Data sheet
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The bridge to possible

Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules

Contents

Cisco offers a comprehensive range of pluggable optical modules in the Cisco® pluggables portfolio. The wide variety of modules gives you flexible and cost-effective options for all types of interfaces. Cisco offers a range of GBIC, SFP, XFP, SFP+, CXP, CFP, Cisco CPAK, and QSFP+ pluggable modules. These small, modular optical interface transceivers offer a convenient and cost-effective solution for an array of applications in the data center, campus, metropolitan-area access and ring network, storage area network, and long-haul network. In recent times, with longer strides of innovation, Cisco has introduced analog DWDM CFP2 interfaces to the market. The latest addition to the Cisco portfolio pushes this boundary further with the introduction of the 400G DIGITAL COHERENT QSFP-DD PLUGGABLE OPTICAL MODULE.
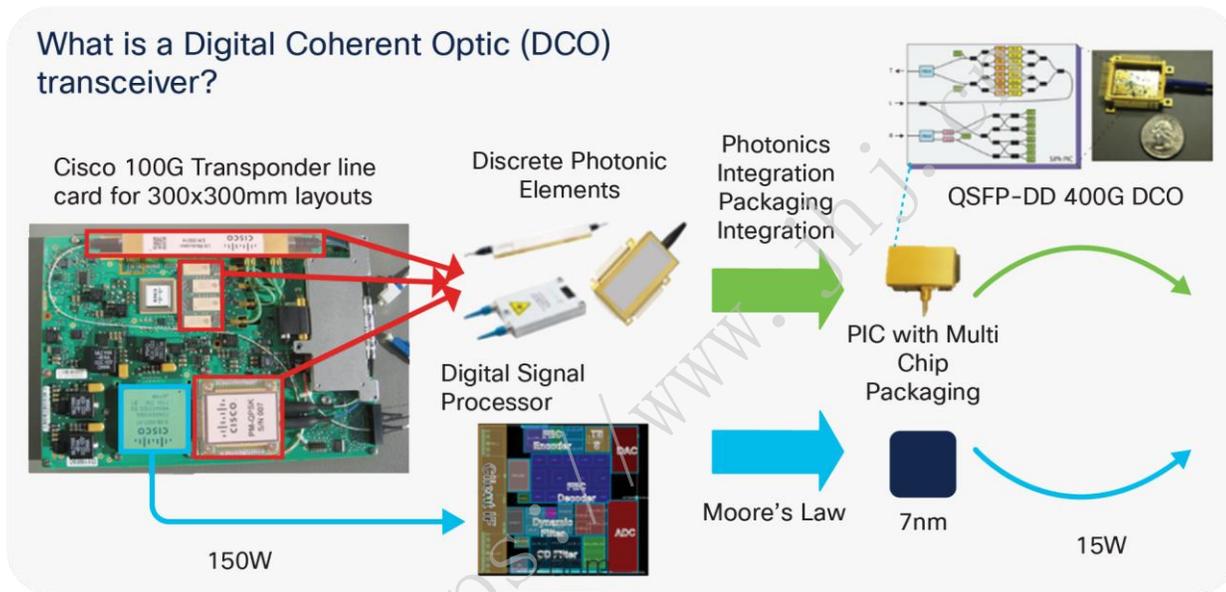

Figure 1.
From Discrete components to Integrated Coherent Pluggable.

Product overview

Cisco now offers a range of all new 400G Digital Coherent QSFP-DD transceivers. Cisco already offers a range of Digital Coherent CFP2 transceivers capable of supporting up to a 200-Gbps wavelength. Thanks to the miniaturization of the technology with a 7-nm manufacturing procedure and innovation in silicon photonic technology, it is now possible to squeeze a 400G-capable Digital Coherent WDM interface within a QSFP-DD form factor.

Two product variants are available:

1. ZR variant

2. ZR Plus variant

QDD ZR overview

The QSFP-DD ZR variant complies with OIF MSA, allowing to provide compatibility with the equivalent component compliant with the same MSA standard. The key application for the ZR standard is allowing the transmission of a 400G wavelength in point-to-point topology up to a distance of 120 km with the Mux/Demux and Amplifier as depicted the below.
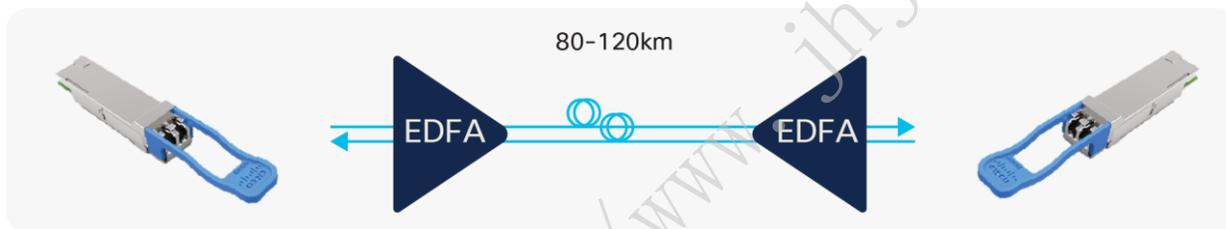

Figure 2.
QSFP DD ZR Application.

In this product variant, the pluggable can support both a 400GE and 4x 100GE interface with the host card.

QDD ZR Plus overview

The QSFP-DD ZR Plus variant complies with OpenZR+ MSA, allowing to cope for distances going from regional to long haul with multiple amplification sites between the end point. This variant is also providing multiple configuration options in terms of Modulation scheme, TX filter shaping, and baud rates on top of what OpenZR+ MSA defines.

This variant is also the one capable of reaching the longest transmission distance thanks to the high-performing O-FEC algorithm.

It is able to support an ~60G baud rate, QPSK, and 8-QAM and 16-QAM modulation scheme to cope with a 200G (QPSK), 300G (8-QAM), and 400G (16-QAM) per wavelength transmission capacity.

It is also capable of supporting 100G signals leveraging QPSK modulation scheme at ~30G baud as well as 200G signal at 16-QAM (~30Gbaud) and 8-QAM (~40 Gbaud).

From the signal shaping mode of view, two different configurations are supported (with or without Tx shaping) to cope with different filtering requirements.

Features and benefits

As line card ports become universal, it is possible to design new line cards optimized for 400G, knowing that by simply replacing the pluggable, the port can support bitrates down to 100G to guarantee backward compatibility with previous-generation routers. In addition, the IPoDWDM options, available by simply using the 400G ZR/ZR+ optics, provides, for the first time, the same density of grey line cards, eventually solving the usual dilemma of having to choose between the benefits of integration and maximizing the throughput of router line cards.

Some network operators chose to take a different approach at 400G upon recognizing the lessons learned from the efforts at 100G. In late 2016, these network operators and a few vendors identified 400G as an intersection point for the industry to support coherent optics in the same form factors as emerging high-volume client optics, such as QSFP-DD. In less than one year, the OIF defined most of the 400ZR interface technical details, which helped motivate increased industry investment in pluggable, interoperable coherent interfaces.

A key requirement was to accommodate hyperscale DCI links beyond 120 km, while maintaining the same QSFP-DD/OSFP form factors. A survey of 400G standardization efforts pointed to elements of OpenROADM that could provide a standard-based, high-performance addition to the 400ZR standard. Thus, the industry began looking at the next logical step, which would be to combine these vetted specifications and achieve the goal of addressing 400G Ethernet-centric solutions beyond 120 km. This would enable the extension of hyperscale DCIs beyond the edge to regional distances, and expand the addressable market for module suppliers, providing greater economies of scale that benefit the entire distribution chain. This combination of the 400ZR standard with elements of OpenROADM became known as OpenZR+.
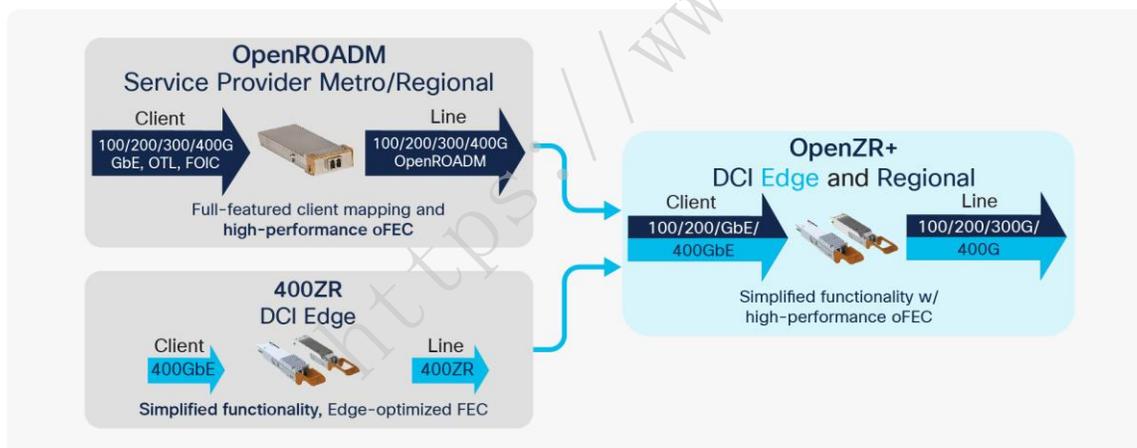

Figure 3.
OpenZR+ is the logical combination of two industry standardization efforts that enables high-performance DCI pluggable modules supporting multivendor interoperability.

As illustrated in Figure 1, OpenZR+ is a combination of two industry standardization efforts created to maintain the simple Ethernet-only host interface of 400ZR while adding support for features such as: (1) higher coding gain using oFEC from the OpenROADM standard, which extends the reach capability; (2) multirate Ethernet, which enables the multiplexing of 100GbE and 200GbE clients over the line-side link, providing optimization options for the switch/router equipment to channelize the traffic over the transport link; (3) adjustable 100G, 200G, 300G, or 400G line-side transport links (using QPSK, 8QAM, or 16QAM modulation), which enables reach/capacity optimization over various fiber links; and (4) higher dispersion tolerance. All of these enhanced capabilities would exist in a QSFP-DD designed to utilize OpenZR+, supporting reaches well beyond the 120 km supported by 400ZR.

The table below summarizes the benefits of modules designed to use OpenZR+, compared to 400ZR and OpenROADM.

	400ZR	OpenROADM	OpenZR+
Target Application	Edge DCI	Carrier Metro/LH	Regional DCI
Client Traffic	400GbE only	100-400GbE & OTN	100-400GbE Multirate
Reach	≤120km	>120km[*]	>120km[*]
Form Factor	QSFP-DD/OSFP	CFP2 or other	QSFP-DD/OSFP
SD-FEC	CFEC	oFEC	oFEC

[*] Distance depending on adopted WDM Transport system

Multivendor interoperability

Extensive system-level testing and unmatched technical expertise enable Cisco optics to be successfully used across Cisco as well as multivendor platforms. The strategic supply chain diversity and service capabilities provide the high network availability and peace of mind.

Flexible modulation

As in the case of QSFP+, QSFP56-DD will provide the capability to support lower bitrates, via 4x 100G pluggables. In addition, this pluggable supports the downsize to the port to 200G (or 2x 100G). This one pluggable fit's all type of approach provides great benefits to both vendors and customers, as it enables a simplification in the IP router portfolio and, as a consequence, a simplification in network planning and spare parts.

Specification

Transmitter specifications

Both QDD ZR and ZR+ supports full C band tune ability. Tx parameter specifications are showed in the table below.

Product ID	Max Transmit Power	Symbol Rate (+/-20ppm)	Modulation (Payload)	FEC	OOB OSNR	OIB OSNR
QDD-400G-ZR-S	Without TX Shaping: -8.5 (Typ) -10 (Worst case)	59,843,750,000	16-QAM (400G)	C-FEC	30 dB	34 dB
QDD-400G-ZRP-S	Without TX Shaping: -8.0 (Typ) -10.0 (Worst case) With TX Shaping: -11.0 (Typ) -13.0 (Worst case)	60,138,546,798	16-QAM (400G)	OFEC	42 dB	42 dB
	Without TX Shaping: -8.6 (Typ) -10.2 (Worst case) With TX Shaping: -10.4 (Typ) -11.9 (Worst case)	60,138,546,798	8-QAM (300G)	OFEC	42 dB	42 dB
	Without TX Shaping: -6.2 (Typ) -7.7 (Worst case) With TX Shaping: -9.0 (Typ) -10.5 (Worst case)	60,138,546,798	QPSK (200G)	OFEC	42 dB	42 dB
	TX shaping only: -9.0 (Typ) -11 (Worst case)	40,092,364,532	8-QAM (200G)	OFEC	42 dB	42 dB
	TX shaping only: -8.0 (Typ) -10 (Worst case)	30,069,273,399	16-QAM (200G)	OFEC	42 dB	42 dB
	Without TX shaping only: -5.9 (Typ)	30,069,273,399	QPSK (100G)	OFEC	42 dB	42 dB

Product ID	Max Transmit Power	Symbol Rate (+/-20ppm)	Modulation (Payload)	FEC	OOB OSNR	OIB OSNR
	-7.5 (Worst case)					

Rx parameter specifications

Product ID	Modulation (Payload)	RX OSNR Sensitivity (dB)	RX Sensitivity Optimal	Extended Range RX Sensitivity (1dB OSNR Penalty)	RX Power Sensitivity (No ASE Noise)	Max Rx Power	CD Robustness (ps/nm)
QDD-400G-ZR-S	16-QAM (400G)	26	-12dBm	-15dBm	-20dBm	13dBm	+/-2400
QDD-400G-ZRP-S	16-QAM (400G)	Without TX Shaping: 23.7 With TX Shaping: 23.1	-12dBm	-16dBm	Without TX Shaping: -20dBm With TX Shaping: -21dBm	13dBm	Default: +/- 13,000 Configurable up to: +/-52,000
	8-QAM (300G)	Without TX Shaping: 20.8 With TX Shaping: 19.5	-15dBm	-19dBm	Without TX Shaping: -22dBm With TX Shaping: -23dBm	13dBm	Default: +/- 26,000 Configurable up to: +/- 100,000
	QPSK (200G)	Without TX Shaping: 15.3 With TX Shaping: 15.0	-18dBm	-22dBm	-28dBm	13dBm	Default: +/- 50,000 Configurable up to: +/- 100,000
	8-QAM (200G)	17.4 (Only TX shaping supported)	-16dBm	-20dBm	-28dBm	13dBm	Default: +/- 26,000 Configurable up to: +/-100,000
	16-QAM (200G)	19.3 (Only TX shaping supported)	-15dBm	-20dBm	-24dBm	13dBm	Default: +/- 21,000 Configurable up to: +/- 85,000
	QPSK (100G)	11.8 (No Tx shaping)	-20dBm	-25dBm	-28dBm	13dBm	Default: +/- 80,000 Configurable up to: +/-160,000

Rx Optical Polarization specifications

Product ID	Modulation (Payload)	State of Polarization Change rate w/ 0.5dB of OSNR penalty	State of Polarization Change rate w/ 1dB of OSNR penalty	State of Polarization Change rate w/ 2dB of OSNR penalty	DGD Robustness (ps)
QDD-400G-ZR-S	16-QAM (400G)	50 rad/ms	50 rad/ms	50 rad/ms	33
QDD-400G-ZRP-S	16-QAM (400G)	80 rad/ms	150 rad/ms	200 rad/ms	60
	8-QAM (300G)	120 rad/ms	200 rad/ms	300 rad/ms	60
	QPSK (200G)	800 rad/ms	1000 rad/ms	1400 rad/ms	60
	8-QAM (200G)	70 rad/ms	100 rad/ms	150 rad/ms	60
	16-QAM (200G)	50 rad/ms	100 rad/ms	150 rad/ms	60
	QPSK (100G)	400 rad/ms	500 rad/ms	800 rad/ms	80

Rx Multichannel Interaction specifications

Product ID	Modulation (Payload)	Multichannel Xtalk tolerance by 15 additional channels	Multichannel Xtalk OSNR penalty induced by 2 adjacent channels
QDD-400G-ZR-S	16-QAM (400G)	15db with OSNR oenalty ≤ 1dB	0.5 dB (adjacent chs at 75Ghz)
QDD-400G-ZRP-S	16-QAM (400G)	15db with OSNR oenalty ≤ 0.5dB	0.5 dB (adjacent chs at 75Ghz)
	8-QAM (300G)	15db with OSNR oenalty ≤ 0.3dB	0.3 dB (adjacent chs at 75Ghz)
	QPSK (200G)	15db with OSNR oenalty ≤ 0.3dB	0.2 dB (adjacent chs at 75Ghz)
	8-QAM (200G)	15db with OSNR oenalty ≤ 0.3dB	0.7 dB (adjacent chs at 50Ghz)
	16-QAM (200G)	15db with OSNR oenalty ≤ 0.3dB	0.8 dB (adjacent chs at 50Ghz)
	QPSK (100G)	17db with OSNR oenalty ≤ 0.35dB	0.6 dB (adjacent chs at 37.5Ghz)

Physical

Product ID	Temp Range	MTBF	Roundtrip Latency
QDD-400G-ZR-S	Operating Case Temperature range: 15 to +75°C	442,477 hrs	400GE: 7.9 microsec 4x100GE: 8.2 microsec
QDD-400G-ZRP-S	Short term operating case temperature range +80°C. Note: a short term condition is present for 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. Note: the module turn up from cold start at ambient temperature as low as -5°C and it will warm up with a case temperature higher than the ambient temperature, but it will meet optical performance specs only with case temperature within the range defined above.	442,477 hrs	400GE: 4.7 microsec 4x100GE: 5.2 microsec 3x100GE: 6.0 microsec 2x100GE: 6.9 microsec

Ordering information

QSFP Double-Density Digital Coherent Optical Modules 400G

Product ID	Product 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+

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Reference links to information about key environmental sustainability topics (mentioned in the "Environment Sustainability" section of the CSR Report) are provided in the following table:

Sustainability topic	Reference
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Information on electronic waste laws and regulations, including products, batteries, and packaging	WEEE compliance

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Document history

Table 1.   Document history

New or Revised Topic	Described In	Date
01	First Version	
02	Provided additional Optical parameterlist	

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