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Juniper 800G Optical Transceivers and Cables Guide

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About This Guide

Use this guide to learn about the Juniper Networks® 800G optical transceivers and cables, their specifications, and how to install, remove, and maintain these transceivers.

1

CHAPTER

800G Optical Transceivers Overview

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Know Your 800G Transceiver

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800 Gigabit (800G) transceivers are optical modules capable of handling data rates of 800 Gbps. With a transmission rate of up to 800 Gbps, 800G transceivers offer double the capacity of their latest predecessor (400G transceivers). 800G transceivers are ideal for:

- Any host platform with 800G ports
- Networks with 800 gigabits data transmission
- Telecommunication networks that require high-speed data transmission with minimal loss

An 800G transceiver uses multiple lanes of optical signals and advanced modulation techniques to achieve higher capacities. 800G transceivers employ multiplexing using multiple fibers. These transceivers also use a combination of fiber and wavelength multiplexing to transmit an optic signal. All 800G client optics use 8 lanes of 100G with Pulse amplitude modulation 4-level (PAM4) modulation. PAM4 has a modulation of 53 Gbaud x 2 bits per symbol. 800G optics do not currently support Wavelength Division Multiplexing (WDM) systems that use only wavelength multiplexing and demultiplexing techniques.

800G transceivers support multiple transmission rates and breakout modes to ensure compatibility with various network transport requirements. This flexibility allows a single physical transceiver to be logically divided into multiple lower-speed Ethernet ports, adapting to different deployment scenarios:

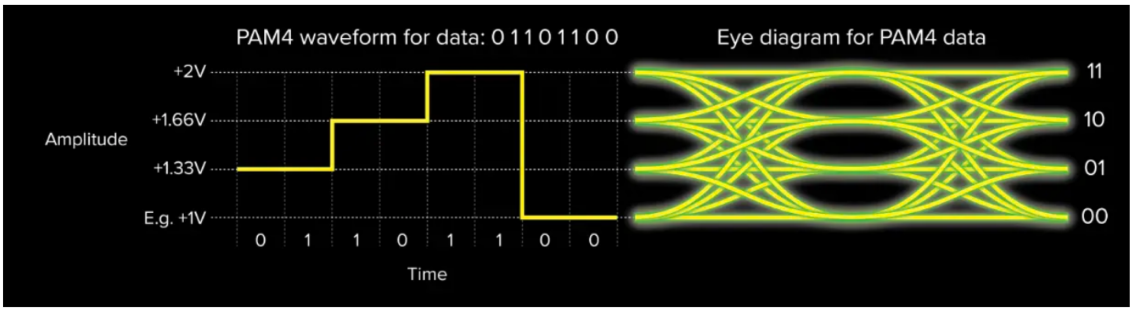
- 1x800G—The transceiver functions as a single 800G port to achieve a total capacity of 800 Gbps.
- 2x400G—The breakout cable provides the port as two separate 400G ports to achieve a total capacity of 800 Gbps.
- 8x100G—The transceiver can break out into eight separate 100G ports to achieve a total capacity of 800 Gbps.

Juniper's 800G transceivers use the OSFP800 and QSFP-DD800 form factors. This document refers to the form factors as OSFP and QSFP-DD.

Modulation Methods

- PAM4—PAM4 is a modulation method that combines two bits into a single symbol with four amplitude levels. That is, PAM4 effectively doubles the amount of data that you can transmit over a network. PAM4 has a higher than required signal to noise ratio (SNR) and is susceptible to four-Wave Mixing (FWM). FWM is a nonlinear optical phenomenon that occurs in fiber-optic communication systems when multiple optical signals (wavelengths) interact within the fiber. The challenge of achieving 800G optical transmission over distances greater than 10 km using PAM4 modulation is mainly due to FWM. It is necessary to configure forward error correction (FEC) to handle the signal integrity. You must configure FEC at both the transmitter and receiver ends of a communication link that uses 800G optical transceivers. When you configure FEC at both ends, the FEC algorithm encodes data before transmission and decodes and corrects the errors in data upon reception. In summary, PAM4 enables efficient short distance data transmission, but it demands more signal processing and error correction.

Figure 1: PAM4 Modulation



- Non-return to zero (NRZ) modulation—Non-return to zero (NRZ) modulation is commonly used as the modulation format for lower speed client optics up to 100G. However, industry standards for 800G optics do not use NRZ modulation. Hence, Juniper's 800G clients optics do not support this.

800G optical transceivers use the following technologies:

Digital Signal Processing

Advanced digital signal processing (DSP) techniques enhance signal integrity and extend the reach of 800G transceivers over optical fiber.

Clock Data Recovery

Clock data recovery (CDR) extracts timing information from a data signal and ensures accurate data retrieval and transmission in an optic network.

Forward Error Correction

The 800G optical transceiver handles high transmission speeds. Hence, it is susceptible to errors caused by noise, signal distortions, and nonlinear effects. Forward Error Correction (FEC) is a method of error control in which the transmitter adds redundant data or parity bits to the original data stream. This redundancy allows the receiver to detect and correct errors without requiring retransmission. Retransmission is impractical in optical transceivers due to high latency and the need for real-time transmission.

FECs are implemented through FEC algorithms. FEC algorithms are specific mathematical techniques or coding schemes. FEC algorithms detect and correct errors in transmitted data without requiring retransmission. The FEC process involves two steps:

- Encoding (at the Tx or transmitter)—The FEC algorithm processes the original data and adds redundant bits or parity bits based on a specific mathematical rule. The encoded data is then transmitted over the communication channel.
- Decoding (at the Rx or Receiver)—The receiver uses the FEC algorithm to analyze the received data, including the redundant bits. If errors are detected, the algorithm attempts to correct them based on the redundancy.

The error correction capability of FEC depends on the specific algorithm used and the amount of redundancy added. Some of the commonly used FEC algorithms include:

- Reed-Solomon (RS) FEC
- Soft-Decision FEC (SD-FEC)
- Low-Density Parity-Check (LDPC) Codes
- Bose-Chaudhuri-Hocquenghem (BCH) Codes
- Concatenated FEC

The choice of FEC algorithm depends on the specific requirements of the communication system:

- Data Rate—High-speed systems require more efficient algorithms. This could be LDPC or turbo codes.
- Error Characteristics—Burst errors are better handled by block codes such as Reed-Solomon.
- Latency—Real-time applications such as video streaming require low-latency algorithms.

- Power and Complexity—Systems with limited computational resources may use simpler codes like Hamming or BCH.

See the Hardware Compatibility Tool for the list of transceivers, their specifications, and the list of devices supported by the transceivers.

Key Characteristics

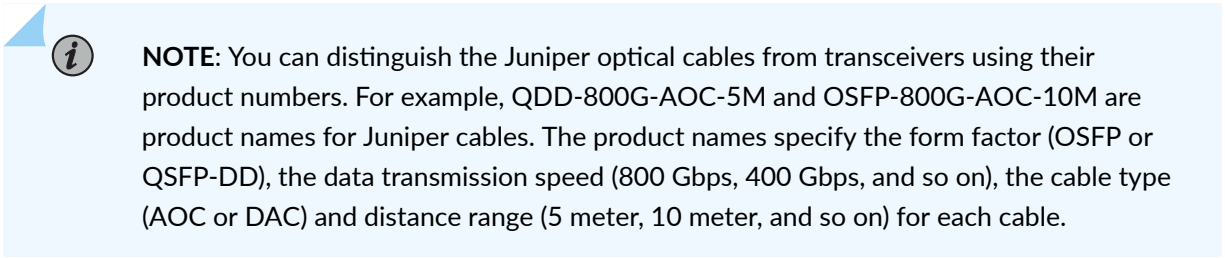
The following are the key characteristics of an 800G transceiver:

- Form factor—Common form factors for 800G transceivers include OSFP and QSFP-DD. The OSFP and QSFP-DD transceiver modules are designed to accommodate the higher power and thermal requirements of 800 Gbps of data transmission. The OSFP form factor has larger dimensions than the QSFP-DD form factor. It allows transceivers with OSFP form factor to handle higher power dissipation and provide better cooling solutions.
- Fiber type and reach—The fiber type specifies the type of optical fiber (singlemode or multimode) compatible with 800G transceivers. The reach provides the maximum supported distance or range for an optical transceiver. It helps you to select the appropriate optical transceiver for different applications, such as inter-data center, intra-data center and so on.
- Lane distribution—Juniper's 800G optics uses eight parallel lanes, either with multiple fiber pairs or wavelength multiplexing. 800G optics has parallel fibers that are used over shorter distances. Wavelength multiplexing using duplex single-mode fiber is used for longer distance optical communication.

Juniper Optical Product Numbers

Juniper's optical components such as transceivers, cables, and connectors follow a naming convention. Each element in the product name corresponds to a specification. It helps you to better understand and select the appropriate optical component. For example:

- QDD-2x400G-DR4
  - QDD—Short for QSFP-DD. It identifies the form-factor of the transceiver.
  - 2x400G—It indicates that the transceiver supports break-out into two independent 400G Ethernet interfaces for data transmission.
  - DR4—Stands for 400GBase-DR4. It is a specific standard and indicates that each 400G channel uses four parallel lanes of 100 Gbps to deliver 400 Gbps.



NOTE: You can distinguish the Juniper optical cables from transceivers using their product numbers. For example, QDD-800G-AOC-5M and OSFP-800G-AOC-10M are product names for Juniper cables. The product names specify the form factor (OSFP or QSFP-DD), the data transmission speed (800 Gbps, 400 Gbps, and so on), the cable type (AOC or DAC) and distance range (5 meter, 10 meter, and so on) for each cable.

800G (X8) Transceiver Architecture

The 8x100 gigabit architecture for an 800G transceiver uses eight lanes of 100 Gbps each. The following are the different components of an 800G transceiver architecture:

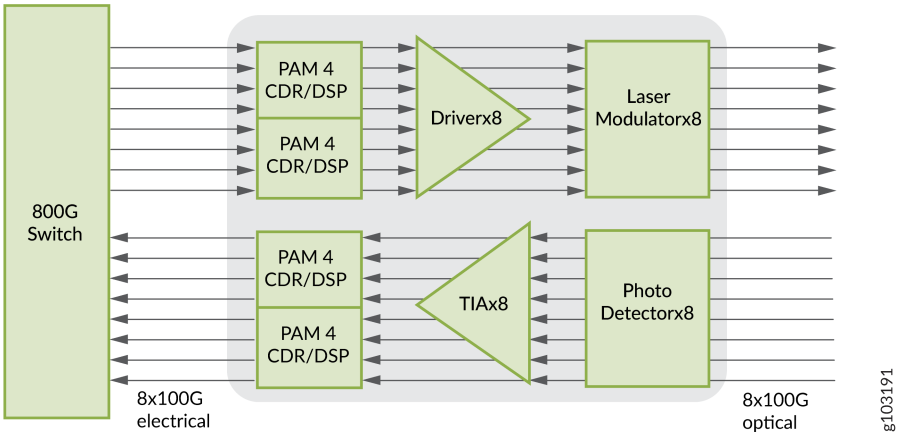
- Host platforms—Juniper devices that support 800G architecture.
- 8x100G electrical—The electrical interface between the switch and the transceiver components. It can transmit data over eight separate 100 Gbps electrical lanes.
- PAM4 clock data recovery (CDR)/digital signal processor (DSP)—A PAM4 CDR/DSP supports 100 Gbps electrical lanes. PAM4 effectively doubles the amount of data that you can transmit. The CDR is responsible for re-timing incoming data to reduce jitter. The DSP handles functions like equalization, error correction, and other signal processing tasks.
- Driver x8—Drivers are electronic components that amplify the electrical signal. The x8 transceiver architecture has eight drivers. Each driver corresponds to a 100 Gbps electrical lanes.
- Modulator x8—Eight modulators correspond to 100 Gbps electrical lanes (x8). 800G optics uses the following types of modulators:
  - Vertical cavity surface emitting Lasers (VCSEL)—VCSEL is used for multimode optics such as SR8/VR8.
  - Directly modulated lasers (DMLs)—DMLs are used for single-mode optics such as DR8. DMLs use distributed feedback (DFB) structures that incorporate a diffraction grating for stable direct modulation. Their modulation speed and transmission distance depend on the spectral line-width. A narrower line-width allows higher speeds and longer distances. In DMLs, data is modulated by adjusting the injection current on the laser diode, resulting in a compact design suitable for low-power applications.
  - Electro-absorption Modulated Laser (EMLs)—An EML integrates a laser diode with an electro-absorption modulator on a single chip. The laser operates continuously and the modulator turns the signal on and off.

Unlike DMLs, EMLs maintain constant laser properties during modulation, offering advantages in higher speed and longer distance transmissions due to lower chromatic dispersion. EMLs are primarily used for speeds over 25 Gbps and distances of 10 kilometers to 40 kilometers in telecom applications.

- 8x100G optical module—Optical interfaces that carry data in the form of light pulses. Each fiber in this model carries 100 Gbps of data.
- Transimpedance amplifiers (TIA) x8—A TIA converts and amplifies the electrical current from the photodiode into an electrical voltage level. It can operate with very low signal levels that are typical for optical communication.
- Photo-detector x8—It works in tandem with the TIA to convert the optical information back into electrical form.

An 8x100G architecture employs eight lanes to achieve a total data transmission rate of 800 Gbps. Each lane handles 100 Gbps.

Figure 2: 800G (X8) Transceiver Architecture



Optical PMD in 800G Transceiver Architecture

Optical physical medium dependent (PMD) sublayer is a component of an optic fiber's physical layer. It is responsible for the physical transmission of data. PMD formats the data correctly, then transmits and receives it through the optical medium. The following are some of the optical PMD models:

Parallel Single-mode Fiber Optics and Parallel Multi-mode Fiber Optics

Parallel single-mode fiber optics uses multiple single-mode fibers to send separate data streams simultaneously. It supports high-speed transmissions over long distances. Parallel multi-mode fiber optics involves multiple multi-mode fibers for simultaneous data streams. It is ideal for high-speed connections over shorter distances due to the larger core size of the fibers. For more information on single-mode fiber (SMF) and multi-mode fiber (MMF) optic cables, see "Active Optical Cable (AOC)" on page 33.

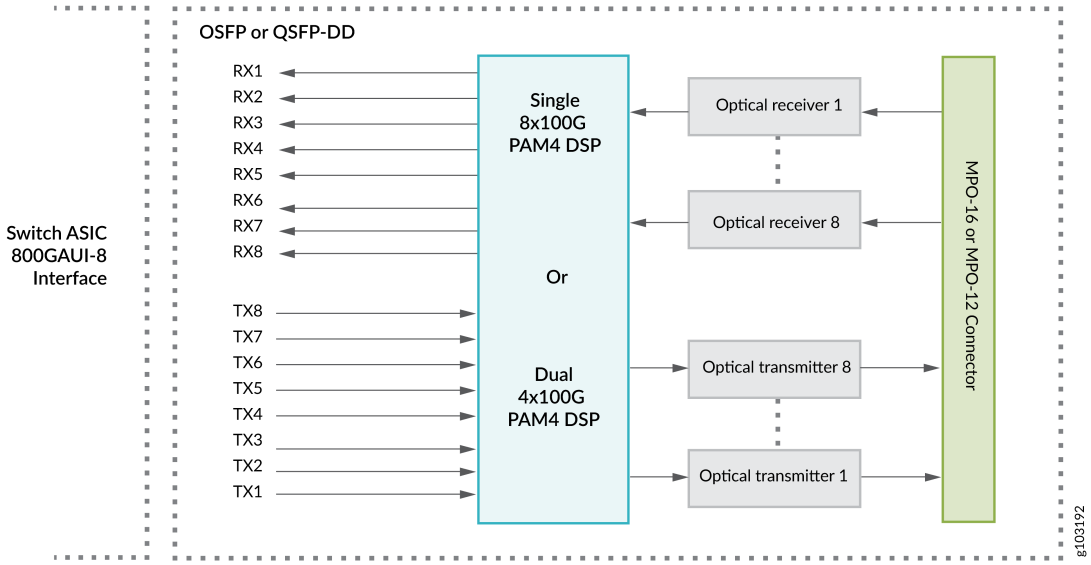
- **1λ single-mode fiber (SMF) solution for 800G DR8 and 800G DR8-2**—It is designed for a single wavelength (1λ), SMF solution. 1λ SMF indicates the use of a single wavelength for light propagation. That is, only one mode or one path in the optical fiber allows light propagation. These optics use a single-wavelength but eight parallel fiber pairs. 1λ SMF benefits data transmission by minimizing loss. Also, it enables transmission over longer distances with less signal loss than multimode fibers. The 800G DR8 or DR8-2 transceivers utilize eight-channel, direct-reach modules that are preferred in Tunable DWDM optics. See Figure 3 on page 9. The 1λ SMF solutions for 800G DR8 and 800G DR8-2 from Juniper include OSFP-2X400G-DR4, QDD-2X400G-DR4-P, QDD-8X100G-FR1, and QDD-8X100G-LR1.

  NOTE: As per Juniper naming convention, DR8-2 refers to 8x100G-FR1.

- **1λ multimode fiber (MMF) solution for 800G VR8 and 800G SR8**—It is designed for a single-wavelength (1λ) operation in multimode, parallel fiber solutions with MPO-16 and 2xMPO-12 connectors. 1λ refers to the use of a single wavelength. That is, the architecture can handle only one wavelength for the propagation of light. The use of single wavelength allows data transmission with minimal loss. The SR8 transceiver employs eight channels in the Short Reach (SR) mode that offers high data rates over a shorter distance. The VR8 transceiver employs eight channels in the Very Short Reach (VR) mode, which offers high data rates over an even shorter distance compared to SR8. The 1λ MMF solutions for 800G VR8 from Juniper include OSFP-2X400G-VR4-P.

  NOTE: Juniper does not currently support 800G SR8 optics.

Figure 3: 1λ SMF Solution: 800G DR8, SR8, and DR8-2

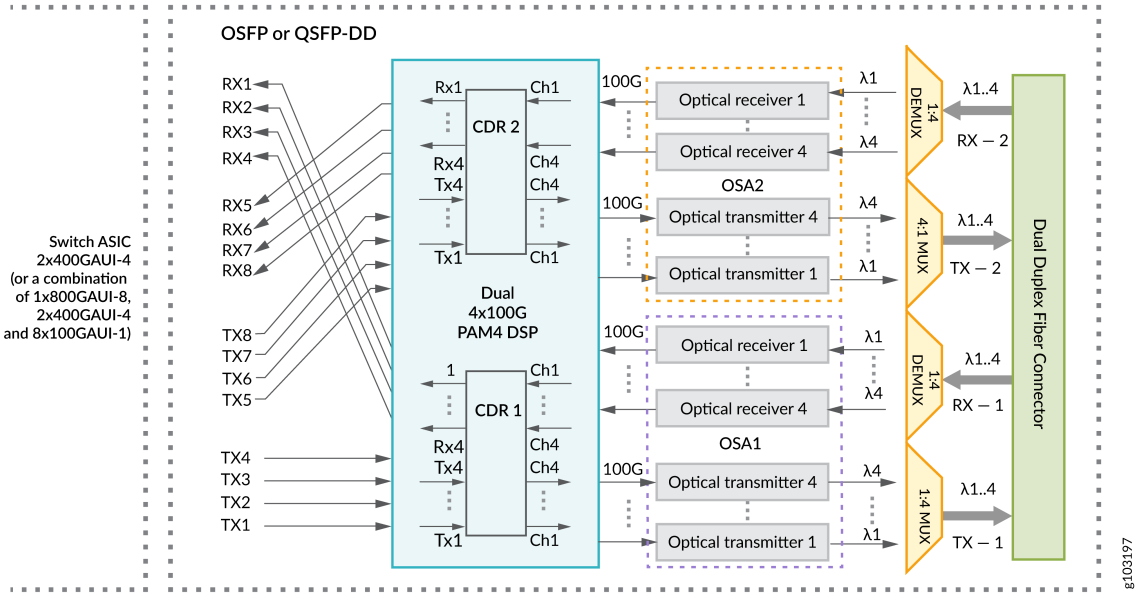


NOTE: Juniper's 800G optics use both OSFP and QSFP-DD form factors.

Duplex Single-mode Fiber Optics

- **4λ SMF solution for 2xFR4**—It is designed for a quad-wavelength (4λ) operation in SMF solutions. 4λ represents the usage of four differentiated wavelengths signaling four distinctive paths for light propagation. It can transfer more data per fiber pair and can breakout to 2x400G, with each 400G using duplex SMF fiber for transmission. It uses the four-level Pulse Amplitude Modulation (PAM4) technology.

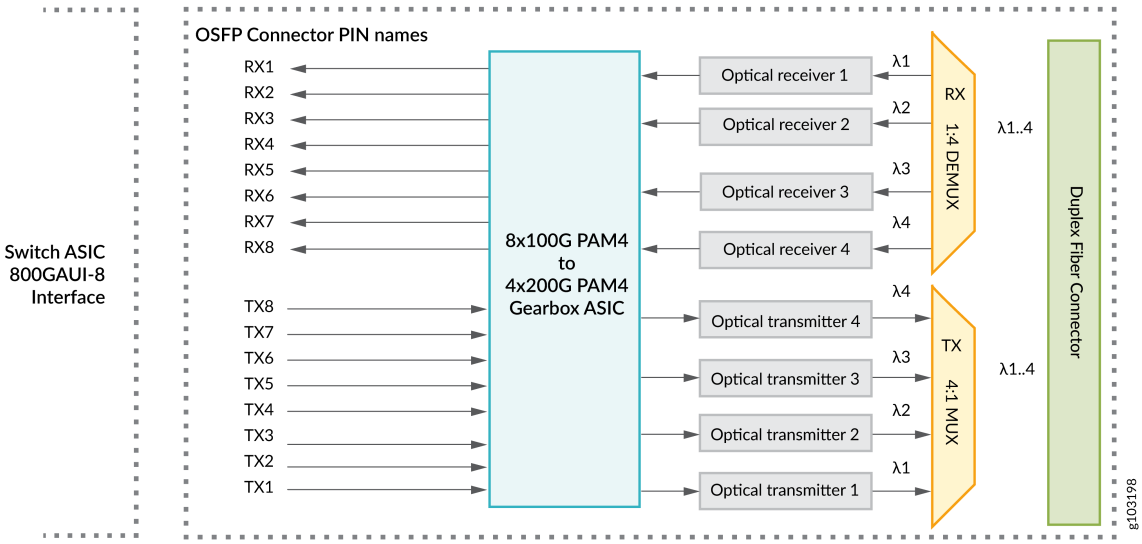
Figure 4: 4λ SMF Solution: 2xFR4



- **4λ SMF solution for FR4**—It is designed for a quad-wavelength (4λ) operation in SMF solutions that employ duplex fiber connectors. 4λ represents the use of four varying wavelengths. Thereby, it indicates four distinct wavelengths for light propagation. Due to the multiplicity of wavelengths, it can handle larger volumes of data transmission with manageable loss. It uses the four-level Pulse Amplitude Modulation (PAM4) technology. Each wavelength uses 200G PAM4 modulation with a 4x200G optical input and output. The FR4-500 is suitable for medium-reach transmissions of 500 meters or less. The PAM4 design enables the architecture to effectively convert eight-channel transmission into four-channel transmission.

NOTE: 4λ SMF solution for FR4 is currently not available from Juniper.

Figure 5: 4λ SMF Solution: FR4



- **4λ SMF solution for LR4**—It is designed for quad-wavelength (4λ) operation in single-mode fiber (SMF) systems that use duplex fiber connectors. The 4λ configuration involves four distinct wavelengths for light propagation, allowing it to handle larger volumes of data transmission with manageable loss. It utilizes four-level Pulse Amplitude Modulation (PAM4) technology, which enables the transmission of more data by encoding two bits per symbol. The LR4 is suitable for long-reach transmissions of up to 10 kilometers. The PAM4 design facilitates the architecture in effectively consolidating data transmission across four channels.

The duplex single-mode fiber optics from Juniper include QDD-2X400G-FR4, QDD-2X400G-FR4-P, QDD-2X400G-LR4-10, and QDD-2X400G-LR4-P.

Types of Optics

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- Half Retimed Optics or Linear Receive Optics | **12**
- Linear Pluggable Optics | **13**
- Tunable DWDM Optics | **15**

AI clusters and cloud data centers demand faster, more efficient data transmission with minimal power loss. To efficiently transmit (Tx) and receive (Rx) data in such networks, optical transceivers utilize various types of optics. The following sections provide an overview of these different optics types.

Fully-retimed Optics

Fully-retimed optics are traditional optical modules designed to ensure the highest levels of signal integrity and performance. Fully-retimed optics utilize re-timing mechanisms for both the transmit (Tx) and receive (Rx) signals. That is, these optics operate with two DSPs. Re-timing involves regenerating the clock signals for both directions of data flow, minimizing jitter and other signal distortions. This approach results in a cleaner and more robust signal, facilitating high-speed data transmission with low latency and high reliability. Fully-retimed optics are especially critical in applications where data integrity and low latency are critical, such as in high-performance computing environments and data center interconnects (DCI).

Fully-retimed offers the following advantages:

- Highest signal integrity and reliability—Fully retimed optics eliminate jitter and ensure the highest level of signal clarity by regenerating clock signals on both transmission and reception paths.
- Low latency—By minimizing signal distortions and maintaining signal integrity, fully retimed optics support low-latency communication essential for time-sensitive applications.

Fully-retimed optics could pose the following challenges:

- Higher power consumption—The use of DSPs for both Tx and Rx signals increases the power requirements of the module.
- Increased cost—Incorporating two DSPs and associated retiming mechanisms makes fully retimed optics more expensive compared to solutions like Linear Receive Optics (LRO) or Linear Pluggable Optics (LPO).

Half Retimed Optics or Linear Receive Optics

Half retimed optics or LRO applies re-timing mechanisms to only one direction of data flow, mostly to the transmit (Tx) signals. That is, LRO modules operate with a single DSP. The receive (Rx) signals are typically handled by the host system in an LRO implementation. This approach offers a balance between performance and cost. By retiming only one direction, LRO modules still enhance signal quality and reduce jitter, although not as effectively as fully retimed optics. These optics are ideal for scenarios where moderate signal integrity improvement is adequate, providing a cost-effective solution for less critical datapath within a network.

LRO offers the following advantages:

- Reduced power draw—By eliminating the retiming function on the receive side, LRO modules consume less power compared to fully retimed modules. While the power savings are not as substantial as those of LPO modules, they still offer significant reductions.
- Cost efficiency—The absence of retiming circuitry on the receive side simplifies the receiver module and reduces its cost compared to fully retimed modules. Although the cost reduction is not as pronounced as in LPO modules, it is still beneficial.
- Improved interoperability—LRO modules reduce the overall risk to link performance by concentrating retiming within a single DSP mid-span between hosts. This configuration minimizes interoperability challenges and simplifies integration.

LRO could pose the following challenges:

- Moderate signal integrity—While LRO enhances signal integrity, it does not achieve the same level of improvement as fully retimed optics. The host system must ensure it can manage the signal recovery effectively.
- Compromise in savings—LRO represents a compromise solution, offering roughly half the power and cost savings compared to LPO interfaces. Although it provides some benefits, it does not fully maximize efficiency.

Linear Pluggable Optics

Linear optics or linear pluggable optics (LPO) rely on direct detection and analog signal processing for transmission. An LPO does not incorporate full retiming mechanisms, such as DSP circuitry. That is, LPO modules operate without any DSP. The latest generation of optical transceivers including 400G, 800G, and 1.6 T use LPO modules. Unlike traditional fully retimed optical modules, LPO transceivers depend on the host to handle retiming and signal conditioning. By omitting the DSP, LPO achieves lower power consumption and higher energy-efficient while still supporting high-speed data transmission.

LPO offers the following advantages:

- Lower power consumption—Removing the retimers reduces energy usage. Retimers are energy-intensive, and their absence in the module leads to significant power savings.
- Cost efficiency—LPO reduces module costs by eliminating the DSP. DSP accounts for over one-fourth cost of a typical transceiver module.

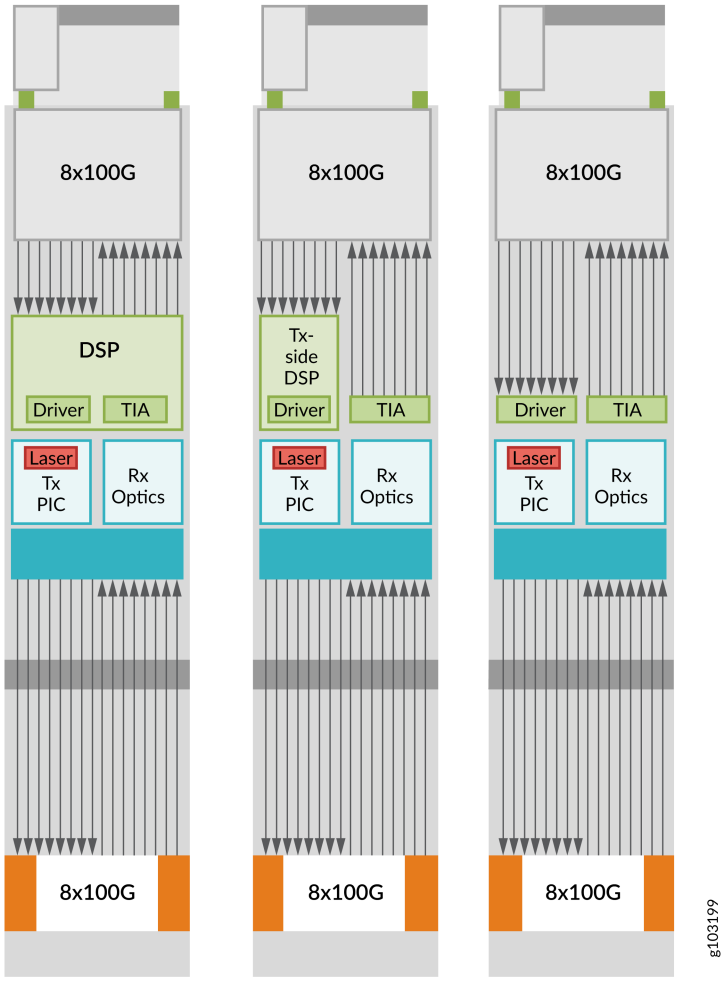
LPO could pose the following challenges:

- Signal integrity challenges—Ensuring robust link signal integrity is more challenging with LPO systems. The system must support approximately 16 dB of loss from the host switch to the module on both transmit and receive sides, along with several dB of optical loss.
- Interoperability issues—Connecting an LPO module with another LPO switch from a different manufacturer is a challenge at 100 Gbps per channel. This difficulty increases at 200 Gbps per channel.

Possible workarounds to mitigate these challenges include:

- Book-ended solution—This approach involves using one specific manufacturer's hardware on both sides of the link, simplifying implementation but limiting flexibility and leading to vendor lock-in.
- Engineered link—Custom designing connections for specific setups avoids vendor lock-in but increases the complexity and costs, making large-scale deployments less feasible.

Figure 6: Architecture of Fully-retimed, LPO, and LRO Optic Modules

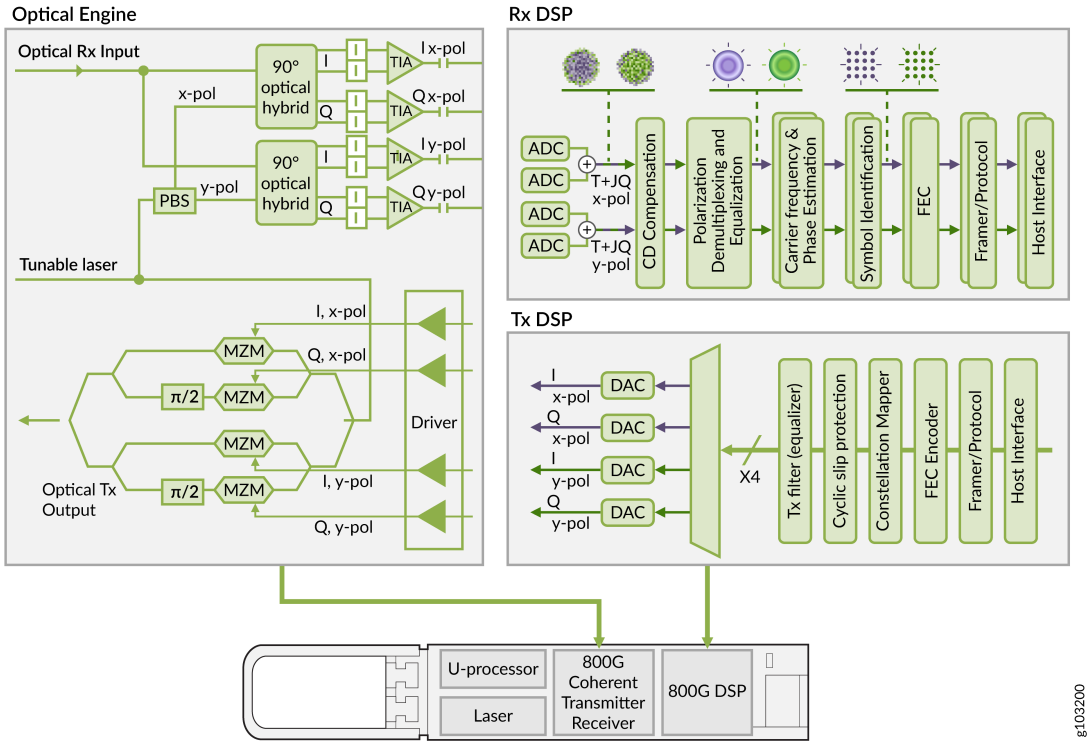


Tunable DWDM Optics

Tunable DWDM optics or coherent optics utilizes advanced modulation formats and DSP to achieve high data transmission rates over long distances with exceptional signal integrity. Tunable DWDM optics employ sophisticated techniques such as phase modulation, amplitude modulation, and polarization multiplexing to encode data onto light waves. The use of coherent detection allows for precise reccoovery of the transmitted signals, even in the presence of significant dispersion and noise. Tunable

DWDM optics support high spectral efficiency, making them ideal for modern high-capacity optical transport networks.

Figure 7: Tunable DWDM Optics Architecture



For more information about the DWDM-based ZR and OpenZR+ optical transceivers from Juniper for 800G transmission, see 800ZR and 800G OpenZR+ Optical Transceivers.

Standards for 800G Transceivers

800G optical components such as transceivers adhere to industry standards set by organizations such as IEEE. It helps to ensure compatibility and interoperability with other networking equipment and technologies used in your network.

Established in 2022, the 800G transceivers and modules adhere to the IEEE 802.3-2022 standards. For more information about the IEEE 802.3-2022 standard, see IEEE Standard for Ethernet.

The IEEE802.3 standard provides specifications for optical modules with varied transmission speeds. Juniper 800G transceivers use the following specification standards:

- 800GBASE-DR8
- 400GBASE-DR4
- 100GBASE-DR
- 400GBASE-FR4
- 400GBASE-LR4
- 800GBASE-VR8
- 400GBASE-VR4
- 200GBASE-VR2
- 100GBASE-FR1
- 100GBASE-LR1
- 100GBASE-VR1

2

CHAPTER

800G Optical Transceivers Specifications

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Form Factors

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- Quad Small Form Factor Pluggable Double Density (QSFP-DD800) | 21
- Comparison between OSFP and QSFP-DD Form Factors | 22

Form factor refers to the physical dimensions and shape of a transceiver. Form factor includes aspects like the size, shape, connector type, and other physical characteristics. It determines how the transceiver fits into networking equipment like switches, routers, or servers.

Juniper supports the following form factors for 800G transceivers:

- OSFP800
- QSFP-DD800

Octal Small Form Factor Pluggable (OSFP800)

OSFP is designed for high-speed applications, including Juniper's 800G transceivers. It focuses on efficiently managing heat dissipation. It is compatible with some of the other form factors such as OSFP400. Based on the design, an OSFP transceiver module can be of two types:

- OSFP transceiver module with integrated heat sink (OSFP or OSFP-IHS)—The standard configuration for an OSFP transceiver.
- OSFP transceiver module with riding heat sink (OSFP-RHS)—The OSFP-RHS is a 9.5 mm tall pluggable module that is used in place of the standard integrated heat sink.

OSFP and OSFP-RHS are two different form factors. You cannot have a common host for these optical transceivers. The following are the features of OSFP-RHS:

- 3.2 T capacity using 400G lanes
- Optimization for cold-plate, liquid-cooled system
- Input voltage of 12 V (optimized for the anticipated power consumption)

Table 1: Feature Comparison of OSFP and OSFP-RHS

Transceiver Feature	OSFP or OSFP-IHS	OSFP-RHS (in Comparison to OSFP)
Transceiver module (height)	13 mm height for OSFP within the cage	9.5 mm height without heat sink
Connector	Identical with surface mount connector	Identical with surface mount connector
Host PCB board layout	Identical with surface mount type	Identical with surface mount type
Cage	Port height/positive stop/bezel cutout is different from OSFP-RHS	The OSFP-RHS cannot be installed in an OSFP cage, as it is mechanically distinct and incompatible with the standard OSFP design.
Insertion, extraction, and retention	Identical	Identical
Durability	Identical	Identical
Thermal requirement	• Standard: 0 through 70° C • High power modules: 75° C to 80° C	• Standard: 0 through 70° C • High power modules: 75° C to 80° C
Power requirement	• Gray optics: 16 W to 18 W • ZR/ZR+ Optics: Up to 30 W	• Gray optics: 16 W to 18 W • ZR/ZR+ Optics: Up to 30 W
Electrical and management interface	Identical	Identical

NOTE: If the feature is not explicitly specified for OSFP-RHS, the same specifications of OSFP are applicable.

Quad Small Form Factor Pluggable Double Density (QSFP-DD800)

QSFP-DD is smaller in size than the OSFP form factor. Hence, it can accommodate more ports per unit area. That is, a QSFP-DD form factor is ideal for networks that require high-density port layouts. QSFP-DD is compatible with QSFP56, QSFP28, and QSFP+ modules.

The following are the performance requirements of a QSFP-DD transceiver module:

Table 2: Performance Requirements of a QSFP-DD Transceiver Module

Performance Parameters	Description	Requirements
Mechanical or physical tests		
Plating type	Plating type on connector contacts	Precious
Surface treatment	Surface treatment on connector contacts	Manufacturer to specify
Wipe length	Designed distance a contact traverses over a mating contact surface during mating and resting at a final position. If less than 0.127 mm, test group 6 is required	Manufacturer to specify
Rated durability cycles	The number of durability cycles a component encounters over the course of its life	Connector cage: 100 cycles Module: 50 cycles
Mating force[1]	Amount of force needed to mate a module with a connector when latches are deactivated	QSFP module: 60 N QSFP-DD module: 90 N
Unmating force[1]	Amount of force needed to separate a module from a connector when latches are deactivated	QSFP module: 30 N QSFP-DD module: 50 N
Latch retention[1]	Amount of force the latching mechanism can withstand without unmating	QSFP module: 90 N QSFP-DD module: 90 N

Table 2: Performance Requirements of a QSFP-DD Transceiver Module *(Continued)*

Performance Parameters	Description	Requirements
Cage latch strength[1]	The amount of force that the cage latches can hold without being damaged	125 N
Cage retention to host board[1]	Amount of force a cage can withstand without separating from the host board	114 N
Environmental requirements		
Field life	The expected service life for a component	10 years
Field temperature[2]	The expected service temperature for a component	65°C
Electrical requirements		
Current	Maximum current to which a contact is exposed in use	0.5 A per signal contact MAX 1.5 A per power contact MAX 2.0 A (Single port QSFP-DD 1600) per contact MAX
Operating rating voltage	Maximum voltage to which a contact is exposed in use	30 V DC per contact MAX

1—These performance criteria are not validated by EIA-364-1000 testing.

2—Field temperature is the ambient air temperature around the component.

Comparison between OSFP and QSFP-DD Form Factors

Both OSFP800 and QSFP-DD800 are designed to support a data transmission speed of 800 Gbps. However, QSFP-DD800 and OSFP800 are different form factors and aren't physically compatible. That

is, you cannot plug a QSFP-DD800 transceiver module into an OSFP800 slot, nor can you plug an OSFP800 into a QSFP-DD800 slot.

Table 3: Comparison of OSFP and QSFP-DD Form Factors

Feature	OSFP-IHS	OSFP-RHS	QSFP-DD	Notes
Size	Large	Large	Small	
Heat sink	Supports an integrated heat sink limited by size constraints	Designed for higher heat dissipation. Supports both air and liquid cooled solutions with a riding heat sink.	Standard heat sink limited by size constraints. Supports a riding heat sink	
Connector style	Large connector with 60 connector pins	Large connector with 60 connector pins	Small connector with 38 connector pins	The connectors are designed for high-density connections.
Power consumption	Gray optics: 16 W to 18 W	Gray optics: 16 W to 18 W	Gray optics: 16 to 18 W	These form factors aim for efficient power consumption
	ZR/ZR+ optics: Up to 30 W		ZR/ZR+ optics: Up to 30 W	
Thermal requirements	• Standard: 0 through 70° C • High power modules: 75° C to 80° C	• Standard: 0 through 70° C • High power modules: 75° C to 80° C	• Standard: 0 through 70° C • High power modules: 75° C to 80° C	The transceiver modules with OSFP and QSFP-DD form factors are designed to operate within the case temperature ranges provided.

Table 3: Comparison of OSFP and QSFP-DD Form Factors *(Continued)*

Feature	OSFP-IHS	OSFP-RHS	QSFP-DD	Notes
Backward compatibility	Unique design, no backward compatibility with QDD optics.	Unique design, no backward compatibility with OSFP(IHS) and QDD optics.	Compatible with some of the other QSFP transceiver module ports such as QSFP56, QSFP28, and QSFP +.	Backward compatibility with the existing hardware ensures smooth transition, upgrade, operational flexibility, and cost savings.

The following are some of the key features to compare the OSFP and QSFP-DD form factors:

Color Codes

The OSFP and QSFP-DD transceiver modules adhere to a color code by application of color to its pull-tab or other appropriate method.

Table 4: OSFP Color Codes

Product Type	Color	Pantone Code
OSFP copper cables	Black	Not applicable
OSFP AOC cables	Gray	422U
OSFP 850 nm solutions	Beige	475U
OSFP 1310 nm solutions for up to 500 m	Yellow	107U
OSFP 1310 nm solutions for up to 2 km	Green	354C
OSFP 1310 nm solutions for up to 10 km	Blue	300U

Table 4: OSFP Color Codes *(Continued)*

Product Type	Color	Pantone Code
OSFP 1310 nm solutions for up to 40 km	Red	1797U
OSFP 1550 nm solutions for up to 80 km	White	Not applicable

Table 5: QSFP-DD Color Codes

Product Type	Color	Pantone Code
QSFP-DD copper cables	Black	Not applicable
QSFP-DD AOC Cables	Gray	422U
QSFP-DD 850 nm solutions	Beige	475U
QSFP-DD 1310 nm solutions for up to 500 m	Yellow	107U
QSFP-DD 1310 nm solutions for up to 2 km	Green	354C
QSFP-DD 1310 nm solutions for up to 10 km	Blue	300U
QSFP-DD 1310 nm solutions for up to 30 km	Red	1797U
QSFP-DD 1310 nm solutions for up to 40 km	Tangerine	1575U
QSFP-DD 1550 nm solutions for up to 80 km	White	Not applicable

Insertion, Extraction, and Retention Forces

The following are details about the insertion, extraction, and retention forces acting on an OSFP transceiver module:

Table 6: Insertion, Extraction, and Retention Forces for an OSFP Transceiver Module

Action	Minimum (N)	Maximum (N)	Notes
OSFP transceiver module insertion	Not applicable	40 (55)	Transceiver module to be inserted into connector and cage with latch mechanism engaged (55 N if the cage has riding heat sink)
OSFP transceiver module extraction	Not applicable	30 (45)	Transceiver module to be removed from connector and cage with latching mechanism disengaged (45 N if the cage has riding heat sink)
OSFP transceiver module retention	125	Not applicable	If the module has a pull tab, the pull tab should be able to withstand up to 90 N of the pulling under maximum operating temperature of the module.

Thermal Requirements

The OSFP transceiver module is required to meet the following thermal requirements while sustaining maximum power:

Table 7: OSFP Transceiver Module Thermal Requirements

Parameter	Value
Life expectancy	10 years
Maximum temperature rise (when all signal and power contacts are simultaneously energized)	Vendor specific

The QSFP-DD transceiver module is required to meet the following thermal requirements while sustaining maximum power:

Table 8: QSFP-DD Transceiver Module Thermal Requirements

Parameter	Value
Maximum temperature rise (when all signal and power contacts are simultaneously energized)	Vendor specific

Electrical Interfaces

The electrical interface of an OSFP transceiver module consists of a 60 contacts edge connector:

- 16 contacts for 8 differential pairs of high-speed transmission signals
- 16 contacts for 8 differential pairs of high-speed receive signals
- 4 contacts for low-speed control signals
- 4 contacts for power
- 20 contacts for ground

LED Indicators

An OSFP transceiver module has the following LEDs as status indicators:

Table 9: LED Signaling for an OSFP Transceiver Module

LED Status	Indication
On for 0.22 seconds (Channel 1)	Green—Indicates channel 1 is operational. Yellow—Indicates channel 1 is non-operational or disabled.
Off for 0.22 seconds (Channel 1)	Pause until LED indicates status of next channel.
On for 0.22 seconds (Channel 2)	Green—Indicates channel 2 is operational. Yellow—Indicates channel 2 is non-operational or disabled.
Off for 0.22 seconds (Channel 2)	Pause until LED indicates status of next channel.
...	The ellipsis pattern repeats to the final (nth) port.
Off for 1.76 seconds	Long pause for clear separation before pattern repeats from the beginning.

Power Requirements

Transceiver modules have varying power consumption levels and thermal output. It depends on the overall platforms design, airflow, size, height, and quality of the heat sinks on top of the ports.

- OSFP and OSFP-RHS—The 800G gray optics clients that use the OSFP and OSFP-RHS form factor consume 16 W to 18 W approximately. The power consumption for the ZR/ZR+ optics clients is up to 30 W.
- QSFP-DD—The 800G gray optics clients that use the QSFP-DD form factor consume 16 W to 18 W approximately.

Juniper 800G Transceivers

IN THIS SECTION

- Platform Support for 800G Transceivers | 29

Juniper's 800G transceivers cater to data center and AI-ML cluster applications for routing and switching solutions. To support the multi-vendor network environment, Juniper 800G transceivers adhere to key industry standards.

Juniper's 800G transceivers use the OSFP800 and QSFP-DD800 form factors (referred as OSFP and QSFP-DD respectively). For a list of all 800G optics and their supported platforms, see Hardware Compatibility Tool.

Platform Support for 800G Transceivers

For information about the Juniper platforms that 800G transceivers support, see the Supported Platforms tab for 800G transceivers in Hardware Compatibility Tool.

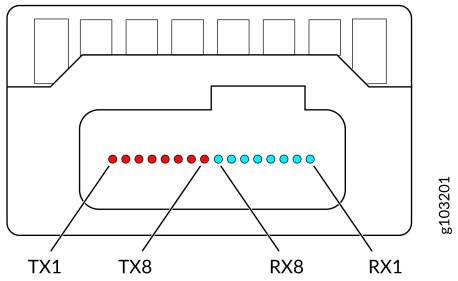
Connector Types

Optical connectors ensure efficient and reliable connections between fiber optic cables. Connectors are designed to minimize insertion loss and back reflection, ensuring high-quality signal transmission.

800G transceivers support the following connector types:

- MPO-16/APC—A multi-fiber push-on 16 (MPO-16) connector has 16 optical fibers in a single connector. With angled physical contact (APC), the connector minimizes back reflection and ensure better signal integrity. MPO connectors offer high-density connections and support multiple fibers in a single connector. MPO connectors are often used in data centers.

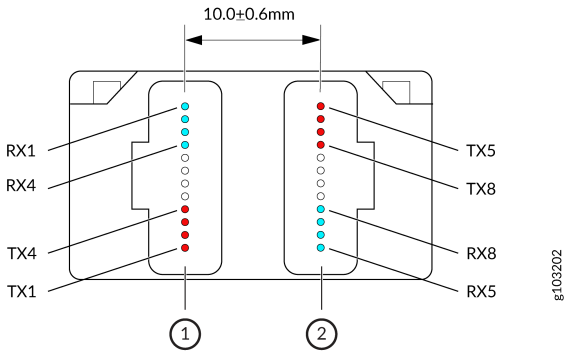
Figure 8: MPO-16 Connector



The connector has 16 fiber channels arranged in a single row. Tx (transmit) is handled by eight channels (denoted in red). The Tx channels are denoted as Tx1, Tx2, Tx3, Tx4, Tx5, Tx6, Tx7, and Tx8 from left to right. Rx (receive) is handled by the other eight channels (denoted in blue). The Rx channels are denoted as Rx1, Rx2, Rx3, Rx4, Rx5, Rx6, Rx7, and Rx8 from right to left.

- Dual MPO-12/APC—It has two separate MPO-12 connectors, each having 12 optical fibers. That is, a Dual MPO-12/APC connector can connect 24 optical fibers at once. Like, an MPO-16, the Dual MPO-12 also provides an angled physical contact.

Figure 9: Dual MPO-12 Connector



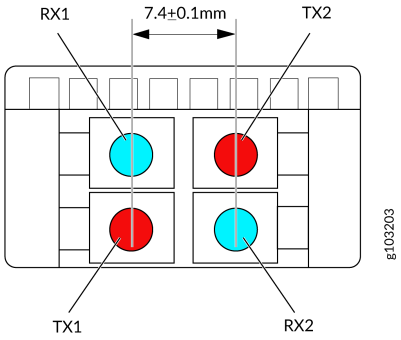
1– Connector 1	2– Connector 2

Tx channels are denoted in red. Rx channels are denoted in blue.

- Dual Duplex LC/UPC—It is a type of lucent connector or local connector (LC). LCs have a small form factor. With a dual duplex construction, the dual duplex LC/UPC connector includes two LC connectors in a single housing. Each of these connectors contain two fibers in each LC connector, one for transmission and the other for reception. With ultra physical contact (UPC), the connector

has a zero-degree angle or flat surface. Though this reduces the amount of back reflection, it is not as efficient as an APC.

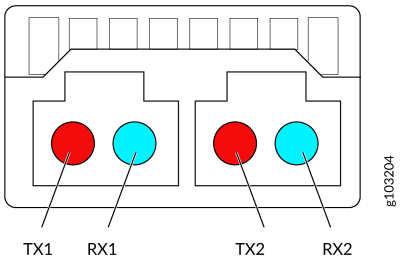
Figure 10: Dual Duplex LC Connector



Tx channels are denoted in red. Rx channels are denoted in blue.

- Dual CS/UPC— It is a type of compact small (CS) connector. CS connectors are small form factor connectors, specifically designed to cater to high-density network environments where space is a premium concern. With a dual construction, the Dual CS/UPC connector includes two CS connectors in a single housing. Each of these connectors houses two fibers, one for transmission and the other for reception. With Ultra Physical Contact (UPC), the connector has a zero-degree angle or flat surface. This design minimizes the amount of back reflection, though it is not as effective in reducing reflection as an angled physical contact (APC) connector.

Figure 11: Dual CS Connector



Tx channels are denoted in red. Rx channels are denoted in blue.

Cable Types and Length

IN THIS SECTION

- Direct Attach Copper Cables (DAC) | 32
- Active Optical Cable (AOC) | 33
- Architecture of AOC and DAC Cables | 35
- Cable Length or Range | 36

Cables are the physical medium that transmit optical and electrical signals. Juniper offers a broad variety of high-performance and cost-effective cables. These optical and electrical cables are available in various dimensions, distance ranges, and speeds. Cables offer a wide selection of breakout configurations that enable you to operate at lower transmission speeds. It helps to effectively interconnect devices and increase port density. For more information, see Optical and Electrical Cables.

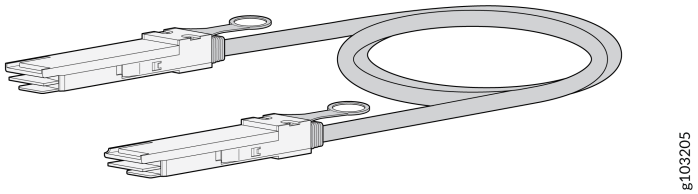
The two broad types of cables are:

- Direct attach copper cables (DAC)
- Active optical cables (AOC)

Direct Attach Copper Cables (DAC)

Made of Twinax copper, the primary type of DAC cable is known as Twinax Cable. It is ideal for ultra short-range connections. DAC supports high-speed connections between servers, switches, and storage devices. DAC cables are lower cost. It is more durable than optical fibers. Also, it is less susceptible to dust and environmental disturbances.

Figure 12: 800G DAC Cable



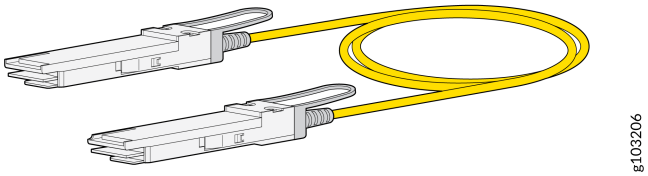
DAC cables can be of two types:

- Passive DAC cables—Passive DAC cables transmit signals without the use of electrical components to boost or regenerate the signal. The network equipment's host handles signal amplification and conditioning. Typically, passive DAC cables are limited to a maximum length of seven meters, as their performance diminishes over longer distances.
- Active DAC cables—Active DAC cables, in contrast, include an additional driving chip that conditions the signal, enhancing transmission quality over longer distances. These cables share the same setup as passive DAC cables but provide signal boosting through built-in electronics. Active DAC cables can typically extend up to 10 meters or more, offering a longer reach in compare with passive DAC cables. By offering both passive and active options, DAC cables provide flexible solutions for various network environments, balancing signal integrity with distance requirements.

Active Optical Cable (AOC)

AOC consists of duplex optical fibers with connectors on both ends. AOC utilizes fiber optic transceivers within the connectors, making it more complex and costly in comparison with DAC cables. Unlike passive cables, AOC requires external power to convert optical signals to electrical signals, and also to convert electrical signals back to optical signals. The use of fiber optics in AOC allows for extended reach, supporting longer distances. It makes AOC an ideal choice for high-performance networking where longer cable runs are necessary.

Figure 13: 800G AOC Cable



AOC is lightweight in design in comparison with DAC cables. AOCs are immune to electromagnetic interference. It has higher throughput at longer distances in comparison with DACs. With AOCs, you can select your cabling solution considering a variety of form factors, breakout cables and speed options.

AOC cables can be of two types:

- Single-Mode fiber (SMF)—It has a core diameter of 9 microns and supports higher data rates and longer distances with minimal dispersion. The applications include long-distance communication and high-bandwidth transmission.
- Multimode fiber (MMF)—It has a core diameter of 50 or 62.5 microns. It is easier to install and align but has higher attenuation and dispersion than SMF, making it suitable for shorter distances. The applications include short to medium-distance communication, typically within buildings or campuses.

The AOC cables used along with 800G transceivers include:

Table 10: AOC Cables

OSFP	QDD
OSFP-800G-AOC-1M	QDD-800G-AOC-1M
OSFP-800G-AOC-3M	QDD-800G-AOC-3M
OSFP-800G-AOC-5M	QDD-800G-AOC-5M
OSFP-800G-AOC-7M	QDD-800G-AOC-7M
OSFP-800G-AOC-10M	QDD-800G-AOC-10M

Table 10: AOC Cables *(Continued)*

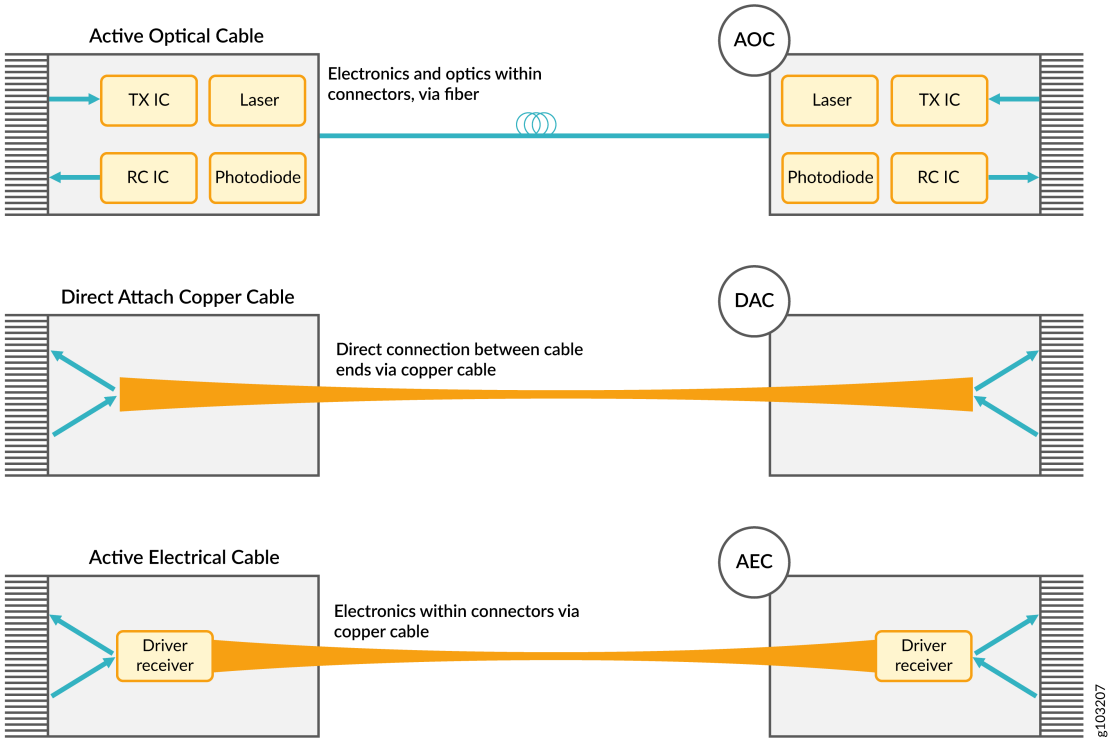
OSFP	QDD
OSFP-800G-AOC-15M	QDD-800G-AOC-15M
OSFP-800G-AOC-20M	QDD-800G-AOC-20M
OSFP-800G-AOC-30M	QDD-800G-AOC-30M

Architecture of AOC and DAC Cables

AOC and DAC each use distinct architectures, resulting in different operational characteristics. DAC cables, both active and passive, use copper wires to transmit electrical signals. Passive DAC cables directly transmit signals without any conditioning. Active DAC cables incorporate a driving chip within the transceivers to enhance and condition the signals.

In contrast, AOC cables transform electrical signals into optical signals using fiber optics, requiring external power for this conversion. The optical signals are then converted back to electrical signals at the receiving end. This architecture enables AOC cables to maintain high signal integrity over longer distances.

Figure 14: Architecture of AOC and DAC Cables



Cable Length or Range

Juniper 800G transceivers support varying cable lengths to meet specific needs. For more information about the specific distance range of individual transceivers, see Hardware Compatibility Tool.

Breakout Capability

IN THIS SECTION

- Serializer/Deserializer (SerDes) | 37
- Breakout Cables | 38

Breakout capability or port channelization is the ability to split a high-capacity optical link into multiple lower-capacity links. To achieve the split, use breakout cables with suitable connectors. The breakout cables split the single high-speed ports into multiple lower-speed connections. For more information, see Port Speed Channelization.

You can configure channelization speeds at the level of an individual port, a block of ports, or a quad of ports. A block of ports is a group of ports that share hardware resources within a Juniper switch or router. Hence, the configuration of breakout mostly impacts the entire set of ports in the block. For a block of port that supports breakout capability, you use the SerDes (Serializer and Deserializer) technology. See "Serializer/Deserializer (SerDes)" on page 37.

You can configure port speeds at the chassis level or the interface level. The chassis-level configuration can be as follows:

- Channelize individual port—Configure an individual port to operate at a specific channel speed. Specify a port number and channel speed.
- Channelize block of ports—Channelize a block of ports. Specify a port range and channel speed.
- Configure speed per quad—Configure port speeds only per quad (group of 4 ports) and not individually. Specify the speed for the first port of the quad ports. All ports operate at a single speed within the quad.

For information about interface-level configuration, see Configure Speed at Interfaces Level.

Breakout capability is crucial for optimizing the use of available bandwidth and physical infrastructure in various networking scenarios. For an 800G transceiver, breakout capability allows a single high-speed 800 Gbps port to be split into multiple lower-speed ports. Juniper supports the following breakout speed or mode options for its 800 Gbps ports:

- 8x100G
- 2x400G
- 1x800G

Breakout capability enables a network architect to configure a single port to support standardized 100 Gbps, 400 Gbps, or 800 Gbps data, depending on the network requirement. For more information about the breakout configuration that you can use in your Juniper device, use Port Checker.

Serializer/Deserializer (SerDes)

A SerDes consists of an integrated circuit (IC or chip) transceiver. An IC can hold multiple SerDes. Each SerDes within an IC can have multiple lanes. Each of these lanes in a SerDes can handle input and output traffic. The two functional units or blocks within a SerDes are:

- Parallel in serial out (PISO) or the Serializer—Converts parallel data into serial data. The transmitter section of the transceiver functions as a parallel-to-serial converter that converts parallel data to serial data.
- Serial in parallel out (SIPO) or the Deserializer—Converts serial data into parallel data. The receiver section of the transceiver serves as a serial-to-parallel converter that converts the serial data back to parallel data.

SerDes devices support multiple operational modes between two points:

- Full-duplex operations—Allows data conversion to occur in both directions simultaneously.
- Simplex operations—Allows data conversion to occur only in one direction.
- Half-duplex—Allows data conversion to occur in both directions, but not simultaneously.

SerDes reduces the number of data paths and connecting pins or wires needed to transmit data. It counters the common issues associated with parallel power transmission such as increased power consumption, electromagnetic interference, and clock timing errors. Using SerDes, you can efficiently transmit the data signals from a port through its multiple breakout channels into the optic network and vice versa.

Breakout Cables

Breakout cables have a single transceiver at an end and multiple transceivers at the other end. You can use the breakout cables to channelize a port and increase the number of interfaces. To channelize the network ports on your Juniper device, connect the breakout cables and configure the recommended CLI commands. For more information, see Port Settings.

The inclusion of APC connectors help to minimize reflection loss and ensure high precision. To connect two transceivers of the same type, you can use the a variety of cables with the suitable connector. Breakout cables are use-specific. Depending on port channelization and the type of connectors, some of the breakout cables are:

- 12-Fiber Ribbon Patch Cables with MPO-12/APC Connectors.
- 12-Fiber Ribbon Breakout Cables with MPO-12/APC-to-LC Duplex Connectors.
- 12-Ribbon Patch and Breakout Cables Available from Juniper Networks—See Table 11 on page 39.
- Patch cables with LC duplex connectors.

Table 11: 12-Ribbon Patch and Breakout Cables

Juniper Model Number	Cable Type	Connector Type	Fiber Type	Cable Length
MTP-4LC-S10M	12-ribbon breakout cable	MTP to 4xLC pairs	SMF	10 m
MTP-4LC-S1M	12-ribbon breakout cable	MTP to 4xLC pairs	SMF	1 m
MTP-4LC-S3M	12-ribbon breakout cable	MTP to 4xLC pairs	SMF	3 m
MTP-4LC-S5M	12-ribbon breakout cable	MTP to 4xLC pairs	SMF	5 m
MTP12-FF-S10M	12-ribbon patch cable	MTP 12 fiber	SMF	10 m
MTP12-FF-S1M	12-ribbon patch cable	MTP 12 fiber	SMF	1 m
MTP12-FF-S3M	12-ribbon patch cable	MTP 12 fiber	SMF	3 m
MTP12-FF-S5M	12-ribbon patch cable	MTP 12 fiber	SMF	5 m

NOTE: The terms MPO and multifiber termination push-on (MTP) describe the same connector type.

3

CHAPTER

Install or Remove 800G Optical Transceivers and Fiber-Optic Cables

SUMMARY

Use the information in this topic to install and remove OSFP800 or QSFP-DD800 optical transceivers and fiber-optic cables.

IN THIS CHAPTER

- Install an OSFP or QSFP-DD Transceiver | **41**
- Remove an OSFP or QSFP-DD Transceiver | **43**
- Connect a Fiber-Optic Cable | **46**
- Disconnect a Fiber-Optic Cable | **46**
- How to Handle Fiber-Optic Cables | **47**
- Install an OSFP or QSFP-DD Transceiver | **48**
- Remove an OSFP or QSFP-DD Transceiver | **50**
- Maintain Fiber-Optic Cables | **53**

Juniper Networks transceivers are hot-removable and hot-insertable field-replaceable units (FRUs). You can remove and replace them without powering off your device or disrupting device functions.

To understand how to install or remove a transceiver and fiber-optic cables of your device, read the following sections.

Install an OSFP or QSFP-DD Transceiver

SUMMARY

Use the information in this topic to install OSFP or QSFP-DD optical transceivers and fiber-optic cables. Juniper Networks transceivers are hot-removable and hot-insertable field-replaceable units (FRUs). You can remove and replace them without powering off your device or disrupting device functions. To understand how to install or remove a transceiver and fiber-optic cables of your device, read the following sections.

Before you install a transceiver in a device, ensure that you have taken the necessary precautions for safe handling of lasers (see Laser and LED Safety Guidelines and Warnings).

NOTE: We recommend that you use only optical transceivers and optical connectors purchased from Juniper Networks with your Juniper Networks device.

CAUTION: The Juniper Networks Technical Assistance Center (JTAC) provides complete support for Juniper-supplied optical modules and cables. However, JTAC does not provide support for third-party optical modules and cables that are not qualified or supplied by Juniper Networks. If you face a problem running a Juniper device that uses third-party optical modules or cables, JTAC may help you diagnose host-related issues if the observed issue is not, in the opinion of JTAC, related to the use of the third-party optical modules or cables. Your JTAC engineer will likely request that you check the third-party optical module or cable and, if required, replace it with an equivalent Juniper-qualified component.

Use of third-party optical modules with high-power consumption (for example, coherent ZR or ZR+) can potentially cause thermal damage to or reduce the lifespan of the host equipment. Any damage to the host equipment due to the use of third-party optical

modules or cables is the users' responsibility. Juniper Networks will accept no liability for any damage caused due to such use.

To install an OSFP or QSFP-DD transceiver:

1. Wrap and fasten one end of the ESD wrist strap around your bare wrist, and connect the other end of the strap to a site ESD point or to the ESD point on the device.
2. Remove the transceiver from its bag.

   CAUTION: To avoid electrostatic discharge (ESD) damage to the transceiver, do not touch the connector pins at the end of the transceiver.

3. Check to see whether the transceiver is covered by a rubber safety cap. If it is not, cover the transceiver with a rubber safety cap.

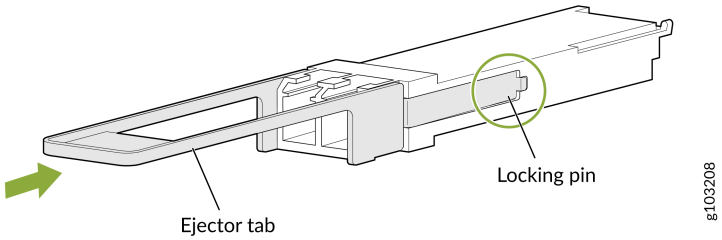
   LASER WARNING: Do not leave a fiber-optic transceiver uncovered except when inserting or removing a cable. The rubber safety cap keeps the port clean and prevents accidental exposure to laser light.

4. If the port in which you want to install the transceiver is covered with a dust cover, remove the dust cover and save it in case you need to cover the port later. If you are hot-swapping a transceiver, wait for at least 10 seconds after removing the transceiver from the port before installing a new transceiver.

   NOTE: Make sure to use a dust cap to cover ports that are unused.

5. Orient the transceiver over the port so that the transceiver connector faces the appropriate direction.
6. Slide the transceiver into the slot until the locking pins lock in place. If there is resistance, remove the transceiver and flip it so that the connector faces the other direction.

Figure 15: Install an OSFP or QSFP-DD Transceiver



7. Remove the rubber safety cap from the transceiver when you are ready to connect the cable to the transceiver.

LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

NOTE: After you insert a transceiver or after you change the media-type configuration, wait for 6 seconds for the interface to display operational commands.

Remove an OSFP or QSFP-DD Transceiver

SUMMARY

Use the information in this topic to remove OSFP or QSFP-DD optical transceivers and fiber-optic cables. Juniper Networks transceivers are hot-removable and hot-insertable field-replaceable units (FRUs). You can remove and replace them without powering off your device or disrupting device functions. To understand how to install or remove a transceiver and fiber-optic cables of your device, read the following sections.

Before you remove a transceiver from a device, take the necessary precautions for safe handling of lasers (see Laser and LED Safety Guidelines and Warnings).

CAUTION: The Juniper Networks Technical Assistance Center (JTAC) provides complete support for Juniper-supplied optical modules and cables. However, JTAC does not provide support for third-party optical modules and cables that are not qualified or supplied by Juniper Networks. If you face a problem running a Juniper device that uses third-party optical modules or cables, JTAC may help you diagnose host-related issues if the observed issue is not, in the opinion of JTAC, related to the use of the third-party optical modules or cables. Your JTAC engineer will likely request that you check the third-party optical module or cable and, if required, replace it with an equivalent Juniper-qualified component.

Use of third-party optical modules with high-power consumption (for example, coherent ZR or ZR+) can potentially cause thermal damage to or reduce the lifespan of the host equipment. Any damage to the host equipment due to the use of third-party optical modules or cables is the users' responsibility. Juniper Networks will accept no liability for any damage caused due to such use.

Ensure that you have the following parts and tools available:

- An antistatic bag or an antistatic mat
- Rubber safety caps to cover the transceiver and fiber-optic cable connector
- A dust cover to cover the port or a replacement transceiver

To remove an OSFP or QSFP-DD transceiver:

1. Place the antistatic bag or antistatic mat on a flat, stable surface.
2. Wrap and fasten one end of the ESD wrist strap around your bare wrist, and connect the other end of the strap to a site ESD point or to the ESD point on the device.
3. Label the cable connected to the transceiver so that you can reconnect it correctly.
4. Remove the cable connected to the transceiver (see Disconnect a Fiber-Optic Cable). Cover the transceiver and the end of each fiber-optic cable connector with a rubber safety cap immediately after disconnecting the fiber-optic cables.

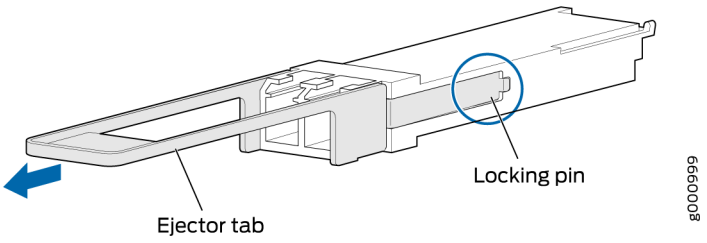
LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

LASER WARNING: Do not leave a fiber-optic transceiver uncovered except when inserting or removing a cable. The rubber safety cap keeps the port clean and protects your eyes from accidental exposure to laser light.

CAUTION: Do not bend fiber-optic cables beyond their minimum bend radius. An arc smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.

5. If there is a cable management system, arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it does not support its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
6. Pull the transceiver's ejector tab straight back. The locking pins on the transceiver release automatically.
7. Gently slide the transceiver straight out of the port and place the transceiver on the antistatic mat or in the electrostatic bag.

Figure 16: Remove an OSFP or QSFP-DD Transceiver



CAUTION: To avoid ESD damage to the transceiver, do not touch the connector pins at the end of the transceiver.

NOTE: After you remove a transceiver or after you change the media-type configuration, wait for 6 seconds for the interface to display operational commands.

8. Insert a dust cover in the empty port.

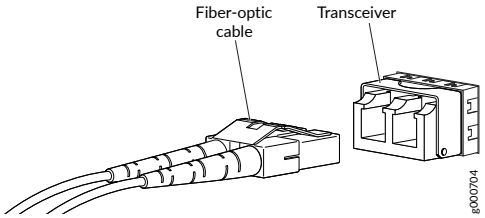
Connect a Fiber-Optic Cable

Before you connect a fiber-optic cable to an optical transceiver installed in a device, take the necessary precautions for safe handling of lasers (see Laser and LED Safety Guidelines and Warnings).

To connect a fiber-optic cable to an optical transceiver installed in a device:

LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

1. If the fiber-optic cable connector is covered with a rubber safety cap, remove the cap. Save the cap.
2. Remove the rubber safety cap from the optical transceiver. Save the cap.
3. Insert the cable connector into the optical transceiver.



4. Secure the cables so that they do not support their own weight. Place excess cable out of the way in a neatly coiled loop. Placing fasteners on a loop helps cables maintain their shape.

CAUTION: Do not bend fiber-optic cables beyond their minimum bend radius. An arc smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.

Do not let fiber-optic cables hang free from the connector. Do not allow fastened loops of cables to dangle, which stresses the cables at the fastening point.

Disconnect a Fiber-Optic Cable

Before you disconnect a fiber-optic cable from an optical transceiver, ensure that you have taken the necessary precautions for safe handling of lasers. See Laser and LED Safety Guidelines and Warnings.

Ensure that you have the following parts and tools available:

- A rubber safety cap to cover the transceiver
- A rubber safety cap to cover the fiber-optic cable connector

Juniper Networks devices have optical transceivers to which you can connect fiber-optic cables.

To disconnect a fiber-optic cable from an optical transceiver installed in the device:

1. Disable the port in which the transceiver is installed by issuing the following command:

```
[edit interfaces]
user@device# set interface-name disable
```

LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

2. Carefully unplug the fiber-optic cable connector from the transceiver.
3. Cover the transceiver with a rubber safety cap.

LASER WARNING: Do not leave a fiber-optic transceiver uncovered except when inserting or removing a cable. The rubber safety cap keeps the port clean and protects your eyes from accidental exposure to laser light.

4. Cover the fiber-optic cable connector with the rubber safety cap.

How to Handle Fiber-Optic Cables

Fiber-optic cables connect to optical transceivers that are installed in Juniper Networks devices.

Follow these guidelines when handling fiber-optic cables:

- When you unplug a fiber-optic cable from a transceiver, place rubber safety caps over the transceiver and on the end of the cable.
- Anchor fiber-optic cables to prevent stress on the connectors. When attaching a fiber-optic cable to a transceiver, be sure to secure the fiber-optic cable so that it does not support its own weight as it hangs to the floor. Never let a fiber-optic cable hang free from the connector.

- Avoid bending the fiber-optic cables beyond their minimum bend radius. Bending fiber-optic cables into arcs smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.
- Frequent plugging and unplugging of fiber-optic cables in and out of optical instruments can damage the instruments, which are expensive to repair. To prevent damage from overuse, attach a short fiber extension to the optical equipment. The short fiber extension absorbs wear and tear due to frequent plugging and unplugging. Replacing the short fiber extension is easier and cost efficient compared with replacing the instruments.
- Keep fiber-optic cable connections clean. Microdeposits of oil and dust in the canal of the transceiver or cable connector can cause loss of light, reduction in signal power, and possibly intermittent problems with the optical connection.
  - To clean the transceiver canal, use an appropriate fiber-cleaning device such as RIFOCS Fiber Optic Adaptor Cleaning Wands (part number 946). Follow the instructions in the cleaning kit you use.
  - After cleaning the transceiver, make sure that the connector tip of the fiber-optic cable is clean. Use only an approved alcohol-free fiber-optic cable cleaning kit such as the Opptex Cletop-S® Fiber Cleaner. Follow the instructions in the cleaning kit you use.

Install an OSFP or QSFP-DD Transceiver

SUMMARY

Use the information in this topic to install OSFP or QSFP-DD optical transceivers and fiber-optic cables. Juniper Networks transceivers are hot-removable and hot-insertable field-replaceable units (FRUs). You can remove and replace them without powering off your device or disrupting device functions. To understand how to install or remove a transceiver and fiber-optic cables of your device, read the following sections.

Before you install a transceiver in a device, ensure that you have taken the necessary precautions for safe handling of lasers (see Laser and LED Safety Guidelines and Warnings).

NOTE: We recommend that you use only optical transceivers and optical connectors purchased from Juniper Networks with your Juniper Networks device.

CAUTION: The Juniper Networks Technical Assistance Center (JTAC) provides complete support for Juniper-supplied optical modules and cables. However, JTAC does not provide support for third-party optical modules and cables that are not qualified or supplied by Juniper Networks. If you face a problem running a Juniper device that uses third-party optical modules or cables, JTAC may help you diagnose host-related issues if the observed issue is not, in the opinion of JTAC, related to the use of the third-party optical modules or cables. Your JTAC engineer will likely request that you check the third-party optical module or cable and, if required, replace it with an equivalent Juniper-qualified component.

Use of third-party optical modules with high-power consumption (for example, coherent ZR or ZR+) can potentially cause thermal damage to or reduce the lifespan of the host equipment. Any damage to the host equipment due to the use of third-party optical modules or cables is the users' responsibility. Juniper Networks will accept no liability for any damage caused due to such use.

To install an OSFP or QSFP-DD transceiver:

1. Wrap and fasten one end of the ESD wrist strap around your bare wrist, and connect the other end of the strap to a site ESD point or to the ESD point on the device.
2. Remove the transceiver from its bag.

   CAUTION: To avoid electrostatic discharge (ESD) damage to the transceiver, do not touch the connector pins at the end of the transceiver.

3. Check to see whether the transceiver is covered by a rubber safety cap. If it is not, cover the transceiver with a rubber safety cap.

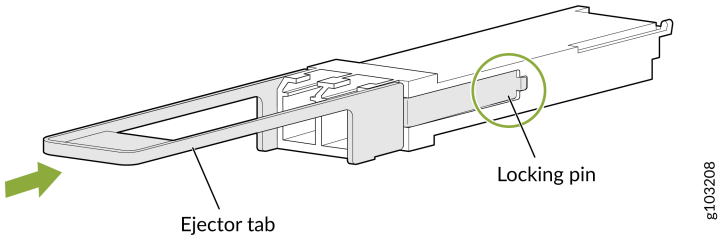
   LASER WARNING: Do not leave a fiber-optic transceiver uncovered except when inserting or removing a cable. The rubber safety cap keeps the port clean and prevents accidental exposure to laser light.

4. If the port in which you want to install the transceiver is covered with a dust cover, remove the dust cover and save it in case you need to cover the port later. If you are hot-swapping a transceiver, wait for at least 10 seconds after removing the transceiver from the port before installing a new transceiver.

   NOTE: Make sure to use a dust cap to cover ports that are unused.

5. Orient the transceiver over the port so that the transceiver connector faces the appropriate direction.
6. Slide the transceiver into the slot until the locking pins lock in place. If there is resistance, remove the transceiver and flip it so that the connector faces the other direction.

Figure 17: Install an OSFP or QSFP-DD Transceiver



7. Remove the rubber safety cap from the transceiver when you are ready to connect the cable to the transceiver.

LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

NOTE: After you insert a transceiver or after you change the media-type configuration, wait for 6 seconds for the interface to display operational commands.

Remove an OSFP or QSFP-DD Transceiver

SUMMARY

Use the information in this topic to remove OSFP or QSFP-DD optical transceivers and fiber-optic cables. Juniper Networks transceivers are hot-removable and hot-insertable field-replaceable units (FRUs). You can remove and replace them without powering off your device or disrupting device functions. To understand how to install or remove a transceiver and fiber-optic cables of your device, read the following sections.

Before you remove a transceiver from a device, take the necessary precautions for safe handling of lasers (see Laser and LED Safety Guidelines and Warnings).

CAUTION: The Juniper Networks Technical Assistance Center (JTAC) provides complete support for Juniper-supplied optical modules and cables. However, JTAC does not provide support for third-party optical modules and cables that are not qualified or supplied by Juniper Networks. If you face a problem running a Juniper device that uses third-party optical modules or cables, JTAC may help you diagnose host-related issues if the observed issue is not, in the opinion of JTAC, related to the use of the third-party optical modules or cables. Your JTAC engineer will likely request that you check the third-party optical module or cable and, if required, replace it with an equivalent Juniper-qualified component.

Use of third-party optical modules with high-power consumption (for example, coherent ZR or ZR+) can potentially cause thermal damage to or reduce the lifespan of the host equipment. Any damage to the host equipment due to the use of third-party optical modules or cables is the users' responsibility. Juniper Networks will accept no liability for any damage caused due to such use.

Ensure that you have the following parts and tools available:

- An antistatic bag or an antistatic mat
- Rubber safety caps to cover the transceiver and fiber-optic cable connector
- A dust cover to cover the port or a replacement transceiver

To remove an OSFP or QSFP-DD transceiver:

1. Place the antistatic bag or antistatic mat on a flat, stable surface.
2. Wrap and fasten one end of the ESD wrist strap around your bare wrist, and connect the other end of the strap to a site ESD point or to the ESD point on the device.
3. Label the cable connected to the transceiver so that you can reconnect it correctly.
4. Remove the cable connected to the transceiver (see Disconnect a Fiber-Optic Cable). Cover the transceiver and the end of each fiber-optic cable connector with a rubber safety cap immediately after disconnecting the fiber-optic cables.

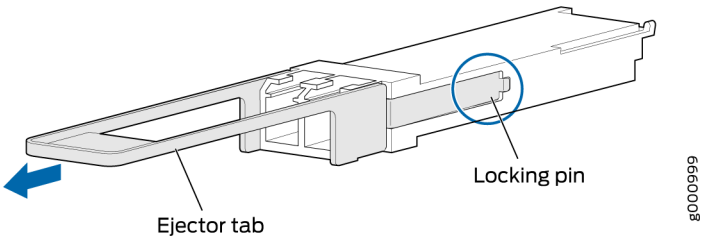
LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

LASER WARNING: Do not leave a fiber-optic transceiver uncovered except when inserting or removing a cable. The rubber safety cap keeps the port clean and protects your eyes from accidental exposure to laser light.

CAUTION: Do not bend fiber-optic cables beyond their minimum bend radius. An arc smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.

5. If there is a cable management system, arrange the cable in the cable management system to prevent it from dislodging or developing stress points. Secure the cable so that it does not support its own weight as it hangs to the floor. Place excess cable out of the way in a neatly coiled loop in the cable management system. Placing fasteners on the loop helps to maintain its shape.
6. Pull the transceiver's ejector tab straight back. The locking pins on the transceiver release automatically.
7. Gently slide the transceiver straight out of the port and place the transceiver on the antistatic mat or in the electrostatic bag.

Figure 18: Remove an OSFP or QSFP-DD Transceiver



CAUTION: To avoid ESD damage to the transceiver, do not touch the connector pins at the end of the transceiver.

NOTE: After you remove a transceiver or after you change the media-type configuration, wait for 6 seconds for the interface to display operational commands.

8. Insert a dust cover in the empty port.

Maintain Fiber-Optic Cables

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- Disconnect a Fiber-Optic Cable | 54
- How to Handle Fiber-Optic Cables | 55

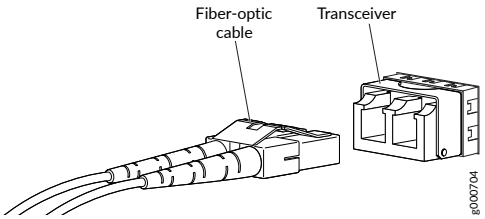
Connect a Fiber-Optic Cable

Before you connect a fiber-optic cable to an optical transceiver installed in a device, take the necessary precautions for safe handling of lasers (see Laser and LED Safety Guidelines and Warnings).

To connect a fiber-optic cable to an optical transceiver installed in a device:

LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

1. If the fiber-optic cable connector is covered with a rubber safety cap, remove the cap. Save the cap.
2. Remove the rubber safety cap from the optical transceiver. Save the cap.
3. Insert the cable connector into the optical transceiver.



4. Secure the cables so that they do not support their own weight. Place excess cable out of the way in a neatly coiled loop. Placing fasteners on a loop helps cables maintain their shape.

CAUTION: Do not bend fiber-optic cables beyond their minimum bend radius. An arc smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.

Do not let fiber-optic cables hang free from the connector. Do not allow fastened loops of cables to dangle, which stresses the cables at the fastening point.

Disconnect a Fiber-Optic Cable

Before you disconnect a fiber-optic cable from an optical transceiver, ensure that you have taken the necessary precautions for safe handling of lasers. See Laser and LED Safety Guidelines and Warnings.

Ensure that you have the following parts and tools available:

- A rubber safety cap to cover the transceiver
- A rubber safety cap to cover the fiber-optic cable connector

Juniper Networks devices have optical transceivers to which you can connect fiber-optic cables.

To disconnect a fiber-optic cable from an optical transceiver installed in the device:

1. Disable the port in which the transceiver is installed by issuing the following command:

```
[edit interfaces]
user@device# set interface-name disable
```

LASER WARNING: Do not look directly into a fiber-optic transceiver or into the ends of fiber-optic cables. Fiber-optic transceivers and fiber-optic cables connected to transceivers emit laser light that can damage your eyes.

2. Carefully unplug the fiber-optic cable connector from the transceiver.
3. Cover the transceiver with a rubber safety cap.

LASER WARNING: Do not leave a fiber-optic transceiver uncovered except when inserting or removing a cable. The rubber safety cap keeps the port clean and protects your eyes from accidental exposure to laser light.

4. Cover the fiber-optic cable connector with the rubber safety cap.

How to Handle Fiber-Optic Cables

Fiber-optic cables connect to optical transceivers that are installed in Juniper Networks devices.

Follow these guidelines when handling fiber-optic cables:

- When you unplug a fiber-optic cable from a transceiver, place rubber safety caps over the transceiver and on the end of the cable.
- Anchor fiber-optic cables to prevent stress on the connectors. When attaching a fiber-optic cable to a transceiver, be sure to secure the fiber-optic cable so that it does not support its own weight as it hangs to the floor. Never let a fiber-optic cable hang free from the connector.
- Avoid bending the fiber-optic cables beyond their minimum bend radius. Bending fiber-optic cables into arcs smaller than a few inches in diameter can damage the cables and cause problems that are difficult to diagnose.
- Frequent plugging and unplugging of fiber-optic cables in and out of optical instruments can damage the instruments, which are expensive to repair. To prevent damage from overuse, attach a short fiber extension to the optical equipment. The short fiber extension absorbs wear and tear due to frequent plugging and unplugging. Replacing the short fiber extension is easier and cost efficient compared with replacing the instruments.
- Keep fiber-optic cable connections clean. Microdeposits of oil and dust in the canal of the transceiver or cable connector can cause loss of light, reduction in signal power, and possibly intermittent problems with the optical connection.
    - To clean the transceiver canal, use an appropriate fiber-cleaning device such as RIFOCS Fiber Optic Adaptor Cleaning Wands (part number 946). Follow the instructions in the cleaning kit you use.
    - After cleaning the transceiver, make sure that the connector tip of the fiber-optic cable is clean. Use only an approved alcohol-free fiber-optic cable cleaning kit such as the Opptex Cletop-S® Fiber Cleaner. Follow the instructions in the cleaning kit you use.

CHAPTER 4

800G Optical Transceivers FAQs

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Frequently Asked Questions

IN THIS SECTION

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Why should I use 800G optics?

- Increased capacity—800G optics offer twice the capacity of 400G optics, allowing for faster data transmission.
- Higher port density—One 800G optic can replace two 400G optics, providing a higher port density and easier aggregation of 400G optics.
- Scalability—800G optics are compatible with upcoming network devices and can support constantly evolving deployment scenarios.

Which 800G optics does Juniper offer?

See Hardware Compatibility Tool for a list of all the 800G optics offered by Juniper, along with their detailed specifications.

Which 800G optics are supported on my device?

See Hardware Compatibility Tool for a list of the supported optics for your device.

Can I use a third-party optic with my device?

We recommend that you use only optical transceivers and optical connectors purchased from Juniper Networks with your Juniper Networks device.

CAUTION: The Juniper Networks Technical Assistance Center (JTAC) provides complete support for Juniper-supplied optical modules and cables. However, JTAC does not provide support for third-party optical modules and cables that are not qualified or supplied by Juniper Networks. If you face a problem running a Juniper device that uses third-party optical modules or cables, JTAC may help you diagnose host-related issues if the observed issue is not, in the opinion of JTAC, related to the use of the third-party optical modules or cables. Your JTAC engineer will likely request that you check the third-party optical module or cable and, if required, replace it with an equivalent Juniper-qualified component.

Use of third-party optical modules with high-power consumption (for example, coherent ZR or ZR+) can potentially cause thermal damage to or reduce the lifespan of the host equipment. Any damage to the host equipment due to the use of third-party optical modules or cables is the users' responsibility. Juniper Networks will accept no liability for any damage caused due to such use.

What are the form factors supported on 800G optics?

Juniper supports OSFP800 and QSFP-DD800 transceivers.

OSFP transceivers are larger than QSFP-DD transceivers, and can handle higher power dissipation.

What are the speeds supported on an 800G optic?

800G optics can support a range of speeds, depending upon their type. They can support:

- A single port of 800 Gbps
- Two ports of 400 Gbps
- Four ports of 200 Gbps
- Eight ports of 100 Gbps

What are the standards followed by 800G optics?

800G transceivers and modules adhere to the IEEE 802.3-2022 standards. See "Standards for 800G Transceivers" on page 16 for a complete list of standards.

What does the name of the optic mean?

Optics follow a naming convention where the product name contains the form factor, data rates, and lane distribution of the optic. See "Juniper Optical Product Numbers" on page 5 for a detailed example.

What is meant by DR, FR, LR, and VR in an optic?

- Datacenter Reach (DR)—Transceivers designed for short range data transmission over single-mode fibers.
- Forward Reach (FR)—Transceivers desgined for medium range data transmission over single-mode fibers.
- Long Reach (LR)—Transceivers designed for long range data transmission over single-mode fibers.
- Very Short Reach (VR)—Transceivers designed for very short range data transmission over multi-mode fibers.

What is the lane distribution on 800G optics?

800G optics use 8 parallel lanes, each of which support 100 Gbps. Multiplexing occurs over multiple fiber pairs, or using a combination of fiber and wavelength multiplexing.

What are the modulation techniques supported on 800G optics?

800G optics use Pulse Amplitude Modulation 4-level (PAM4). PAM4 combines two bits into a single symbol with four amplitude levels, enabling you to transmit twice as much data. It has a high signal-to-noise ratio which requires shorter transmission distances. It requires Forward Error Correction (FEC) to handle the loss of signal integrity. You must configure FEC at both ends of the 800G link.

Juniper 800G optics do not support Non-return to Zero (NRZ) modulation.

What is Clock Data Recovery (CDR)?

Clock Data Recovery is the process of extracting timing information from a data signal. The receiver uses the timing information embeddded in the data signal to determine the frequency of the transmitter's clock. The receiver then uses this information to re-time the signal to ensure accurate data retrieval and transmission. CDR helps to reduce jitter and improve signal integrity and reach.

What are the components of an 800G optic architecture?

800G (x8) optics are composed of the following:

- 800G Host Platform
- 8x100G Electrical Interface
- PAM4 Digital Signal Processor/Clock Data Recovery (DSP/CDR)
- Drivers (8)
- Modulators (8)
- 8x100G Optical Interfaces
- Transimpedance Amplifiers (TIA) (8)
- Photo-Detectors (8)

See "800G (X8) Transceiver Architecture" on page 6 for a detailed explanation of each component.

What are breakout capability and breakout cables?

Breakout capability is the ability to split a high-speed optical link into multiple smaller, lower-speed links. This is also called channelization. Breakout capability is crucial for optimizing the use of available bandwidth and physical infrastructure in various networking scenarios.

You can configure port speeds at the chassis level or the interface level. You can channelize an individual port, a block of ports, or a quad of ports.

Breakout cables have a single transceiver at one end and multiple transceivers at the other end. You can use breakout cables to physically split a single high-speed port to multiple lower-speed ports.

For more details, see "Breakout Capability" on page 36.

How is breakout/channelization supported on my device?

See Port Checker for details on channelization support for your device.

What are single-mode and multi-mode fibers?

Single-mode fibers (SMF) are designed to trasmit only one mode of an optical signal at a time. They have a core diameter of 9 microns. They have low attenuation and can support higher data rates and longer transmission distances.

Multi-mode fibers (MMF) can transmit multiple optical signals at the same time. They have a core diameter between 50 to 62.5 microns. They are easier to handle and manufacture as compared to SMF. They have higher attenuation and are used to transmit data over shorter distances.

What are the different types of cables used in 800G optics?

800G optics use direct attach cables (DAC) and active optical cables (AOC). See "Cable Types and Length" on page 32 for details.

For a list of AOC and DAC cables supported by Juniper, see Hardware Compatibility Tool.

What is the length of cables used for 800G optics?

The cable length supported on 800G optics ranges from 0.5 m to 2000 km. Check the details of your transceiver for the specific distance or range.

What are the different types of connectors used in 800G optics?

800G optical cables use MPO-16/APC, dual MPO-12/APC, dual duplex LC/UPC, and dual CS/UPC connectors. They can also use quad SN or MMC connectors. See "Connector Types" on page 29 for more details.

What is the power requirement for 800G optics?

OSFP and QSFP-DD optics require 16 W to 18 W of power. ZR/ZR+ optics require up to 30 W.

What is the difference between OSFP and OSFP-RHS optics?

OSFP-RHS is an OSFP module with a riding heat sink instead of an integrated heat sink. The are two different form factors and cannot be supported on a common host. See Table 1 on page 20 for more details.

What is the difference between OSFP and QSFP-DD optics?

OSFP and QSFP-DD are different physical form factors that support transmission speeds of 800 Gbps. See "Comparison between OSFP and QSFP-DD Form Factors" on page 22 for a detailed comparison.

Can I plug OSFP modules into QSFP-DD ports or vice versa?

No. OSFP and QSFP-DD refer to optics with different form factors. An OSFP port supports only OSFP optics and a QSFP-DD port supports only QSFP-DD optics.

Can I plug 400G modules into 800G ports?

Yes, if the physical form factors are compatible.

Can I plug 800G modules into 400G ports?

We do not recommend plugging an 800G module into a 400G port. 400G optical ports cannot support the 100G per lane speeds that 800G ports can support.

Can there be an OSFP connector on one end of an 800G link and a QSFP-DD connector on the other?

Yes. OSFP and QSFP-DD connectors can interoperate with each other on the same link, provided the Ethernet media type is the same.

Can I plug a 100G QSFP module into a QSFP-DD port?

Yes. The QSFP-DD ports are compatible with the QSFP56, QSFP28, and QSFP+ ports.

You must configure the QSFP-DD port for a data rate of 100G (or 40G) instead of 400G or 800G.