Configuring 400G Digital Coherent Optics

This chapter describes the 400G Digital Coherent QSFP-DD optical modules and their supported configurations.

400G Digital Coherent Optics Overview

Coherent optics uses phase and amplitude to encode data, unlike PAM4 optics (Pulse amplitude modulation) which only uses amplitude. This allows coherent optics to be more resistant to noise and support long-haul distance transmission.

For more information on Cisco 400G Digital Coherent Optics, see Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules Data Sheet.

There are two variants of 400G Digital Coherent Optics.

- **ZR variant**: 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.
- **ZR Plus variant**: The QSFP-DD OpenZR+ module complies with the OpenZR+ MSA. ZR+ pluggable coherent optics support regional to long-haul transmission of wavelengths with multiple amplification sites between endpoints. ZR+ supports multiple configuration options in terms of modulation scheme, shaping, and baud rates to support different network topologies and allows longest transmission distance (> 120 km).

400G Digital Coherent Optics Parameters

400G Digital Coherent Optics is configurable and allows configuration for the following parameters on the optics. For more information on configuration values, see Table 1: 400G Digital Coherent QSFP-DD Traffic Configuration Values, on page 3:

- **Transponder/Muxponder mode**: This parameter is used to configure a media line at 400G and have maximum 4 clients on a host side.
- **DAC rate**: Digital Analog Conversion (DAC) parameter is used to set oversample (pulse shape enable or disable) and media line modem to Standard (S) or Enhanced (E).
- **FEC mode**: Forward Error Correction (FEC) supports cFEC or oFEC modes on a media line and is used for controlling errors during data transmission.
- **Modulation**: This parameter is used to control an optical wave or to encode information on a carrier optical wave. Supported modulations are 16 QAM, 8 QAM, and QPSK.
- **CD min/max**: Chromatic Dispersion (CD) is a phenomenon that is an important factor in fiber optic communications. It is the result of the different colors, or wavelengths, in a light beam arriving at their destination at slightly different times. This parameter is used to set range for the device to get good optical signal and frequency.

Muxponder-FEC-Modulation	CD default High (ps/nm)	CD default Low (ps/nm)	Max provisionable CD High (ps/nm)	Min. provisionable CD Low (ps/nm)
400G-400GZR-cFEC-16QAM	2400	-2400	2400	-2400
400G-400GZR-oFEC-16QAM	13000	-13000	52000	-52000
200G-200GZR-oFEC-QPSK	50000	-50000	100000	-100000
200G-200GZR-oFEC-8QAM	26000	-26000	100000	-100000
200G-200GZR-oFEC-16QAM	21000	-21000	85000	-85000
100G-100GZR-oFEC-QPSK	80000	-80000	160000	-160000

- **Tx power**: The transmitted optical power refers to the output optical power of the light source at the transmitting end of the optical module, and the received optical power refers to the input optical power of the light source at the receiving end of the optical module.

  Each optical module has its own transmitting (TX) power range. You can change the transmitting (TX) power value based on the module capability.

Optical Module	Trunk Speed[1,3]	Optical Transmit Power (Tx) Shaping	Interval	Supported Range of Optical Transmit Power (Tx) Values (in units of 0.1dBm)[2]		
				Minimum Value	Maximum Typical Value	Maximum Worst CaseValue
QDD-400G-ZR-S	400G	No	1	-150	-100	-100
QDD-400G-ZRP-S	400G	Yes	1	-150	-110	-130
QDD-400G-ZRP-S	200G	Yes	1	-150	-90	-105
QDD-400G-ZRP-S	100G	Yes	1	-150	-59	-75

- **Frequency**: In fiber-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes several Optical Carrier signals onto single optical fiber by using different wavelengths (i.e., colors) of laser light. This technique enables bidirectional communications over a single strand of fiber, also called wavelength-division duplexing, and multiplication of capacity. This parameter is used to set any frequency on ITU C-BAND table. For more information on the values, see ITU C-BAND table section.

  For more information on configuration, see Configuring 400G Digital Coherent Optics on ZR Module, on page 8 section.

The following table contains the possible traffic configuration values for the 400G Digital Coherent QSFP-DD optical modules, in the Transponder (TXP) and Muxponder (MXP) mode:

Table 1: 400G Digital Coherent QSFP-DD Traffic Configuration Values

Client Speed	Trunk Speed	Frequency	FEC	Modulation	DAC Rate
QDD-400G-ZR-S Transponder and Muxponder Configuration Values					
1 client, 400G speed	1 trunk, 400G	C-Band, 196.1 To 191.3 THz	cFEC	16 QAM	1x1
QDD-400G-ZRP-S Transponder and Muxponder Configuration Values					
1X400GA UI-8	1 trunk, 400G speed	C-Band, 196.1 To 191.3 THz	cFEC	16 QAM	1x1
4X100GA UI-2					

Client Speed	Trunk Speed	Frequency	FEC	Modulation	DAC Rate
1X400GA UI-8	1 trunk, 400G speed	C-Band, 196.1 To 191.3 THz	cFEC	16 QAM	1x1.5
4X100GA UI-2					
1X400GA UI-8	1 trunk, 400G speed	C-Band, 196.1 To 191.3 THz	oFEC	16 QAM	1x1.25
4X100GA UI-2					
1X400GA UI-8	1 trunk, 400G speed	C-Band, 196.1 To 191.3 THz	oFEC	16 QAM	1x2
4X100GA UI-2					
1X400GA UI-8	1 trunk, 400G speed	C-Band, 196.1 To 191.3 THz	oFEC	16 QAM	1x1
4X100GA UI-2					
1X400GA UI-8	1 trunk, 400G speed	C-Band, 196.1 To 191.3 THz	oFEC	16 QAM	1x1.5
4X100GA UI-2					
2X100GA UI-2	1 trunk, 200G speed	C-Band, 196.1 To 191.3 THz	oFEC	QPSK	1x1.5
				QPSK	1
100G	1 trunk, 100G speed	C-Band, 196.1 To 191.3 THz	oFEC	QPSK	1x1.5

Traffic Configuration Parameters

The following table displays the different traffic configuration supported:

TXP/MXP	Client	Trunk	Modulation	FEC	DAC Rate
400G-TXP	1 Client, 400G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1,1x1.25, 1x1.5 and 1x2
400G-TXP	1 Client, 400G speed	1 trunk, 400G speed	16 QAM	cFEC	1x1, and 1x1.5

TXP/MXP	Client	Trunk	Modulation	FEC	DAC Rate
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1, 1x1.25, 1x1.5, and 1x2
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	cFEC	1x1, and 1x1.5
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	QPSK	oFEC	1x1, and 1x1.5
			8 QAM		1x1.25
			16 QAM		1x1.25
1x100G-MXP	1 client, 100G speed	1 trunk, 100G speed	QPSK	oFEC	1x1.5

Note

- ZR supports only 1x400G transponder.
- ZR supports only 1x1 DAC rate.
- For configuring 4x100, and 2x100 muxponder, you need to perform interface breakout prior to ZRP configuration. For more information, see Configuring Breakout, on page 11 section.

Guidelines and Limitations for 400G Digital Coherent Optics

The 400G Digital Coherent Optics has the following guidelines and limitations:

- Beginning with Cisco NX-OS Release 10.4(1)F, 400G Digital Coherent Optics (DCO) support is provided on Cisco Nexus 9300-GX2 and 9408 platform switches.
- Beginning with Cisco NX-OS Release 10.4(2)F, QDD-400G-ZR-S and QDD-400G-ZRP-S optics support is provided on the following switches and line cards:
  - Cisco Nexus 93600CD-GX, 9316D-GX switches and Cisco Nexus 9508/9504 switches with X9716D-GX line cards.
  - Cisco Nexus 9804/9808 switches with Cisco Nexus X98900CD-A and X9836DM-A line cards.
- The 1x100G transponder and 2x100G muxponder modes are not supported on Cisco Nexus 93600CD-GX, 9316D-GX switches and Cisco Nexus X98900CD-A and X9836DM-A line cards.
- QDD-400G-ZR-S optics doesn't support interface breakout.
- QDD-400G-ZRP-S optics supports interface breakout. There are multiple breakouts maps supported for ZRP optics.
- Use the breakout map **100g-2x-pam4** option for the 2x100 breakout interface.
- For better system stability and efficiency, it is recommended to avoid frequent insertion and removal of DCO. For OIR, you must wait for at least one minute between back-to-back transceiver insertion and removal.

- The optics maximum link-up time for the ZR/ZRP module can be up to 180 seconds.
- To recover any Coherent optics port or MACsec port affected because of power restrictions, you must disable an active ZR/ZRP port, or unconfigure an existing MACsec session, and flap the affected port.

Note N9K-C9332D-H2R switch does not have any limitation on number of MACSec sessions.

- For some of the platforms, there is hardware power limitation due to which there is restriction on usage of the number of 400Gig-ZR/ZRP transceivers and MACsec configurations together.
- Beginning with Cisco NX-OS Release 10.4(2)F, the 2X100 muxponder supports 8QAM and 16QAM modulation.
- Beginning with Cisco NX-OS Release 10.4(3)F, the following transceivers are supported on Cisco Nexus C93400LD-H1 and N9K-C9332D-H2R switch:
  - QDD-400G-ZRP-S
  - QDD-400G-ZR-S

Note On N9K-C93400LD-H1, QDD-400G-ZRP-S and QDD-400G-ZR-S transceivers can be inserted in either odd or even numbered ports. However, on N9K-C9332D-H2R switch, the QDD-400G-ZRP-S and QDD-400G-ZR-S transceivers must be inserted in odd numbered ports only. Inserting these transceivers to even numbered ports puts the port into error state due to hardware thermal limitation.

- Beginning with Cisco NX-OS Release 10.5(3)M, these commands are introduced.
  - **zr-optics frequency** command allows you to set the frequency of ZR optics modules on Cisco Nexus 9000 switches for optimal performance in DWDM systems.
  - **transceiver auto-squelch** command helps you to manage signal integrity automatically by controlling the squelch functionality of optical transceivers
  - **transceiver loopback** command allows you to configure loopback modes on optical transceivers on Cisco devices
  - **transceiver performance-monitoring** enables performance monitoring for optical transceivers on Cisco devices
  - **transceiver alarms** command allows you to configure alarms on optical transceivers on Cisco devices

- **For DP04QSDD-HE0**
  - From Release 10.4(3)F, DP04QSDD-HE0 is supported only in 1x400 and 1x100 mux ponder modes on GX/GX2 platform and X98900CD-A and X9836DM-A line cards, with the following dac rates.
    - dac_rate 1x1_50 with CFEC

- dac_rates 1x1_25 and 1x1_50 with OFEC mode

- The optics maximum link-up time can be up to 240 seconds.
- From Cisco NX-OS Release 10.5(1)F, DP04QSDD-HE0(Bright-ZR) is supported in 4x100 and 2x100 mux ponder modes on GX/GX2 platform and X98900CD-A and X9836DM-A line cards.

- The restrictions are as summarized below:
  - **For Cisco Nexus 9364D-GX2A:**
    - When system has 9 or more MACsec sessions configured and no ZR/ZRP transceiver is present, inserting a ZR/ZRP transceiver disables the corresponding port. The maximum number of MACsec sessions allowed is 16 when no ZR/ZRP transceiver is present.
    - When system has 9 or more ZR/ZRP transceivers in active state and no MACsec session exists, bringing-up of a new MACsec session will fail. The maximum number of active ZR/ZRP transceivers is 13 when no MACsec session is present in the system. Inserting a 14th ZR/ZRP transceiver disables the corresponding port.
    - When both MACsec sessions and active ZR/ZRP transceivers coexist, the combined limit is up to 8 MACsec session and up to 8 ZR/ZRP transceivers. Configuring the 9th MACsec session or adding the 9th active ZR/ZRP will disable the corresponding port.
    - The ZR/ZRP transceivers are supported only on the odd numbered front ports of this platform. Inserting a ZR/ZRP transceiver into an even numbered front port puts the port into error state.
  - **For Cisco Nexus 9332D-GX2B:**
    - When system has 5 or more MACsec sessions configured and no active ZR/ZRP transceiver is present, adding a ZR/ZRP transceiver disables the corresponding port. The maximum number of MACsec sessions allowed is 8 when no active ZR/ZRP transceiver is present. Configuring a 9th MACsec session disables the corresponding port.
    - When system has 5 or more active ZR/ZRP transceivers inserted and no MACsec session exists, bringing-up of a new MACsec session will fail. The maximum number of active ZR/ZRP transceivers is 8 when no MACsec session is present in the system. Inserting a 9th ZR/ZRP transceiver disables the corresponding port.
    - When both MACsec sessions and active ZR/ZRP transceivers coexist, the combined limit is up to 4 MACsec session and up to 4 active ZR/ZRP transceivers. Configuring the 5th MACsec session or inserting the 5th ZR/ZRP disables the corresponding port.
    - The ZR/ZRP transceivers are supported on any of the front ports of this platform.
  - **For Cisco Nexus 9348D-GX2A:**
    - The ZR/ZRP transceivers are supported on the following 24 front ports of this platform:
      - 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 26, 29, 32, 35, 38, 41, 44, 47

Note Inserting ZR/ZRP transceivers to other front ports that are not in the above list puts the port into error state.

- **For Cisco Nexus 9408:**
  - System can support up to 32 active ZR/ZRP transceivers irrespective of whether the MACsec configuration is present or not.
  - The ZR/ZRP transceivers are supported on only the Cisco Nexus X9400-8D module.

Configuring 400G Digital Coherent Optics on ZR Module

You can configure the coherent optics on the ZR module for DAC rate, muxponder mode, modulation, and FEC parameters.

Before you begin

Ensure that the following points are taken care during DCO configuration:

- Without insertion of ZR optics, the coherent optics configuration will not work.
- When we configure specific zr-optics on the ZRP module, the coherent configuration will not work.
- When we configure specific zrp-optics on the ZR module, the coherent configuration will not work.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet** {*type slot/port*}
3. [**no**] **zr-optics fec** *fec_val* **muxponder** *mxp_val* **modulation** *mod_val* **dac-rate** *dr_val*
4. (Optional) **zr-optics cd-min** *cd_min* **cd-max** *cd_max*
5. (Optional) **zr-optics transmit-power** *tx_pwr*
6. (Optional) **zr-optics dwdm-carrier** [**100MHz-grid frequency** *freq_100mhz_val* | **100GHz-grid frequency** *freq_100ghz_val* | **50GHz-grid** { **frequency** *freq* | **itu-channel** *itu-chan* | **wavelength** *wavelen*}]
7. (Optional) [**no**] **zr-optics frequency** *frequency-value*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface ethernet** {*type slot/port*}
	Example:
	`switch(config)# interface ethernet 1/3`
	`switch(config-if)#`
		Specifies an interface to configure, and enters interface configuration mode.

	Command or Action	Purpose
Step 3	[**no**] **zr-optics fec** *fec_val* **muxponder** *mxp_val* **modulation** *mod_val* **dac-rate** *dr_val* **Example:** `switch(config-if)# zr-optics fec cFEC muxponder 1x400 modulation 16QAM dac-rate 1x1`	Configures the following parameters on ZR optics. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section: • FEC • Muxponder • Modulation • DAC
Step 4	(Optional) **zr-optics cd-min** *cd_min* **cd-max** *cd_max* **Example:** `switch(config-if)# zr-optics cd-min -2300 cd-max 2300`	Configures chromatic dispersion on coherent optics with set minimum and maximum values. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section. **Note** When you configure the maximum and minimum values of CD for any data rate, ensure that the minimum difference between the configured values is equal to or greater than 1000 ps/nm.
Step 5	(Optional) **zr-optics transmit-power** *tx_pwr* **Example:** `switch(config-if)# zr-optics transmit-power -190`	Sets the transmit power of the optical signal. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section. **Note** The Tx power parameter is the best effort configuration which programs user configuration to hardware. However, the ZR/ZRP transceiver firmware will only use it as reference and calculates the actual optimal Tx power value at run time, which may or may not be the same as a user configuration.
Step 6	(Optional) **zr-optics dwdm-carrier** [**100MHz-grid frequency** *freq_100mhz_val* | **100GHz-grid frequency** *freq_100ghz_val* | **50GHz-grid** { **frequency** *freq* | **itu-channel** *itu-chan* | **wavelength** *wavelen*}] **Example:** `switch(config-if)# zr-optics dwdm-carrier 100MHz-grid frequency 1913000`	Configures frequency based on the configured frequency (100MHz-grid or 100GHz-grid or 50GHz-grid). The 50GHz-grid provide additional ITU-channel, or wavelength parameters. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section. **Note** If the frequency is configured using **50Ghz-grid wavelength** or **50Ghz-grid itu-channel** option, the system calculates the frequency for a given wavelength or ITU-channel and use it to program the hardware.
Step 7	(Optional) [**no**] **zr-optics frequency** *frequency-value* **Example:** `switch(config-if)# zr-optics frequency 193500.0`	Configures operating the frequency of a ZR optics module in GHz to align with DWDM grid requirements. Use the **no** form to disable frequency configuration.

Configuring 400G Digital Coherent Optics on ZRP Module

You can configure the coherent optics on the ZRP module for DAC rate, muxponder mode, modulation, and FEC parameters.

Before you begin

Ensure that the following points are taken care during DCO configuration:

- Without insertion of ZRP optics, the coherent optics configuration will not work.
- When we configure specific zr-optics on the ZRP module, the coherent configuration will not work.
- When we configure specific zrp-optics on the ZR module, the coherent configuration will not work.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet** {*type slot/port*}
3. [**no**] **zrp-optics fec** *fec_val* **muxponder** *mxp_val* **modulation** *mod_val* **dac-rate** *dr_val*
4. (Optional) **zrp-optics cd-min** *cd_min* **cd-max** *cd_max*
5. (Optional) **zrp-optics transmit-power** *tx_pwr*
6. (Optional) **zrp-optics dwdm-carrier** [**100MHz-grid frequency** *freq_100mhz_val* | **100GHz-grid frequency** *freq_100ghz_val* | **50GHz-grid** { **frequency** *freq* | **itu-channel** *itu-chan* | **wavelength** *wavelen*}]

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface ethernet** {*type slot/port*}
	Example:
	`switch(config)# interface ethernet 1/3`
	`switch(config-if)#`
		Specifies an interface to configure, and enters interface configuration mode.

Step 3	[**no**] **zrp-optics fec** *fec_val* **muxponder** *mxp_val* **modulation** *mod_val* **dac-rate** *dr_val* **Example:** `switch(config-if)# zrp-optics fec cFEC muxponder 1x400 modulation 16QAM dac-rate 1x1`	Configures the following parameters on ZRP optics. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section: • FEC • Muxponder • Modulation

	Command or Action	Purpose
		• DAC
Step 4	(Optional) **zrp-optics cd-min** *cd_min* **cd-max** *cd_max* **Example:** `switch(config-if)# zrp-optics cd-min -2400 cd-max 2400`	Configures chromatic dispersion on coherent optics with set minimum and maximum values. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section. **Note** When you configure the maximum and minimum values for chromatic dispersion for any data rate, ensure that the mimimum difference between the configured values is equal to or greater than 1000 ps/nm.

Step 5	(Optional) **zrp-optics transmit-power** *tx_pwr*
	Example:
	`switch(config-if)# zrp-optics transmit-power -190`
	Example:
	`switch(config-if)# zrp-optics transmit-power -13.5`
		Sets the transmit power of the optical signal. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section.
		Note
		The Tx power parameter is best effort configuration which programs user configuration to hardware. However, the ZR/ZRP transceiver firmware will only use it as reference and calculates the actual optimal Tx power value at run time, which may or may not be same as an user configuration.
		Note
		The `zrp-optics transmit-power` command now accepts values in both decimal and whole number formats.

Step 6	(Optional) **zrp-optics dwdm-carrier** [**100MHz-grid frequency** *freq_100mhz_val* | **100GHz-grid frequency** *freq_100ghz_val* | **50GHz-grid** { **frequency** *freq* | **itu-channel** *itu-chan* | **wavelength** *wavelen*}] **Example:** `switch(config-if)# zrp-optics dwdm-carrier 100MHz-grid frequency 1913000`	Configures frequency based on the configured frequency (100MHz-grid or 100GHz-grid or 50GHz-grid). The 50GHz-grid provide additional ITU-channel, or wavelength parameters. For more information, see 400G Digital Coherent Optics Parameters, on page 2 section. **Note** If the frequency is configured using **50Ghz-grid wavelength** or **50Ghz-grid itu-channel** option, the system calculates the frequency for a given wavelength or ITU-channel and use it to program the hardware.

Configuring Breakout

You can configure breakout on the interface for ZRP optics.

SUMMARY STEPS

1. **configure terminal**

2. **interface breakout module** {*slot*} **port** {*port_num*} **map** {*breakoutmap*}
3. **interface ethernet** {*type slot/port/sub-port*}
4. [**no**] **zrp-optics fec** *fec_val* **muxponder** *mxp_val* modulation *mod_val* **dac-rate** *dr_val*
5. (Optional) **show running interface ethernet** {*type slot/port*}

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface breakout module** {*slot*} **port** {*port_num*} **map** {*breakoutmap*} **Example:** switch(config)# **interface breakout module 1 port 3 map 100g-2x-pam4**	Configures interface breakout

Step 3	**interface ethernet** {*type slot/port/sub-port*}
	Example:
	`switch(config)# interface ethernet 1/3/1`
	`switch(config-if)#`
		Specifies an interface to configure, and enters interface configuration mode.

Step 4	[**no**] **zrp-optics fec** *fec_val* **muxponder** *mxp_val* modulation *mod_val* **dac-rate** *dr_val* **Example:** `switch(config-if)# zrp-optics fec oFEC muxponder 2x100 modulation QPSK dac-rate 1x1`	Configures the ZRP configuration on the breakout interface.
Step 5	(Optional) **show running interface ethernet** {*type slot/port*} **Example:** `switch(config-if)# show running interface ethernet1/3/1`	Displays the configuration information set on the breakout interface.

Configure Transceiver Auto Squelch

You can use the squelch functionality of optical transceivers to automatically manage signal integrity, preventing undesirable noise and ensuring clean signal transmission.

Use this feature in high-speed optical network environments where signal integrity is critical.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet** {*type slot/port/sub-port*}
3. [**no**] **transceiver auto-squelch**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enter global configuration mode.

Step 2	**interface ethernet** {*type slot/port/sub-port*}
	Example:
	`switch(config)# interface ethernet 1/3/1`
	`switch(config-if)#`
		Specify an interface to configure, and enter interface configuration mode.

Step 3	[**no**] **transceiver auto-squelch** **Example:** `switch(config-if)# transceiver auto-squelch`	Enable squelching in the signal to prevent undesirable noise. This command is enabled by default. Use the **no** form to disable auto squelching.

Configure Transceiver Loopback

You can use loopback testing to diagnose and troubleshoot network connectivity and transceiver functionality by rerouting signals back to origin.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet** {*type slot/port/sub-port*}
3. [**no**] **transceiver loopback**{**internal** | **line**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enter global configuration mode.

	Command or Action	Purpose

Step 2	**interface ethernet** {*type slot/port/sub-port*}
	Example:
	`switch(config)# interface ethernet 1/3/1`
	`switch(config-if)#`
		Specify an interface to configure, and enter the interface configuration mode.

Step 3	[**no**] **transceiver loopback**{**internal** | **line**
	Example:
	`switch(config-if)# transceiver loopback internal`
	`switch(config-if)# transceiver loopback line`
	`switch(config-if)# no transceiver loopback`
		Enable transceiver loopback. This command is disabled by default.
		• **Internal**: Configure internal loopback to verify the transceiver's internal functionality without external signals.
		• **Line**: Configure a line loopback to route the transmitted signal back to the receiver. This mode tests the entire transmission path and checks for errors in the signal or connection.
		Use the **no** form to disable transceiver loopback.
		Note
		Ensure that your network environment is configured to support loopback testing without interrupting services

Enabling or Disabling the TPMON Feature

The TPMON feature must be enabled globally before you can configure or use transceiver performance monitoring on interfaces. Disabling the feature stops all performance monitoring operations and deactivates related configurations.

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enter global configuration mode.

Step 2	**feature tpmon** **Example:** `switch(config)# feature tpmon`	Enables the Transceiver Performance Monitoring (TPMON) feature globally on the switch. This command is required before configuring TPMON on interfaces.
Step 3	**no feature tpmon** **Example:** `switch(config)# no feature tpmon`	Disables the TPMON feature globally. All transceiver performance monitoring operations are stopped and related configurations are deactivated.

When the feature is enabled, you can configure and monitor transceiver performance on supported interfaces. When disabled, all TPMON monitoring is stopped.

Example

Example: Enabling and Disabling TPMON Feature

```
switch# configure terminal
        switch(config)# feature tpmon
        switch(config)# no feature tpmon
```

What to do next

After enabling the TPMON feature, proceed to configure performance monitoring on individual interfaces as required.

Configure Transceiver Performance Monitoring

You can gather and analyze critical metrics to ensure optimal performance and quick detection of potential issues.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet** {*type slot/port/sub-port*}
3. [**no**] **transceiver performance-monitoring**
4. (Optional) **show interface ethernet** {*type slot/port*}**performance-monitoring**
5. (Optional) **show interface ethernet** {*type slot/port*} **transceiver performance-monitoring history** *bucket_interval* {**fec** | **optics**} **interval** *interval_value*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enter global configuration mode.

Step 2	**interface ethernet** {*type slot/port/sub-port*}
	Example:
	`switch(config)# interface ethernet 1/25`
	`switch(config-if)#`
		Specify an interface to configure, and enter interface configuration mode.

Step 3	[**no**] **transceiver performance-monitoring** **Example:**	Configure performance monitoring to monitor and optimize performance.

	Command or Action	Purpose
	`switch(config-if)# transceiver performance-monitoring`	• Real-Time Monitoring: allows you to observe transceiver metrics such as optical power levels, dispersion, and bit error rates. • Fault Detection: allows you to identify and address transceiver issues proactively to prevent network disruptions. • Performance Optimization: allows you to monitor transceivers to operate within specified parameters to maintain network efficiency. Use the **no** form to disable transceiver performance monitoring.

Step 4	(Optional) **show interface ethernet** {*type slot/port*}**performance-monitoring**
	Example:
	`switch(config-if)# show interface ethernet 1/25 transceiver performance-monitoring current 30-sec`
	`Interface Ethernet1/25`
		View the transceiver performance monitoring information.

Step 5	(Optional) **show interface ethernet** {*type slot/port*} **transceiver performance-monitoring history** *bucket_interval* {**fec** | **optics**} **interval** *interval_value* **Example:** `switch# show interface ethernet 1/25 transceiver performance-monitoring history 15-min fec interval 5`	Displays the historical performance monitoring data for the specified interface, bucket interval, data layer, and interval value. • **eth_interface** specifies the Ethernet interface to be queried. • **bucket_interval** indicates the time interval for the data bucket (30-sec, 15-min, or 24-hour). • **fec** or **optics** selects between FEC and optics data layers. • **interval_value** specifies the particular historical interval to display. **Note** This CLI is supported beginning with Cisco NX-OS Release 10.6(1)F.

Example

Verify Transceiver Performance Monitoring information

```
switch(config-if)# show interface ethernet 1/25 transceiver performance-monitoring current
 30-sec
Interface Ethernet1/25
--------------------------

Optics in the current interval [21:32:49 Wed Nov 20 2024 - 21:33:00 Wed Nov 20 2024]
```

```
Parameter          MIN          AVG         MAX
-----------------------------------------------
CD(Short)[ps/nm]  0.00         0.00        0.00
DGD[ps]           0.47         0.55        0.63
RX PWR[dBm]       -9.56        -9.55       -9.54
TX PWR[dBm]       -10.00       -9.99       -9.99
OSNR[dB]          28.10        28.10       28.10
RX CHAN PWR[dBm]  -9.25        -9.24       -9.22
ESNR[dB]          16.60        16.60       16.60
LASER BIAS[mA]    201.00       201.00      201.00
FREQ OFF[Mhz]     -314.00      -303.00     -294.00
SOP RATE[krad/s]  4.00         4.00        4.00
PDL[dB]           0.50         0.50        0.50
SOPMD[ps^2]       1.60         1.79        2.17

FEC in the current interval [21:32:49 Wed Nov 20 2024 - 21:33:00 Wed Nov 20 2024]

EC BITS  : 0
UC WORDS : 0

Parameter          MIN        AVG        MAX
-------------------------------------------
PREFEC BER         9.32e-04   9.38e-04   9.43e-04
POSTFEC BER        0.00e+00   0.00e+00   0.00e+00
Q FACTOR[dB]       9.80       9.86       9.89
Q MARGIN[dB]       2.80       2.80       2.80
```

Clear Transceiver Performance Monitoring information

To clear 30-sec interval counters on an interface

```
clear counters interface ethernet <> transceiver performance-monitoring current 30-sec
```

To clear 15-min interval counters on an interface

```
clear counters interface ethernet <> transceiver performance-monitoring current 15-min
```

To clear 24-hour interval counters on an interface

```
clear counters interface ethernet <> transceiver performance-monitoring current 24-hour
```

To clear 30-sec interval counters on all interfaces

```
clear counters interface transceiver performance-monitoring current 30-sec
```

To clear 15-min interval counters on all interfaces

```
clear counters interface transceiver performance-monitoring current 15-min
```

To clear 24-hour interval counters on all interfaces

```
clear counters interface transceiver performance-monitoring current 24-hour
```

Configure Transceiver Alarms

Set threshold values for key performance parameters to trigger alarms when the threshold values exceed the predefined threshold values.

Procedure

Step 1 Use the **configure terminal** command to enter global configuration mode.

Example:

```
switch# configure terminal
switch(config)#
```

Step 2 Specify the interface to enter interface configuration mode with the **interface ethernet** {*type slot/port/sub-port*} command.

Example:

```
switch(config)# interface ethernet 1/21/1
switch(config-if)#
```

Step 3 Set threshold values for transceiver alarms with the [**no**] **transceiver alarms cd** | **dgd** | **lbc** | **osnr** | **prefec-ber** { **high-threshold** | **low-threshold***threshold-value* }

Example:

```
switch(config)# interface ethernet 1/21
switch(config-if)# transceiver alarms cd high-threshld 300000
switch(config-if)# transceiver alarms dgd high-threshold 100
switch(config-if)# transceiver alarms esnr high-threshold 25
```

Set the threshold values to monitor critical metrics to trigger alarms.

- **cd**: Set high and low threshold values for chromatic dispersion.
- **dgd**: Set high threshold values for differential group delay.
- **ensr**: Set high and low threshold values for the electrical signal-to-noise ratio.
- **lbc**: Set high and low threshold values for parameters for laser bias current.
- **onsr**: Set low threshold values for the optical signal-to-noise ratio.
- **prefec-ber**: Set high and low threshold values for forward error correction bit error rate.

Use the **no** form to disable transceiver alarms.

Note
Determine the threshold values in the network design and performance requirements. Review and adjust threshold values regularly to align with network conditions and objectives.

View transceiver alarms

```
switch# show interface e1/21 transceiver alarms

Interface Ethernet1/21

Current System Time: 03:42:49 Tue Nov 26 2024

                            Current State       Occurrences         Last Trigger
          Last Reset
                            -------------       -----------         ------------
          ----------

DEFAULT TRANSCEIVER ALARMS:
---------------------------

Module Alarms:
  Data path firmware fault              ok           0                      never
              never
```

```
  Module firmware fault                ok          0                    never
             never
  Temperature high alarm               ok          0                    never
             never
  Temperature high warn                ok          0                    never
             never
  Temperature low alarm                ok          0                    never
             never
  Temperature low warn                 ok          0                    never
             never
  Voltage high alarm                   ok          0                    never
             never
  Voltage high warn                    ok          0                    never
             never
  Voltage low alarm                    ok          0                    never
             never
  Voltage low warn                     ok          0                    never
             never

OPT Media Alarms:
  RX LOS                               ok          35       19:19:23 Nov 25 2024
19:19:38 Nov 25 2024
  TX fault                             ok          0                    never
             never
  RX CDR LOL                           ok          0                    never
             never
  TX power high alarm                  ok          0                    never
             never
  TX power high warn                   ok          0                    never
             never
  TX power low alarm                   ok          0                    never
             never
  TX power low warn                    ok          0                    never
             never
  RX power high alarm                  ok          0                    never
             never
  RX power high warn                   ok          0                    never
             never
  RX power low alarm                   ok          23       19:14:21 Nov 25 2024
19:15:28 Nov 25 2024
  RX power low warn                    ok          12       19:19:23 Nov 25 2024
19:19:23 Nov 25 2024
  Freq tuning invalid channel          ok          0                    never
             never

Network Media Alarms:
  TX loss of alignment                 ok          0                    never
             never
  TX out of alignment                  ok          0                    never
             never
  TX clock monitor unit LOL            ok          0                    never
             never
  TX reference clock LOL               ok          0                    never
             never
  TX deskew LOL                        ok          0                    never
             never
  TX FIFO error                        ok          0                    never
             never
  RX demodulator LOL                   ok          0                    never
             never
  RX CD compensation LOL               ok          0                    never
             never
  RX loss of alignment                 ok          0                    never
             never
```

```
  RX out of alignment                ok          0                    never
             never
  RX deskew LOL                      ok          0                    never
             never
  RX FIFO error                      ok          0                    never
             never

Flexo ZR Alarms:
  Flexo GIDM                         ok          0                    never
             never
  Flexo PMM                          ok          0                    never
             never
  Flexo LOM                          ok          1       04:10:58 Nov 23 2024
04:16:21 Nov 23 2024
  Flexo RPF                          ok          0                    never
             never
  Flexo LOF LOM                      ok          1       04:10:58 Nov 23 2024
04:16:21 Nov 23 2024

Hostside Alarms:
 TX LOS:
  Host lane 1                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 2                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 3                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 4                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 5                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 6                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 7                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 8                        ok       1041       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
 TX LOL:
  Host lane 1                        ok       1042       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 2                        ok       1043       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 3                        ok       1050       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 4                        ok       1063       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 5                        ok       1065       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 6                        ok       1072       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 7                        ok       1077       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
  Host lane 8                        ok       1085       03:39:25 Nov 26 2024
03:39:27 Nov 26 2024
 TX adaptive input EQ fault:
  Host lane 1                        ok          0                    never
             never
  Host lane 2                        ok          0                    never
             never
  Host lane 3                        ok          0                    never
             never
  Host lane 4                        ok          0                    never
             never
  Host lane 5                        ok          1       15:37:19 Nov 24 2024
```

```
15:37:20 Nov 24 2024
  Host lane 6                             ok           0                      never
             never
  Host lane 7                             ok           1       18:21:23 Nov 25 2024
18:21:24 Nov 25 2024
  Host lane 8                             ok           0                      never
             never


CONFIGURATION ALARMS:
---------------------

FEC Alarms:
  Pre Fec BER low alarm                   ok           0                      never
             never
  Pre Fec BER high alarm                  ok           0                      never
             never

Optics Alarms:
  CD low alarm                            ok           0                      never
             never
  CD high alarm                           ok           0                      never
             never
  DGD high alarm                          ok           0                      never
             never
  LBC low alarm                           ok           0                      never
             never
  LBC high alarm                          ok           0                      never
             never
  OSNR low alarm                          ok           0                      never
             never
  ESNR low alarm                          ok           0                      never
             never
  ESNR high alarm                         ok           0                      never
             never
```

```
switch# show interface ethernet 1/21 transceiver alarms
 Interface Ethernet1/21
Current System Time: 08:54:38 Wed Apr 23 2025
Current State       Occurrences         Last Trigger                  Last Reset
-------------       -----------         ------------                  ----------
DEFAULT TRANSCEIVER ALARMS:
---------------------------
.
.
.
CONFIGURATION ALARMS:
---------------------

FEC Alarms:
  Pre Fec BER low alarm        ok           0                     never
    never
  Pre Fec BER high alarm       ok           0                     never
    never

Optics Alarms:
  CD low alarm                ok           0                     never
   never
  CD high alarm               ok           0                     never
   never
  DGD high alarm              ok           0                     never
   never
  LBC low alarm               ok           0                     never
   never
  LBC high alarm              ok           0                     never
```

```
  never
 OSNR low alarm              ok           0                     never
  never
 ESNR low alarm              ok           0                     never
  never
 ESNR high alarm           ok           0                     never
never
```

Clear transceiver alarms information

Use the **clear counters interface ethernet transceiver alarms** command to clear alarms on an interface.

```
clear counters interface ethernet 1/21 transceiver alarms
```

Use the **clear counters interface transceiver alarms** comand to clear alarms on all interfaces.

```
clear counters interface transceiver alarms
```

Verifying 400G Digital Coherent Optics

To verify the 400G Digital Coherent Optics configuration information, perform one of the following tasks:

Command	Purpose
show running interface ethernet {*type slot/port*}	Displays the running configuration information of the interfaces configured to validate the coherent ZR/ZRP optics.
show interface ethernet {*type slot/port*} **transceiver details**	Displays the coherent ZR/ZRP optics configuration information of the interfaces.
show interface ethernet {*type slot/port*} **transceiver vdm**	Displays line-by-line diagnostic and Versatile Diagnostics Monitoring (VDM) data for QSFP-DD and OSFP transceivers only.

Configuration Examples for 400G Coherent Optics

The following example show the running configuration with ZR/ZRP optics:

```
switch(config-if)# show running  interface ethernet1/3

!Command: show running-config interface Ethernet1/3
!Running configuration last done at: Mon Aug 28 12:16:40 2023
!Time: Mon Aug 17 12:17:40 2023

version 10.3(2) Bios:version 01.10

interface Ethernet1/3
  zr-optics fec cFEC muxponder 1x400 modulation 16QAM dac-rate 1x1
  zr-optics cd-min -2400 cd-max 2400
  zr-optics transmit-power -190
  zr-optics dwdm-carrier 100MHz-grid frequency 1931000
  no shutdown
```

The following example shows how to verify the coherent configuration:

Until 10.5(2)F:

```
switch# show int e1/3 transceiver details
Ethernet1/3
    transceiver is present
    type is QSFP-DD-400G-ZR-S
    name is CISCO-ACACIA
    part number is DP04QSDD-E20-190
    revision is A
    serial number is ACA2524000V
    nominal bitrate is 425000 MBit/sec per channel
    cisco id is 24
    cisco extended id number is 21
    cisco part number is 10-3495-01
    cisco product id is QDD-400G-ZR-S
    cisco version id is V01
    firmware version is 61.22
    Link length SMF is 12 km
    Nominal transmitter wavelength is 1547.70 nm
    Wavelength tolerance is 166.550 nm
    host lane count is 8
    media lane count is 1
    max module temperature is 80 deg C
    min module temperature is 0 deg C
    min operational voltage is 3.12 V
    vendor OUI is 0x7cb25c
    date code is 210614
    clei code is INUIANYEAA
    power class is 8 (>14 W maximum)
    max power is 20.00 W
    near-end lanes used none
    far-end lane code for 8 lanes Undefined
    media interface is C-band tunable laser
    Advertising code is Optical Interfaces: SMF
    Host electrical interface code is 400GAUI-8 C2M (Annex 120E)

    Optics Status:
        FEC State: cFEC
        DWDM carrier Info: Frequency: 193.1000 THz
                           Wavelength: 1552.524 nm
        DAC Rate: 1x1
        Configured Tx Power: -10.00 dBm
        Modulation Type: 16QAM
        Muxponder Type: 1x400
        Configured CD-MIN: -2400 ps/nm     CD-MAX: 2400 ps/nm
        Transceiver Squelch Status: Enable
        Laser Admin State: On
        Laser Oper State: On
        Loopback Mode: Disabled

    Vendor Details:
        Optics Type: QSFP-DD-400G-ZR-S
        Firmware Version: Major.Minor.Build
                Active  : 61.22.21
                Inactive: 61.10.12
Lane Number:1 Network Lane
  ------------------------------------------------------------------------------------
                     Current                      Alarms                  Warnings
                     Measurement             High        Low         High          Low
  ------------------------------------------------------------------------------------
  Temperature          46.00 C             80.00 C      -5.00 C      75.00 C      15.00 C
  Voltage               3.26 V              3.46 V       3.13 V       3.43 V       3.16 V
  Current                N/A                N/A          N/A          N/A          N/A
  Tx Power           -10.00 dBm           0.00 dBm   -18.23 dBm    -2.00 dBm   -16.02
```

```
dBm
  Rx Power              -9.70 dBm            7.99 dBm   -23.01 dBm     7.99 dBm   -21.54
dBm
  Laser temperature     47.13 C               N/A          N/A          N/A          N/A
  RX Channel Power      -9.57 dbm            3.00 dbm   -23.50 dbm     0.00 dbm   -20.00
dbm
  Pre-FEC BER        8.13e-04                 N/A          N/A          N/A          N/A
  Post-FEC BER       0.00e+00                 N/A          N/A          N/A          N/A
  CD (Short Link)        0.00 ps/nm           N/A          N/A          N/A          N/A
  CD (Long Link)         0.00 ps/nm           N/A          N/A          N/A          N/A
  Diff. group delay      3.00 ps              N/A          N/A          N/A          N/A
  SOPMD                 33.00 ps^2            N/A          N/A          N/A          N/A
  PDL                    0.50 dB              N/A          N/A          N/A          N/A
  OSNR                  36.40 dB              N/A          N/A          N/A          N/A
  ESNR                  18.00 dB              N/A          N/A          N/A          N/A
  Carrier freq off    -391.00 MHz             N/A          N/A          N/A          N/A
  SOP Rate of Chg        0.00 krad/s          N/A          N/A          N/A          N/A
  Laser bias           210.00 mA              N/A          N/A          N/A          N/A
  RX Q factor            9.89 dB              N/A          N/A          N/A          N/A
  RX Q margin            2.70 dB              N/A          N/A          N/A          N/A
  SOPMD LO GR           33.00 ps^2            N/A          N/A          N/A          N/A
  Tx modulator bias     34.93 %               N/A          N/A          N/A          N/A
  Transmit Fault Count = 0
  ----------------------------------------------------------------------------
  Note: ++  high-alarm; +  high-warning; --  low-alarm; -  low-warning
```

The following sample shows how to configure the breakout configuration on the breakout interface:

```
switch(config)# interface ethernet 1/3/1
switch(config-if)# zrp-optics fec ofec muxponder 2x100 modulation QPSK dac-rate 1x1

switch (config-if)# show running interface ethernet1/3/1


interface Ethernet1/3/1
  zrp-optics fec oFEC muxponder 2x100 modulation QPSK dac-rate 1x1
  zrp-optics cd-min -50000 cd-max 50000
  zrp-optics transmit-power -190
  zrp-optics dwdm-carrier 100MHz-grid frequency 1913000
  no shutdown
```

Overview of Optical Line System - Pluggable Support for QSFP-DD

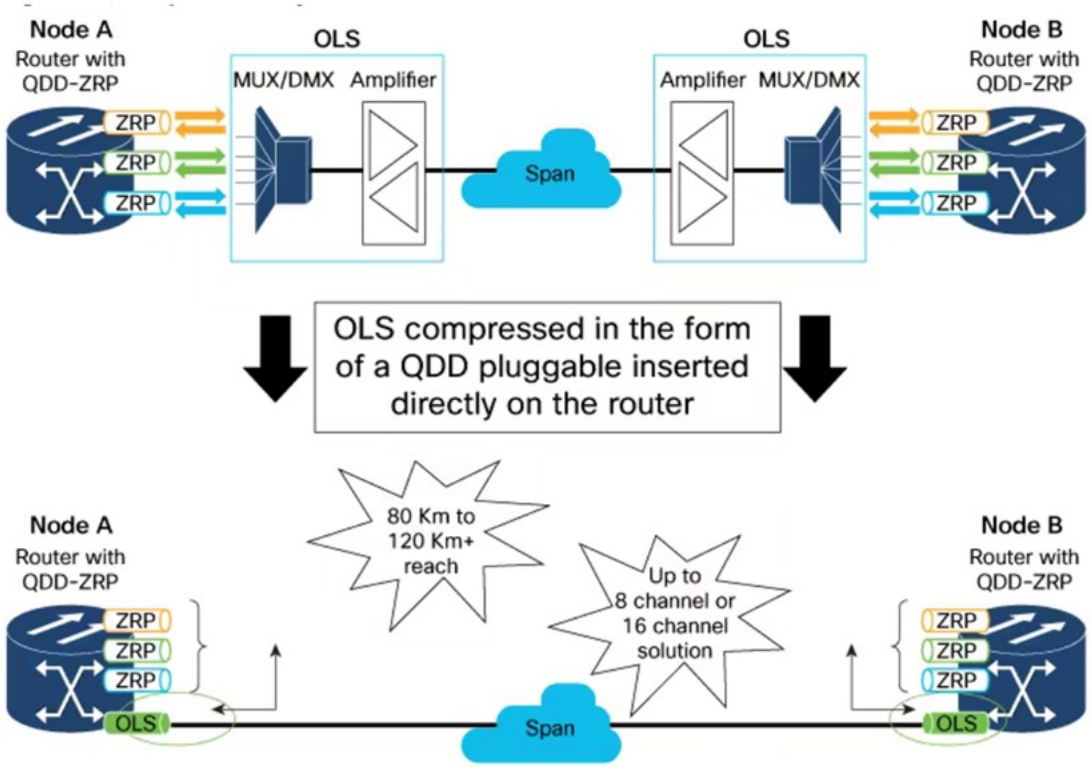
The QDD Optical Line System (OLS) is a pluggable optical amplifier enabling connection between two routers or switches

- for transmitting traffic on a limited number of coherent optical channels, and
- as a single span point-to-point link.

OLS helps transport 8 or 16 optical channels without any additional optical hardware unit.

The OLS topology is displayed as follows:

Figure 1: OLS topology



Benefits

A QSFP-DD module plugged into a port of the router or switch has the ability to provide amplification. The benefits of having the OLS are:

- provides compact solution for amplification,
- provides extended reach,
- increases fiber bandwidth, and
- lowers power dissipation.

Cisco provided solution of the pluggable form of the QSFP-DD OLS for ZR and ZR Plus variant of Coherent optics helps in

- reduction of more equipments, rack space and power,
- avoid usage of external amplifiers and multiplexers,
- extend the reach of a 400G QSFP-DD ZR or ZR plus link from 40 to 130 km or longer depending on fiber specification, the channel count, and the line rate of the signal, and

- extend the reach of a 400G Bright QSFP-DD ZR or ZR+ link from 80 to 130 km or longer depending on fiber specification, the channel count, and the line rate of the signal

Supported Platforms

- Cisco Nexus 9300 Series Switch
  - N9K-C9364D-GX2A
  - N9K-C9332D-GX2B
  - N9K-C9348D-GX2A
- Cisco Nexus 9400 Series Switch (N9K-C9408 with N9K-X9400-8D LEM)

Guidelines and Limitations

OLS operational mode guidelines

The following are the guidelines for the configuration of OLS operational mode:

- Use the command **no shutdown** on an interface to activate and apply the OLS configuration.
- In automatic power control mode, amplifier output power is kept constant, irrespective of incoming signal strength.
- In manual control mode, gain value is based on loss between RX on peer OLS and TX of transmitting OLS. Use link loss for configuring the correct gain on COM and LINE side to achieve high signal-to-noise ratio for critical applications.

  The gain value is based on loss between RX on peer OLS and TX of transmitting OLS. The link loss between two OLS (ols A and ols B) is A -> B = tx_power on ols A - rx_power on ols B. The loss is compensated by gain on ols B

  For example, if the link loss is 10db and ols-A tx power is 0db, then rx_power on ols B = 0-10 = -10dbm. The 10dbm gain is applied on ols B to compensate on com(receive) side.

Optical Safety Remote Interlock (OSRI) guidelines

When OSRI is enabled, the maximum output power can be -15dBm based on the input power.

OLS safety control mode

- Safety control mode is enabled only on Line side.
- When safety-control-mode is enabled and if LOS is detected on the line RX. The line TX normalizes the signal output power to 8 dBm putting the line amplifier in Automatic Power Reduction (APR). This prevents the launch of high level optical power on an open Line.

- APR (Automatic Power Reduction) is a temporary condition that keeps the amplifier in a safe, fixed an well known power level (8dbm), if safety control is enabled and rx-los is detected. You can force APR permanently (independently by the link connectivity) to troubleshoot.
- When the link connectivity is verified then the amplifier is moved to the final working state (either gain controlled or power controlled).

Recommendations for wavelength and frequency

Note Ensure that there is a unique frequency while using coherent optics with OLS.

Channel Spacing	Total Bandwidth	Wavelength in nm		Frequency in THz	
		Start	End	Start	End
8 Channels – 200 GHz spaced	19.2 nm	1539.1	1558.4	192.375	192.775
16 Channels – 100 GHz spaced	2.4 THz				

Recommendations for 8 Channel System

ITU XR Channel	Frequency (in THz)	Wavelength (in nm)
37	194.3	1542.94
41	194.1	1544.53
45	193.9	1546.12
49	193.7	1547.72
53	193.5	1549.32
57	193.3	1550.92
61	193.1	1552.52
65	192.9	1554.13

Recommendations for 16 Channel System

ITU XR Channel	Frequency (in THz)	Wavelength (in nm)
37	194.3	1542.94
39	194.2	1543.73
41	194.1	1544.53

ITU XR Channel	Frequency (in THz)	Wavelength (in nm)
43	194.0	1545.32
45	193.9	1546.12
47	193.8	1546.92
49	193.7	1547.72
51	193.6	1548.51
53	193.5	1549.32
55	193.4	1550.12
57	193.3	1550.92
59	193.2	1551.72
61	193.1	1552.52
63	193.0	1553.33
65	192.9	1554.13
67	192.8	1554.94

Link Loss for QDD-ZR

Line Rate	Traffic mode setting	TX power setting	Guranteed Link Loss Range (dB)
400G	400ZR-CFEC-16QAm-0-S	Default	0-19

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	22	3
1	23	

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
2	24	4
3		5
4		6
5		7
6		8
7		9
8		10
9		11
10		12
11		13
12		14
13		15
14		16
15		17
16		18
17		19
18		20
19		21
20	24	22
21	24	23
22	NA	NA
23	NA	NA
24	NA	NA
25	NA	NA
26	NA	NA
27	NA	NA
28	NA	NA
29	NA	NA
30	NA	NA
31	NA	NA
32	NA	NA

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
33	NA	NA

Link Loss for QDD-ZRP

Line Rate	Traffic mode setting	TX power setting	Guranteed Link Loss Range (dB)
400G	400ZR-oFEC-16QAM-1-E	Default	0 to 23
300G	300ZR-oFEC-8QAM-1-E	Default	0 to 26
200G	200ZR-oFEC-16QPSK-0-S	Default	0 to 29

Link Loss for QDD-ZRP 400G

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	22	3
1	23	
2	24	
3		4
4		5
5		6
6		7
7		8
8		9
9		10
10		11
11		12
12		13
13		14
14		15
15		16
16		17
17		18
18		19
19		20
20		21
21		22
22		23
23		24
24	24	24
25	24	24
26	NA	NA
27	NA	NA
28	NA	NA
29	NA	NA

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
30	NA	NA
31	NA	NA
32	NA	NA
33	NA	NA

Link Loss for QDD-ZRP 300G

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	22	3
1	23	
2	24	
3		4
4		5
5		6
6		7
7		8
8		9
9		10
10		11
11		12
12		13
13		14
14		15
15		16
16		17
17		18
18		19
19		20
20		21
21		22
22		23
23		24
24		
25		
26		
27	24	24
28	24	24
29	NA	NA

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
30	NA	NA
31	NA	NA
32	NA	NA
33	NA	NA

Link Loss for QDD-ZRP 200G

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	21	3
1	22	
2	23	
3	24	
4		4
5		5
6		6
7		7
8		8
9		9
10		10
11		11
12		12
13		13
14		14
15		15
16		16
17		17
18		18
19		19
20		20
21		21
22		22
23		23
24		24
25		
26		
27		
28		
29		

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
30	24	24
31	NA	NA
32	NA	NA
33	NA	NA

Link Loss for Bright-ZRP

Line Rate	Traffic mode setting	TX power setting	Guranteed Link Loss Range (dB)
400G	400ZR-oFEC-16QAM-1-E	Default	0 to 28
300G	300ZR-oFEC-8QAM-1-E	Default	0 to 29
200G	200ZR-oFEC-8QAM-1-S	Default	0 to 29

Link Loss for Bright-ZRP 400G

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	13	3
1	14	
2	15	
3	16	
4		4
5		5
6		6
7		7
8		8
9		9
10		10
11		11
12		12
13		13
14		14
15		15
16		16
17		17
18		18
19		19
20		20
21		21
22		22
23		23
24		24
25		
26		
27		
28		
29	17	24

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
30	17	24
31	NA	NA
32	NA	NA
33	NA	NA

Link Loss for Bright -ZRP 300G

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	13	3
1	14	
2	15	
3	16	
4		4
5		5
6		6
7		7
8		8
9		9
10		10
11		11
12		12
13		13
14		14
15		15
16		16
17		17
18		18
19		19
20		20
21		21
22		22
23		23
24		24
25		
26		
27		
28		
29		

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
30	17	24
31	17	24
32	NA	NA
33	NA	NA

Link Loss for Bright -ZRP 200G

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
0	13	3
1	14	
2	15	
3	16	
4		4
5		5
6		6
7		7
8		8
9		9
10		10
11		11
12		12
13		13
14		14
15		15
16		16
17		17
18		18
19		19
20		20
21		21
22		22
23		23
24		24
25		
26		
27		
28		
29		

Link Loss	QDD-OLS setting	
	EDFA-TX Gain (dB)	EDFA-RX Gain (dB)
30	17	24
31	17	24
32	NA	NA
33	NA	NA

Configuring amplifier control mode

OLS has two amplifiers.

- COM amplifier

  boosts incoming signal from the fiber network to connected Coherent optics for transmission.

- LINE amplifier

  boosts the signal from Coherent optics to send over the fiber.

SUMMARY STEPS

1. Enter global configuration mode.
2. Enables or disables the amplifier control mode for the line and com.
   - manual for egress control.
   - powermode for egress control

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	Enter global configuration mode. **Example:** `switch# configure terminal`	**configure terminal**
Step 2	Enables or disables the amplifier control mode for the line and com. • manual for egress control. • powermode for egress control **Example:** `switch(config)# ols com egress control manual`	**[no] ols { com | line } egress control <mode>** Default mode is manual. The parameter settings are defined in the table.

Side	Default	Minimum	Maximum
com	manual	power	manual
line	manual	power	manual

Configuring the gain control mode

SUMMARY STEPS

1. Enter global configuration mode.
2. Configure the desired gain value of the OLS pluggable for the line and com.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	Enter global configuration mode. **Example:** `switch# configure terminal`	**configure terminal**
Step 2	Configure the desired gain value of the OLS pluggable for the line and com. **Example:** `switch(config)# ols com egress gain 200`	**[no] { ols com egress <com_gain> | line egress gain <line_gain> }** The gain are in units of 0.1 dBm. The parameter settings are defined in the table.

Side	Default	Minimum	Maximum
com	200	30	250
line	210	70	250

Configuring the power control mode

SUMMARY STEPS

1. Enter global configuration mode.
2. Configure the desired output power (TX) of the OLS pluggable for the line and com.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	Enter global configuration mode. **Example:** `switch# configure terminal`	**configure terminal**

	Command or Action	Purpose
Step 2	Configure the desired output power (TX) of the OLS pluggable for the line and com. **Example:** `switch(config)# ols com egress power 20`	**[no] ols { com egress power <com_power> | line egress power <line_power> }** The power are in units of dBm. The parameter settings are defined in the table.

Side	Default	Minimum	Maximum
com	80	10	170
line	80	0	170

Configuring the power reduction mode

SUMMARY STEPS

1. Enter global configuration mode.
2. Enable or disable the power reduction mode.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	Enter global configuration mode. **Example:** `switch# configure terminal`	**configure terminal**
Step 2	Enable or disable the power reduction mode. **Example:** `switch(config)# ols com egress force power-reduction`	**[no] ols { com | line } egress force power-reduction**

Side	Default	Minimum	Maximum
com	off	on	off
line	off	on	off

Configuring the Optical Safety Remote Interlock (OSRI) mode

To shut down the amplifier, use the Optical Safety Remote Interlock (OSRI) configuration. Use the configuration for maintaince of the pluggable and when the OLS pluggable is not in operation.

SUMMARY STEPS

1. Enter global configuration mode.

2. Enable or disable thepower reduction mode.

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	Enter global configuration mode. **Example:** `switch# configure terminal`	**configure terminal**
Step 2	Enable or disable thepower reduction mode. **Example:** `switch(config)# ols com egress force power-reduction`	**[no] ols { com | line } egress force power-reduction** The default mode is off. The parameter settings are defined in the table.

Side	Default	Minimum	Maximum
com	off	on	off
line	off	on	off

Configuring the safety control mode

SUMMARY STEPS

1. Enter global configuration mode.
2. Enable or disable the safety control mode.
   - auto or
   - disabled

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	Enter global configuration mode. **Example:** `switch# configure terminal`	**configure terminal**
Step 2	Enable or disable the safety control mode. • auto or • disabled	**[no] ols line egress safety-control** The default mode is auto.

	Command or Action	Purpose
	Example: `switch(config)# ols ols line egress safety-control`	

Verify OLS configuration

Display the detailed OLS information

Use the **show interface ethernet transceiver details** command to verify the detailed OLS information.

```
switch# show interface ethernet 1/2 transceiver details
Ethernet1/2
    transceiver is present
    type is ONS-QDD-OLS
    name is CISCO-ACCELINK
    part number is EDFA-211917-QDD
    revision is 27
    serial number is ACW2723Z007
    nominal bitrate is 425000 MBit/sec per channel
    cisco id is 24
    cisco extended id number is 237
    cisco part number is 1010045801
    cisco product id is ONS-QDD-OLS
    cisco version id is V01
    firmware version is 2.7
    host lane count is 0
    media lane count is 0
    max module temperature is 0 deg C
    min module temperature is 0 deg C
    min operational voltage is 0.00 V
    vendor OUI is 0x000000
    date code is 23070401
    clei code is WMOGAT2MAA
    power class is 2 (3.5 W maximum)
    max power is 3.50 W
    near-end lanes used none
    far-end lane code for 8 lanes Undefined
    media interface is others
    Advertising code is Optical Interfaces: SMF
    Host electrical interface code is Undefined
    media interface advertising code is Undefined
    Operational Parameters:
    ----------------------
       COM Side:
          Total Tx Power = -327.68 dBm
          Rx Signal Power = -327.68 dBm
          Tx Signal Power = -327.68 dBm
          Egress Ampli Gain = 0.0 dBm
          Egress Ampli OSRI = ON
          Egress Force APR = ON
       Line Side:
          Total Tx Power = -327.68 dBm
          Rx Signal Power = -327.68 dBm
          Tx Signal Power = -327.68 dBm
          Egress Ampli Gain = 0.0 dBm
          Egress Ampli Safety Control mode = disabled
          Egress Ampli OSRI = ON
          Egress Force APR = ON
    Configured Parameters:
```

```
----------------------
   COM Side:
      Egress Ampli Gain = 20.0 dBm
      Egress Ampli Power = 17.0 dBm
      Egress Ampli OSRI = ON
      Ampli Control mode = Power
      Rx Low Threshold = -300.0 dBm
      Tx Low Threshold = -50.0 dBm
      Egress Force APR = ON
   Line Side:
      Egress Ampli Gain = 20.0 dBm
      Egress Ampli Power = 17.0 dBm
      Egress Ampli Safety Control mode = disabled
      Egress Ampli OSRI = ON
      Ampli Control mode = Power
      Rx Low Threshold = -300.0 dBm
      Tx Low Threshold = -50.0 dBm
      Egress Force APR = ON
  Temperature = 19.70 Celsius
  Voltage = 3.34 V
```

Display the brief OLS information

Use the **show interface ethernet brief** command to verify the OLS information in brief.

```
switch# show interface e1/2 brief

--------------------------------------------------------------------------------
Ethernet        VLAN    Type Mode   Status  Reason                 Speed     Port
Interface                                                                    Ch #
--------------------------------------------------------------------------------
Eth1/2          --      eth  routed down    olsInserted              auto(D) --
```

Display the status of the optic

Use the **show interface status** command to verify the status of the optic.

```
switch# show interface e1/2 status

--------------------------------------------------------------------------------
Port          Name               Status    Vlan      Duplex  Speed   Type
--------------------------------------------------------------------------------
Eth1/2        --                 olsInsert routed    auto    auto    ONS-QDD-OLS
```

Display the running configuration

Use the **show running-config interface ethernet** command to display the running configuraton of the OLS.

```
switch# show running-config interface ethernet1/2
!Command: show running-config interface Ethernet1/2
!Running configuration last done at: Mon Feb 26 12:39:24 2024
!Time: Mon Feb 26 13:03:34 2024
version 10.4(3) Bios:version 01.07
interface Ethernet1/2
  ols com egress control power
  ols com egress osri
  ols com egress power 170
  ols line egress control power
  ols line egress osri
  ols line egress gain 200
  ols line egress power 170
  no ols line egress safety-control
  ols com egress force power-reduction
```

```
ols line egress force power-reduction
no shutdown
```