-channel combine and split, a 64-channel mux/dmx can be used (of which 32 channels are used). This (NCS1K-MD-64-C) is passive optical Add/Drop unit belonging to the NCS1K platform able to multiplex/demultiplex up to 64 channels over the 75GHz grid. Due to the limited operating bandwidth of the QSFP-DD-OLS, only a subset of the MD-64 channels can be used: form port CH-19 (194.75 THz) to port CH-50 (192.425 THz), while the other ports form CH-1 to CH-18 and form CH-61 to CH-64 shall be left unused.
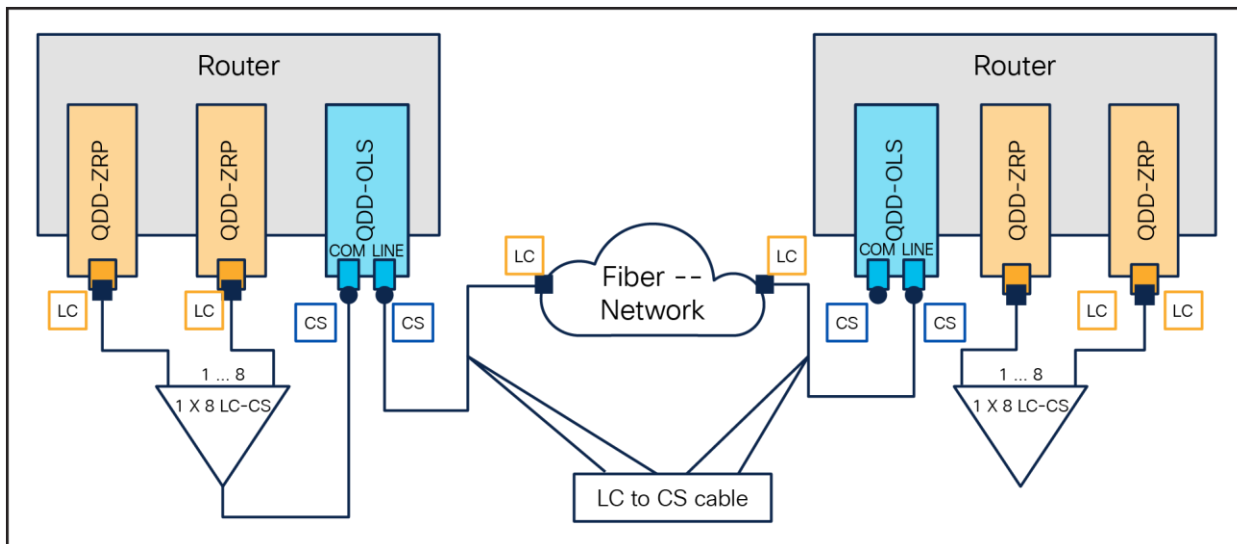

Figure 3.
An 8-channel point-to-point configuration with the QSFP-DD OLS

Product specifications

A simple on-paper calculation considering the QSFP-DD OLS gain, power in/out of the fiber, the N-channel Add/Drop device, and the sensitivity of the QSFP-DD optical source can yield a link design. Cisco is readily available for support should customers desire support on link design.

The following table lists out the Add/Drop options to achieve an N-channel system.

Table 1. Add/Drop options for QSFP-DD line system solution

N-channel system	Add/Drop device
1 channel	Just a pair of ONS-CAB-CS-LC-5 cables (5 m long)
4 channel	Any of the FLD-4 modules listed: 15216-FLD-4-39.7=, 15216-FLD-4-42.9=, 15216-FLD-4-46.1=, 15216-FLD-4-49.3=, 15216-FLD-4-52.5=, 15216-FLD-4-55.7=
8 channel (200 GHz)	ONS-BRK-CS-8LC cable (2 m long)
16 channel (100 GHz)	ONS-BRK-CS-16LC cable (2 m long)
32 channel (75 GHz)	NCS1K-MD-64-C mux/dmx

The following table lists out the specification of various components that form the QSFP-DD Open Line system solution.

Table 2. Specifications of the QSFP-DD OLS components

Factor	Specification
Tx Booster gain range	7 to 25 dB
Rx Preamp gain range	3 to 25 dB
Tx Booster input power range	–25 to 10 dBm
Rx Preamp input power range	–24 to 14 dBm
Tx Booster output power range	17.5 dBm
Rx preamp output power range	17.5 dBm
Wavelength range	192.375 to 194.775 THz
Power dissipation	3.5 W
Insertion loss of ONS-BRK-CS-8LC	9.5 to 11 dB
Insertion loss of ONS-BRK-CS-16LC	12 to 13.5 dB

Platform support

The Cisco QSFP-DD OLS can be directly configured and managed by the IOS® XR SW on board the Cisco router itself. Multiple Cisco routing platforms are in the process of qualifying this QSFP-DD OLS pluggable product. At the GA (first general availability) of the product, the below platforms/products are the supported router hosts.

Table 3.   Supported platform at FCS

Product Family	Products Supported	IOS Images (Feature Sets) Supported
NCS 57xx	NCS-57C3-MOD-S (Eyrie)	IOS XR 7.10.1
NCS 55xx	NCS-55A2-MOD-S (Peyto)	IOS XR 7.10.1
NCS 57xx	NCS-57B1-6D24/5DSE (Shadow Tower)	IOS XR 7.10.1

Ordering information

Table 4.   List of orderable PIDs associated with the QSFP-DD OLS solution

Product ID	Description
ONS-QDD-OLS	QSFP-DD Open Line System, Pre and Bst EDFA, 2.4 THz C-Band
ONS-CAB-CS-LC-5=	Duplex optical patchcord, LC to CS connectors, 5m
ONS-BRK-CS-8LC=	8-chs Colorless Flex-spectrum Mux/Dmx - LCs to CS connector
ONS-BRK-CS-16LC=	16-chs Colorless Flex-spectrum Mux/Dmx - LCs to CS connector
15216-FLD-4-39.7=	Edge 4-Ch Bi-Directional OADM Mod 1539.77 to 1542.14
15216-FLD-4-42.9=	Edge 4-Ch Bi-Directional OADM Mod 1542.94 to 1545.32
15216-FLD-4-46.1=	Edge 4-Ch Bi-Directional OADM Mod 1546.12 to 1548.51
15216-FLD-4-49.3=	Edge 4-Ch Bi-Directional OADM Mod 1549.32 to 1551.72
15216-FLD-4-52.5=	Edge 4-Ch Bi-Directional OADM Mod 1552.52 to 1554.94
15216-FLD-4-55.7=	Edge 4-Ch Bi-Directional OADM Mod 1555.75 to 1558.17
NCS1K-MD-64-C=	NCS 1000 64 chs Odd Mux/Demux Patch Panel - C-band

Table 5. List of associated 400G coherent optical sources

Product ID	Description
QDD-400G-ZR-S=	QSFP-DD transceiver module, coherent DCO, 400G-ZR
QDD-400G-ZRP-S=	QSFP-DD transceiver module, coherent DCO, 400G-ZR+
DP04QSDD-HE0=	QSFP-DD 400G ZR+ - High Tx Power
DP04QSDD-HK9=	QSFP-DD 400G ZR+ - High Tx Power - OTN
DP01QSDD-LK9=	QSFP-DD 400G ZR+ - High Tx Power - OTN - 100G BW

Product sustainability

Information about Cisco's Environmental, Social, and Governance (ESG) initiatives and performance is provided in Cisco's CSR and sustainability [reporting](#).

Table 6. Cisco environmental sustainability information

Sustainability Topic		Reference
General	Information on product-material-content laws and regulations	[Materials](#)
	Information on electronic waste laws and regulations, including our products, batteries, and packaging	[WEEE Compliance](#)
	Information on product takeback and reuse program	[Cisco Takeback and Reuse Program](#)
	Sustainability inquiries	Contact: [csr_inquiries@cisco.com](#)
Material	Product packaging weight and materials	Contact: [environment@cisco.com](#)

Warranty

Product warranty terms and other information applicable to Cisco products are available at [www.cisco.com/go/warranty](#).

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Document history

New or Revised Topic	Described In	Date
1st draft at the launch of the QSFP-DD OLS	Whole datasheet	July 11, 2023

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