Configuring 400G Digital Coherent Optics

Feature Name	Release Information	Description
Support for DP04QSDD-ULH-A1 Optical module	Release 25.4.1	This release introduces support for Cisco 400G QSFP-DD High-Power (Bright) Optical module, Ethernet variant. The Cisco 400G QSFP-DD High-Power (Bright) Optical Module is an enhanced version of the existing QSFP-DD ZR+ Optical Module. It supports the same operational modes as the ZR+ module and introduces a key improvement—an increased transmit (Tx) optical power of up to +1 dBm for extended performance DP04QSDD-ULH-A1 Optical module is supported on these hardware variants: • A9K-20HG-FLEX-SE/TR • A9K-8HG-FLEX-SE/TR • A99-10X400GE-X-SE/TR • A9903-20HG-PEC

Feature Name	Release Information	Description
Support for DP04QSDD-HE0 Optical Module	Release 7.9.1	This release introduces support for the Cisco 400G QSFP-DD High-Power (Bright) Optical Module, Ethernet Variant. The Cisco 400G QSFP-DD High-Power (Bright) Optical module is an enhanced version of the currently available QSFP-DD ZR+ Optical Module, leveraging the same operational modes but providing as a major enhancement the increase of the Tx Optical Power up to +1dBm. DP04QSDD-HE0 optical module is supported in the following hardware: • A9K-20HG-FLEX-SE/TR/FC • A9K-8HG-FLEX-SE/TR/FC
Extended Support for DP04QSDD-HE0 Optical Module	Release 7.10.1	With this release, the support for DP04QSDD-HE0 optical module is extended to the following hardware: • A99-10X400GE-X-SE/TR • A9903-20HG-PEC • A9903-20HG-PEC-FC • ASR9902 (100G) • ASR9902-FC (100G)
Support for 3x100G Muxponder Mode on A99-10X400GE-X-SE/A99-10X400GE-X-TR Line Cards	Release 7.9.1	QDD-400G-ZRP-S optical module operating in A99-10X400GE-X-SE/A99-10X400GE-X-TR line cards now supports 3x100G muxponder mode.
oFEC Traffic Configuration for QDD-400G-ZRP-S	Release 7.9.1	QDD-400G-ZRP-S optical module can now support the following oFEC traffic configurations: • 400G-TXP-1x1 DAC-16 QAM • 3x100G-MXP-1x1 DAC-8 QAM This increases the interoperability of the QDD-400G-ZRP-S optical module across network components supporting these formats.

Feature Name	Release Information	Description
Support for 8 and 16 Quadrature Amplitude Modulation (QAM) Formats on QDD-400G-ZRP-S Optical Modules	Release 7.8.1	QDD-400G-ZRP-S optical module operating in 200G interfaces now supports the 8 QAM and 16 QAM modulation formats. This increases the interoperability of the optical module across network components supporting these formats.

Cisco offers a range of the new 400G Digital Coherent QSFP-DD optical modules. The two optical modules that are available are:

- QDD-400G-ZR-S
- QDD-400G-ZRP-S
- DP04QSDD-HE0
- DP04QSDD-ULH-A1

For more information about the optic module portfolio, see the Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules Data Sheet.

The DP04QSDD-ULH-A1 can only be configured through appsel command. See Application select code provisioning, on page 31.

This chapter describes the 400G Digital coherent optical modules and their supported configurations.

This table shows the line cards, ports, and modes that support these optical modules.

Table 1: Supported line cards, ports, and modes for QDD-400G-ZR-S and QDD-400G-ZRP-S Optical modules

Components	Default Port Speed	Supported Front Panel Ports	1x400G Transponder Mode	4x100G Muxponder Mode	3x100G Muxponder Mode	2x100G Muxponder Mode	1x100G Transponder Mode
[illegible]	1x100G	0, 7, 8, 12, 19	Yes	Yes	Yes	Yes	Yes
[illegible]	1x100G	0, 7	Yes	Yes	Yes	Yes	Yes
[illegible]	1x400G	3, 5, 6, 7, 9	Yes	Yes	Yes	Yes	Yes
A9903-20HG-PEC	1x100G	0, 4, 8, 12, 16	Yes	Yes	Yes	Yes	Yes
ASR-9902	1x100G	11, 37	No	No	No	No	Yes

Table 2: Supported line cards, ports, and modes for DP04QSDD-ULH-A1 Optical modules

Hardware Variants	Default Port Speed	Supported Front Panel Ports	1X400G Transponder Mode	4x100G Muxponder Mode	3x100G Muxponder Mode	2x100G Muxponder Mode	1x100G Transponder Mode
[illegible]	1x100G	0, 7, 8, 12, 19	Yes	Yes	No	No	No

Hardware Variants	Default Port Speed	Supported Front Panel Ports	1X400G Transponder Mode	4x100G Muxponder Mode	3x100G Muxponder Mode	2x100G Muxponder Mode	1x100G Transponder Mode
[illegible]	1x100G	0, 7	Yes	Yes	No	No	No
[illegible]	1x400G	3, 5, 6, 7, 9	Yes	Yes	No	No	No
A9903-20HG-PEC	1x100G	0, 4, 8, 12, 16	Yes	Yes	No	No	No

The 400G Digital Coherent QSFP-DD optical modules enable wavelength-division multiplexing (WDM) functionality in the router. These optical modules are DWDM C-band (196.1 THz to 191.3 THz) tunable optical modules. They can be used in both transponder and muxponder modes.

Cisco IOS XR software creates optics and coherent DSP controllers to configure and monitor the performance of the 400G Digital Coherent QSFP-DD optical modules. Optics controllers are used to configure and monitor optical parameters, such as frequency, chromatic dispersion, transmitted output power, and so on. Coherent DSP controllers are used to monitor network performance parameters like pre- and post-forward error correction (FEC) bit-error rate (pre-FEC BER, post-FEC BER), error corrected bits (EC-BITS), and so on. Forward error correction (FEC) is configured using optical controllers and monitored using coherent DSP controllers.

The 400G Digital Coherent QSFP-DD optical modules support traffic1 configuration and firmware download. The Cisco IOS XR software collects performance monitoring data and alarms.

Due to more power consumption by the 400G Digital Coherent QSFP-DD optical modules, the Cisco IOS XR software operates the fans at an higher speed to cool these optical modules.

Configuring frequency, chromatic dispersion, optical transmit power, digital to analog conversion (DAC) sampling rate, and FEC parameters impacts traffic. Also, configuring modulation is supported. Modulation is dependent on the mode of operation. See Table 5: QDD-400G-ZR-S Transponder and Muxponder Configuration Values, on page 7 and #unique_475 unique_475_Connect_42_table_u5x_f13_ppb, on page 8.

The 400G Digital Coherent QSFP-DD optical module configuration is divided into the following categories:

- Traffic configuration – Comprises configuring DAC rate, breakout, and FEC parameters. Applicable for optics controllers:
  - Configuring DAC Rate, on page 10
  - Configuring Breakout, on page 12
  - Configuring FEC, on page 15
- Optical configuration – Comprises configuring frequency, chromatic dispersion, and optical transmit power. Applicable for optics controllers:
  - Configuring Frequency, on page 16
  - Configuring Chromatic Dispersion, on page 17
  - Configuring Optical Transmit Power, on page 19
- Performance monitoring (PM) – Enables or disables performance monitoring in optical modules. You can also configure PM parameters that comprise signal power, chromatic dispersion, optical signal-to-noise

ratio (OSNR), and differential group delay (DGD). Applicable for optics controllers and coherent DSP controllers:

- Configuring Performance Monitoring, on page 22
- Configuring PM Parameters, on page 22

- Loopback configuration – Configures loopback. Applicable for coherent DSP controller:
  - Configuring Loopback, on page 25

- Alarms threshold configuration – Configures thresholds for monitoring alarms that include optical signal-to-noise ratio (OSNR), differential group delay (DGD), chromatic dispersion (cd high and low), and so on. Applicable for optics controllers:
  - Configuring Alarms Threshold, on page 29

The following table contains the possible traffic configuration values for the 400G Digital Coherent QSFP-DD optical modules, in the transponder and muxponder mode:

Table 3: 400G Digital Coherent QSFP-DD Traffic Configuration Values

Optical Module	Client Speed	Trunk Speed	Frequency	FEC	Modulation	DAC-Rate	Chromatic Dispersion (CD)	Transmitted (Tx) Power
QDD-400G-ZR-S	1x400, 4x100	400G	C-Band, 196.1 To 191.3 THz	cFEC	16QAM	1x1	-2400 to +2400	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	Client Speed	Trunk Speed	Frequency	FEC	Modulation	DAC-Rate	Chromatic Dispersion (CD)	Transmitted (Tx) Power
QDD-400G-ZR-S	1x400, 4x100, 3x100, 2x100, 1x100	400G, 300G, 200G, 100G	C-Band, 196.1 To 191.3 THz	oFEC, cFEC	16QAM, 8QAM, QPSK	1x1.25, 1x1	-160000 to +160000	Each optical module has its own transmitting (TX) power optimal values. You can change the transmitting (TX) power value based on the module capability.
DP04QSDD-HE0	1x400, 4x100, 3x100, 2x100, 1x100	400G, 300G, 200G, 100G	C-Band, 196.1 To 191.3 THz	oFEC, cFEC	16QAM, 8QAM, QPSK	1x1.25, 1x1.5	-160000 to +160000	Each optical module has its own transmitting (TX) power optimal values. You can change the transmitting (TX) power value based on the module capability.

QDD-400G-ZR-S and QDD-400G-ZRP-S FPD Upgrade

Table 4: Feature History Table

Feature Name	Release Information	Feature Description
FPD Upgrades Enabled for QDD-400G-ZR-S and QDD-400G-ZRP-S Optical Modules	Release 7.3.2	This feature allows you to perform Field Programmable Device (FPD) upgrades on the QDD-400G-ZR-S and QDD-400G-ZRP-S optical modules to ensure they have the latest fixes and features. For more information about the optic module portfolio, see the Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules Data Sheet.

Although an FPD upgrade is not mandatory in this release, we recommend upgrading the FPD to the latest version in the subsequent releases to ensure that all the latest fixes and features are enabled on the optical modules. Auto and parallel FPD upgrades are not supported. Only a manual FPD upgrade (one optical module at a time) using the **upgrade hw-module location** *node-id* **fpd** *fpd-name* command is supported.

The *fpd-name* can be obtained from the FPD description column of the **show fpd package** or the **show hw-module fpd** command. The *fpd-name* in the FPD description column displays QDD_*instance_port-number*. For example, depending on the instance and the port number, the FPD names for the QDD-400G-ZR-S and QDD-400G-ZRP-S modules will be QDD_0_3, QDD_0_0, and so on.

Note Only in case of Cisco ASR 9903 routers, the *fpd-name* in the FPD description column displays QDD_*bay_port-number*. The *bay* value for Cisco 9903 routers is always 1. Therefore, depending on the port number, the FPD names for the QDD-400G-ZR-S and QDD-400G-ZRP-S modules will be QDD_1_3, QDD_1_4, and so on.

See the "**Upgrading Field-Programmable Devices**" chapter in the *System Management Configuration Guide for Cisco ASR 9000 Series Routers* for details on the procedure to upgrade the FPD.

QDD-400G-ZR-S Transponder and Muxponder Configuration Values

The following table contains the possible Transponder and Muxponder configuration values for the QDD-400G-ZR-S optical module:

Table 5: QDD-400G-ZR-S Transponder and Muxponder Configuration Values

TXP/MXP	Client	Trunk	Modulation	FEC	DAC Rate
400G-TXP	1 client, 400G speed	1 trunk, 400G	16 QAM	cFEC	1x1
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G	16 QAM	cFEC	1x1

QDD-400G-ZRP-S Transponder and Muxponder Configuration Values

The following table contains the possible Transponder and Muxponder configuration values for the QDD-400G-ZRP-S optical module:

Table 6: QDD-400G-ZRP-S Transponder and Muxponder Configuration Values

TXP/MXP	Client	Trunk	Modulation	FEC	DAC Rate
400G-TXP	1 Client, 400G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1.25
400G-TXP	1 Client, 400G speed	1 trunk, 400G speed	16 QAM	cFEC	1x1
400G-TXP	1 Client, 400G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1.25
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	cFEC	1x1
3x100G-MXP	3 clients, 100G speed	1 trunk, 300G speed	8 QAM	oFEC	1x1.25
3x100G-MXP	3 clients, 100G speed	1 trunk, 300G speed	8 QAM	oFEC	1x1
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	QPSK	oFEC	1x1.50
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	8 QAM	oFEC	1x1.25
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	16 QAM	oFEC	1x1.25
1x100G-MXP	1 client, 100G speed	1 trunk, 100G speed	QPSK	oFEC	1x1.50

DP04QSDD-HE0 Transponder and Muxponder Configuration Values

The following table contains the possible Transponder and Muxponder configuration values for the DP04QSDD-HE0 optical module:

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

TXP/MXP	Client	Trunk	Modulation	FEC	DAC Rate
400G-TXP	1 Client, 400G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1.5
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1.25
4x100G- MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	cFEC	1x1.5
4x100G-MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1.5
3x100G-MXP	3 clients, 100G speed	1 trunk, 300G speed	8 QAM	oFEC	1x1.25
3x100G-MXP	3 clients, 100G speed	1 trunk, 300G speed	8 QAM	oFEC	1x1.5
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	QPSK	oFEC	1x1.5
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	8 QAM	oFEC	1x1.25
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	16 QAM	oFEC	1x1.25
1x100G-MXP	1 client, 100G speed	1 trunk, 100G speed	QPSK	oFEC	1x1.5

DP04QSDD-ULH-A1 Transponder and Muxponder Configuration Values

This table contains the possible transponder and muxponder configuration values for the DP04QSDD-ULH-A1 optical module:

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

TXP/MXP	Client	Trunk	Modulation	FEC	DAC Rate
4x100G-MXP	4 clients, 100G speed	1 trunk, 400G speed	16 QAM	oFEC	1x1.5
3x100G-MXP	3 clients, 100G speed	1 trunk, 300G speed	8 QAM	oFEC	1x1.25
3x100G-MXP	3 clients, 100G speed	1 trunk, 300G speed	8 QAM	oFEC	1x1.5
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	QPSK	oFEC	1x1.5
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	8 QAM	oFEC	1x1.25
2x100G-MXP	2 clients, 100G speed	1 trunk, 200G speed	16 QAM	oFEC	1x1.25
1x100G-MXP	1 client, 100G speed	1 trunk, 100G speed	QPSK	oFEC	1x1.5

Configuring DAC Rate

You can set the DAC (digital to analog conversion) sampling rate on optics controllers. You can modify the DAC sampling rate only on the QDD-400G-ZRP-S optical module.

Note QDD-400G-ZR-S supports 1x1 dac-rate in cFEC mode. QDD-400G-ZRP-S supports 1x1 dac-rate in cFEC mode and 1x1.25 dac-rate in oFEC mode. DP04QSDD-HE0 optical modules support 1x1.5 dac-rate in cFEC mode and 1x1.25 dac-rate in oFEC mode

DAC Rate Configuration Example

The following example shows how to set the DAC rate on the optics controller:

```
Router#config
Router(config)#controller optics 0/19/0/3
Router(config-Optics)#dac-rate 1x1.25
```

Verification

This example shows the running configuration:

```
Router#show run controller optics 0/19/0/3
Thu May 13 12:52:35.020 UTC
controller Optics0/19/0/3
 DAC-Rate 1x1.25
!
!
```

Verification

This example shows how to verify the configured DAC rate for the optics controller:

```
Router#show controller optics 0/19/0/3
 Controller State: Up
 Transport Admin State: In Service
 Laser State: On
 LED State: Green
 FEC State: FEC OFEC
 Optics Status
         Optics Type:  400G QSFP-DD ZRP
         DWDM carrier Info: C BAND, MSA ITU Channel=61, Frequency=193.10THz,
         Wavelength=1552.524nm

         Alarm Status:
         -------------
         Detected Alarms: None
         LOS/LOL/Fault Status:
         Laser Bias Current = 70.9 mA
         Actual TX Power = -7.06 dBm
         RX Power = -7.88 dBm
         RX Signal Power = -7.88 dBm
         Frequency Offset = -220 MHz
         Laser Temperature = 53.79 Celsius
         Laser Age = 0 %
         DAC Rate = 1x1.25

         Performance Monitoring: Enable
         THRESHOLD VALUES
         ----------------
         Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
         ------------------------  ----------  ---------  ------------  -----------
         Rx Power Threshold(dBm)          1.9      -28.2           0.0        -25.0
         Tx Power Threshold(dBm)          0.0      -18.0          -2.0        -16.0
         LBC Threshold(mA)               0.00       0.00          0.00         0.00
         Temp. Threshold(celsius)       80.00      -5.00         75.00        15.00
         Voltage Threshold(volt)         3.46       3.13          3.43         3.16

         LBC High Threshold = 98 %
         Configured Tx Power = -7.00 dBm
         Configured CD High Threshold = 80000 ps/nm
         Configured CD lower Threshold = -80000 ps/nm
         Configured OSNR lower Threshold = 9.00 dB
         Configured DGD Higher Threshold = 180.00 ps
         Baud Rate =  30.0692729950 GBd
         Modulation Type: QPSK
         Chromatic Dispersion -2 ps/nm
```

```
        Configured CD-MIN -4000 ps/nm  CD-MAX 4000 ps/nm
        Second Order Polarization Mode Dispersion = 109.00 ps^2
        Optical Signal to Noise Ratio = 32.30 dB
        Polarization Dependent Loss = 0.05 dB
        Polarization Change Rate = 0.00 rad/s
        Differential Group Delay = 0.00 ps

        Temperature = 48.00 Celsius
        Voltage = 3.30 V

Transceiver Vendor Details

        Form Factor             : QSFP-DD
        Optics type             : QSFP-DD 400G-ZRP-S
        Name                    : CISCO-ACACIA
        OUI Number              : 7c.b2.5c
        Part Number             : DP04QSDD-E30-19E
        Rev Number              : 01
        Serial Number           : ACA2503003X
        PID                     : QDD-400G-ZRP-S
        VID                     : ES03
        Firmware Version        : 61.20 (Build : 13)
        Date Code(yy/mm/dd)     : 21/01/22
```

Configuring Breakout

Feature Name	Release Information	Description
Support for 2x100G, 3x100G and 4x100G Breakout Configurations	Release 7.8.1	This release introduces 2x100G, 3x100G and 4x100G breakout configurations on the following line cards: • A9903-20HG-PEC (2x100G, 3x100G, and 4x100G) • A99-10X400GE-X-SE/TR (3x100G) • A9K-20HG-FLEX-SE/TR (2x100G, 3x100G, and 4x100G) • A9K-8HG-FLEX-SE/TR (2x100G, 3x100G, and 4x100G)

Using the **hw-module location** *node-id* port *port-number* **breakout** *muxponder-mode* command, you can configure breakout on the ports.

For configuring breakout on Cisco ASR 9903 router, use the following command:

hw-module location *node-id* **bay** *bay-number* **port** *port-number* **breakout** *muxponder-mode*

The value for *bay-number* is always 1.

For the supported line cards, ports, and modes, see Table 1: Supported line cards, ports, and modes for QDD-400G-ZR-S and QDD-400G-ZRP-S Optical modules, on page 3.

Configuring Breakout on the Line card with Default 100G Port Speed

The ports with default 100G speed can be configured to operate at 400G port speed using the following command:

This example shows how to configure 1x400G transponder mode on a port with default 100G port speed:

- **hw-module location 0/0/CPU0 port 0 breakout 1xFourHundredGigE**

To remove the breakout configuration and revert to the default 100G port speed, use the **no** form of the command.

For example:

- **no hw-module location 0/0/CPU0 port 0 breakout 1xFourHundredGigE**

Note In the A9903-20HG-PEC card, to configure 1x400G transponder mode, use the **hw-module location 0/0/CPU0 bay 1 port 0 breakout 1xFourHundredGigE** command. To remove the breakout configuration and revert to the default 100G port speed, use the **no** for the command - **no hw-module location 0/0/CPU0 bay 1 port 0 breakout 1xFourHundredGigE**.

To configure 4x100G or 2x100G muxponder mode, use the 4x100G or 2x100G breakout on the supported port(s).

For example:

- **hw-module location 0/0/CPU0 port 0 breakout 4xHundredGigE**
- **hw-module location 0/0/CPU0 port 7 breakout 2xHundredGigE**
- **hw-module location 0/0/CPU0 port 7 breakout 3xHundredGigE**

To remove the breakout configuration and revert to the default 100G port speed, use the **no** form of the command.

For example:

- **no hw-module location 0/0/CPU0 port 0 breakout 4xHundredGigE**
- **no hw-module location 0/0/CPU0 port 7 breakout 2xHundredGigE**
- **no hw-module location 0/0/CPU0 port 7 breakout 3xHundredGigE**

Configuring Breakout on the Line card with Default 400G Port Speed

The ports with default 400G speed can be configured to operate at 100G port speed using the following command:

This example shows how to configure 1x100G transponder mode on a port with default 400G port speed:

For example:

- **hw-module location 0/0/CPU0 port 0 breakout 1xHundredGigE**

To remove the breakout configuration and revert to the default 400G port speed, use the **no** form of the command.

For example:

- **no hw-module location 0/0/CPU0 port 0 breakout 1xHundredGigE**

To configure 4x100G or 2x100G or 3x100G muxponder mode, use the 4x100G or 2x100G or 3x100G breakout on the supported port(s).

For example:

- **hw-module location 0/0/CPU0 port 0 breakout 4xHundredGigE**
- **hw-module location 0/0/CPU0 port 7 breakout 2xHundredGigE**
- **hw-module location 0/0/CPU0 port 7 breakout 3xHundredGigE**

To remove the breakout configuration and revert to the default 400G port speed, use the **no** form of the command.

For example:

- **no hw-module location 0/0/CPU0 port 0 breakout 4xHundredGigE**
- **no hw-module location 0/0/CPU0 port 7 breakout 2xHundredGigE**
- **no hw-module location 0/0/CPU0 port 7 breakout 3xHundredGigE**

Muxponder Mode Configuration Example

The following example shows how to configure muxponder mode on the optics controller:

```
Router#config
Router(config)#hw-module location 0/0/CPU0 port 3 breakout 4xHundredGigE
Router(config-Optics)#commit
Router(config-Optics)#exit
Router(config)#exit
```

Note In the above example, the Cisco IOS XR software creates four Ethernet clients with 100GE speed, which can be verified using the **show ipv4 interface brief location | include** *R/S/I/P* command.

Running Configuration

This example shows the running configuration for the optics controller:

```
Router#show running-config | inc break
Building configuration...
hw-module location 0/1/CPU0 port 1 breakout 1xHundredGigE
hw-module location 0/1/CPU0 port 3 breakout 4xHundredGigE
hw-module location 0/1/CPU0 port 8 breakout 1xHundredGigE
 !
```

Verification

This example shows how to verify the muxponder mode configuration:

```
Router#show ipv4 interface brief location 0/1/CPU0 | inc 0/1/0/3
HundredGigE0/1/0/3/0 unassigned Shutdown Down default
HundredGigE0/1/0/3/1 unassigned Shutdown Down default
HundredGigE0/1/0/3/2 unassigned Shutdown Down default
HundredGigE0/1/0/3/3 unassigned Shutdown Down default
```

Configuring FEC

You can configure forward error correction (FEC) only on optics controllers. You can modify FEC only on the QDD-400G-ZRP-S optical module. FEC is a feature that is used for controlling errors during data transmission. This feature works by adding data redundancy to the transmitted message using an algorithm. This redundancy allows the receiver to detect and correct a limited number of errors occurring anywhere in the message, instead of having to ask the transmitter to resend the message.

Note QDD-400G-ZR-S supports cFEC (concatenated forward error correction) and QDD-400G-ZRP-S supports cFEC and oFEC (open forward error correction).

FEC Configuration Example

The following sample shows how to configure FEC on the optics controller:

```
Router#configure
Router(config)#controller optics 0/19/0/5
Router(config-Optics)#fec CFEC
Router(config-Optics)#commit
Router(config-Optics)#exit
Router(config)#exit
```

Running Configuration

This example shows the running configuration:

```
Router#show run controllers optics 0/19/0/5
controller 0/19/0/5
 fec CFEC
!
```

Verification

This example shows how to verify the FEC configuration for the optics controller:

```
Router#show controller coherentdsp 0/19/0/5

Port                                          : CoherentDSP 0/19/0/5
Controller State                              : Up
Inherited Secondary State                     : Normal
Configured Secondary State                    : Normal
Derived State                                 : In Service
Loopback mode                                 : None
BER Thresholds                                : SF = 1.0E-5  SD = 1.0E-7
Performance Monitoring                        : Enable
Bandwidth                                     : 400.0Gb/s

Alarm Information:
LOS = 0 LOF = 0 LOM = 0
OOF = 0 OOM = 0 AIS = 0
IAE = 0 BIAE = 0        SF_BER = 0
SD_BER = 0      BDI = 0 TIM = 0
FECMISMATCH = 0 FEC-UNC = 0     FLEXO_GIDM = 0
FLEXO-MM = 0    FLEXO-LOM = 0   FLEXO-RDI = 0
FLEXO-LOF = 1
Detected Alarms                               : None

Bit Error Rate Information
```

```
PREFEC  BER                                     : 4.5E-04
POSTFEC BER                                     : 0.0E+00
Q-Factor                                        : 10.40 dB
Q-Margin                                        : 3.20dB
OTU TTI Received

FEC mode                                        : C_FEC
```

Configuring Frequency

You can configure frequency on optics controllers. You can select any C band frequency between the range 196.1 to 191.3 THz, in both ITU and NON-ITU channels.

Note The 100MHz-grid keyword accepts only frequency values as user input. The 50GHz-grid keyword accepts frequency, ITU-channel, or wavelength values as user input. The Cisco IOS XR software then caculates the frequency for a given wavelength or ITU-channel.

Frequency Configuration Example

The following example shows how to configure frequency on the optics controller:

```
Router#config
Router(config)#controller optics 0/1/0/9
Router(config-Optics)#dwdm-carrier 100MHz-grid frequency 1921500
Router(config-Optics)#commit
Router(config-Optics)#exit
Router(config)#exit
```

Running Configuration

This example shows the running configuration:

```
Router#show run controller optics 0/1/0/9
controller Optics0/1/0/9
 dwdm-carrier 100MHz-grid frequency 1921500
 cd-low-threshold -5000
 cd-high-threshold -5000
!
```

Verification

This example shows how to verify the frequency configuration:

```
Router#show controllers optics 0/1/0/9
Controller State: Up
Transport Admin State: In Service
Laser State: On
LED State: Green
FEC State: FEC OFEC
Optics Status

    Optics Type: 400G QSFP-DD ZRP
    DWDM carrier Info: C BAND, MSA ITU Channel=80, Frequency=192.15THz,
    Wavelength=1560.200nm

    Alarm Status:
    -------------
    Detected Alarms: None
    LOS/LOL/Fault Status:
```

```
    Laser Bias Current = 52.5 mA
    Actual TX Power = -11.03 dBm
    RX Power = -12.15 dBm
    RX Signal Power = -12.15 dBm
    Frequency Offset = -140 MHz
    Laser Temperature = 52.45 Celsius
    Laser Age = 0 %
    DAC Rate = 1x1.25
    Performance Monitoring: Enable

    THRESHOLD VALUES
    ----------------
         Parameter                High Alarm  Low Alarm  High Warning  Low Warning
         -----------------------  ----------  ---------  ------------  -----------
         Rx Power Threshold(dBm)         1.9      -23.0           0.0        -20.0
         Tx Power Threshold(dBm)         0.0      -18.0          -2.0        -16.0
         LBC Threshold(mA)              0.00       0.00          0.00         0.00
         Temp. Threshold(celsius)      80.00      -5.00         75.00        15.00
         Voltage Threshold(volt)        3.46       3.13          3.43         3.16

    LBC High Threshold = 98 %
    Configured Tx Power = -7.00 dBm
    Configured CD High Threshold = 5000 ps/nm
    Configured CD lower Threshold = -5000 ps/nm
    Configured OSNR lower Threshold = 9.00 dB
    Configured DGD Higher Threshold = 180.00 ps
    Baud Rate = 60.1385459900 GBd
    Modulation Type: 16QAM
    Chromatic Dispersion 0 ps/nm
    Configured CD-MIN -26000 ps/nm CD-MAX 26000 ps/nm
    Second Order Polarization Mode Dispersion = 36.00 ps^2
    Optical Signal to Noise Ratio = 35.80 dB
    Polarization Dependent Loss = 0.08 dB
    Polarization Change Rate = 0.00 rad/s
    Differential Group Delay = 1.00 ps

    Temperature = 54.00 Celsius
    Voltage = 3.29 V

Transceiver Vendor Details

    Form Factor : QSFP-DD
    Optics type : QSFP-DD 400G-ZRP-S
    Name : CISCO-ACACIA
    OUI Number : 7c.b2.5c
    Part Number : DP04QSDD-E30-19D
    Rev Number : B0
    Serial Number : ACA2440001M
    PID : QDD-400G-ZRP-S
    VID : VES1
    Firmware Version : 61.20 (Build : 13)
    Date Code(yy/mm/dd) : 20/10/02
```

Configuring Chromatic Dispersion

You can configure chromatic dispersion on optics controllers. When you configure the maximum and minimum values for chromatic dispersion for any data rate, ensure that the minimum difference between the configured values is equal to or greater than 1000 ps/nm.

The following table lists the default CD search range:

Table 7: Default CD Search Range

Muxponder Rate	FEC Value	Default CD Search Range (Min-Max)
400	OFEC	-26000 to +26000
400	CFEC	-2400 to +2400
300	OFEC	-50000 to +50000
200	OFEC	-50000 to +50000
100	OFEC	-80000 to +80000

Chromatic Dispersion Configuration Example

This example shows how to configure chromatic dispersion on the optics controller:

```
Router#configure
Router(config)#controller optics 0/19/0/5
Router(config-Optics)#cd-max 2500
Router(config-Optics)#cd-min -2500
Router(config-Optics)#commit
Router(config-Optics)#exit
Router(config)#exit
```

Running Configuration

This example shows the running configuration for the optics controller:

```
Router#show run controller optics 0/19/0/5
controller Optics0/19/0/5
 cd-min -2500
 cd-max 2500
 !
```

Verification

This example shows how to verify the configured chromatic dispersion values for the optics controller:

```
Router#show controller optics 0/19/0/5
 Controller State: Up
 Transport Admin State: In Service
 Laser State: On
 LED State: Red
 FEC State: FEC CFEC
 Optics Status

         Optics Type:  400G QSFP-DD ZR
         DWDM carrier Info: C BAND, MSA ITU Channel=61, Frequency=193.10THz,
         Wavelength=1552.524nm

         Alarm Status:
         -------------
         Detected Alarms: None
         LOS/LOL/Fault Status:
         Laser Bias Current = 52.5 mA
         Actual TX Power = 2.02 dBm
         RX Power = 0.91 dBm
         RX Signal Power = -7.44 dBm
         Frequency Offset = -65 MHz
         Laser Temperature = 54.54 Celsius
```

```
        Laser Age = 0 %
        DAC Rate = 1x1
        Performance Monitoring: Enable

        THRESHOLD VALUES
        ----------------
        Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
        ------------------------  ----------  ---------  ------------  -----------
        Rx Power Threshold(dBm)          1.9      -23.0           0.0        -20.0
        Tx Power Threshold(dBm)          0.0      -18.0          -2.0        -16.0
        LBC Threshold(mA)               0.00       0.00          0.00         0.00
        Temp. Threshold(celsius)       80.00      -5.00         75.00        15.00
        Voltage Threshold(volt)         3.46       3.13          3.43         3.16

        LBC High Threshold = 98 %
        Configured Tx Power = -7.00 dBm
        Configured CD High Threshold = 80000 ps/nm
        Configured CD lower Threshold = -80000 ps/nm
        Configured OSNR lower Threshold = 9.00 dB
        Configured DGD Higher Threshold = 180.00 ps
        Baud Rate =  59.8437500000 GBd
        Modulation Type: 16QAM
        Chromatic Dispersion 1 ps/nm
        Configured CD-MIN -2500 ps/nm  CD-MAX 2500 ps/nm
        Second Order Polarization Mode Dispersion = 39.00 ps^2
        Optical Signal to Noise Ratio = 36.40 dB
        Polarization Dependent Loss = 0.07 dB
        Polarization Change Rate = 0.00 rad/s
        Differential Group Delay = 5.00 ps

        Temperature = 51.94 Celsius
        Voltage = 3.31 V

Transceiver Vendor Details

        Form Factor             : QSFP-DD
        Optics type             : QSFP-DD 400G-ZR-S
        Name                    : CISCO-ACACIA
        OUI Number              : 7c.b2.5c
        Part Number             : DP04QSDD-E20-190
        Rev Number              : A
        Serial Number           : ACA25220027
        PID                     : QDD-400G-ZR-S
        VID                     : V01
        Firmware Version        : 61.20 (Build : 13)
        Date Code(yy/mm/dd)     : 21/06/01
```

Configuring Optical Transmit Power

You can set the transmit power of the optical signal.

Each QDD-400G-ZR-S and QDD-400G-ZRP-S optical module has its own optical transmit (TX) power range. User can change the optical transmit (TX) power value based on the module capability. For "Transmitter specifications", see the *Cisco 400G Digital Coherent Optics QSFP-DD Optical Modules Data Sheet*.

Table 8: Optical Transmit Power Values

Optical Module	Trunk Speed	Optical Transmit Power (Tx) Shaping	Interval	Supported Range of Optical Transmit Power (Tx) Values (in units of 0.1dBm)[1]		
				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
				-150	-104	-119
				-150	-90	-105
				-150	-59	-75
DP04QSDD-HE0	400G	Yes	1	-150	15	25
	300G					
	200G					
	100G					
DP04QSDD-ULH-A1	400G	Yes	1	depends on the appsel configuration	depends on the appsel configuration	depends on the appsel configuration

1. The default optical transmit power (Tx) value is -10 dBm, however with TX shaping enabled the maximum power in 1x400G, 4x100G, 3x100G, and 2x100G modes may be less than -10 dBm.

Transmitting Power Configuration Example

The following example shows how to configure the optical transmit (TX) power on the optics controller:

```
Router#config
Router(config)#controller optics 0/19/0/3
Router(config-Optics)#transmit-power -70
Router(config-Optics)#commit
Router(config-Optics)#exit
Router(config)#exit
```

Running Configuration

This example shows the running configuration for the optics controller:

```
Router#show run controller optics 0/19/0/3
Thu May 13 12:52:35.020 UTC
controller Optics0/19/0/3
 cd-min -4000
 cd-max 4000
 transmit-power -70
!
```

Verification

This example shows how to verify the configured optical transmit power for the optics controller:

```
Router#show controller optics 0/19/0/3
 Controller State: Up
 Transport Admin State: In Service
 Laser State: On
 LED State: Green
 FEC State: FEC OFEC
 Optics Status

         Optics Type:  400G QSFP-DD ZRP
         DWDM carrier Info: C BAND, MSA ITU Channel=61, Frequency=193.10THz,
         Wavelength=1552.524nm

         Alarm Status:
         -------------
         Detected Alarms: None
         LOS/LOL/Fault Status:
         Laser Bias Current = 70.9 mA
         Actual TX Power = -7.06 dBm
         RX Power = -7.88 dBm
         RX Signal Power = -7.88 dBm
         Frequency Offset = -220 MHz
         Laser Temperature = 53.79 Celsius
         Laser Age = 0 %
         DAC Rate = 1x1.25
         Performance Monitoring: Enable

         THRESHOLD VALUES
         ----------------

         Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
         ------------------------  ----------  ---------  ------------  -----------
         Rx Power Threshold(dBm)          1.9      -28.2           0.0        -25.0
         Tx Power Threshold(dBm)          0.0      -18.0          -2.0        -16.0
         LBC Threshold(mA)               0.00       0.00          0.00         0.00
         Temp. Threshold(celsius)       80.00      -5.00         75.00        15.00
         Voltage Threshold(volt)         3.46       3.13          3.43         3.16

         LBC High Threshold = 98 %
      Configured Tx Power = -7.00 dBm
         Configured CD High Threshold = 80000 ps/nm
         Configured CD lower Threshold = -80000 ps/nm
         Configured OSNR lower Threshold = 9.00 dB
         Configured DGD Higher Threshold = 180.00 ps
         Baud Rate =  30.0692729950 GBd
         Modulation Type: QPSK
         Chromatic Dispersion -2 ps/nm
         Configured CD-MIN -4000 ps/nm  CD-MAX 4000 ps/nm
         Second Order Polarization Mode Dispersion = 109.00 ps^2
         Optical Signal to Noise Ratio = 32.30 dB
         Polarization Dependent Loss = 0.05 dB
         Polarization Change Rate = 0.00 rad/s
         Differential Group Delay = 0.00 ps
         Temperature = 48.00 Celsius
         Voltage = 3.30 V

 Transceiver Vendor Details

         Form Factor            : QSFP-DD
         Optics type            : QSFP-DD 400G-ZRP-S
         Name                   : CISCO-ACACIA
         OUI Number             : 7c.b2.5c
         Part Number            : DP04QSDD-E30-19E
         Rev Number             : 01
         Serial Number          : ACA2503003X
```

```
PID                   : QDD-400G-ZRP-S
VID                   : ES03
Firmware Version      : 61.20 (Build : 13)
Date Code(yy/mm/dd)   : 21/01/22
```

Configuring Performance Monitoring

Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds for, and report performance data for early detection of problems. The user can retrieve both current and historical PM counters for the various controllers in 30-second, 15-minute, and 24-hour intervals.

Performance monitoring can be configured on optics controllers and coherent DSP controllers.

To stop performance monitoring on optics or coherent DSP controllers, use the **perf-mon disable** keyword.

Configuring PM Parameters

The performance monitorning (PM) threshold and the threshold crossing alert (TCA) reporting status can be configured for optics controllers and coherent DSP controllers:

Table 9: PM Thresholds and TCA Report Status for Optics Controllers

PM Parameters	Description
CD	Sets the CD (chromatic dispersion) threshold or TCA reporting status.
DGD	Sets the DGD (differential group delay) threshold or TCA reporting status.
LBC	Sets the LBC (laser bias current) threshold or TCA reporting status in mA.
FREQ-OFF	Sets the FREQ-OFF (low signal frequency offset) threshold or TCA reporting status in Mhz.
OPR	Sets the OPR (optical power RX) threshold or TCA reporting status in uW or dbm.
OPT	Sets the OPT (optical power TX) threshold or TCA reporting status in uW or dbm.
OSNR	Sets the OSNR (optical signal-to-noise ratio) threshold or TCA reporting status.
PCR	Sets the PCR (polarization change rate) threshold or TCA reporting status.
PDL	Sets the PDL (polarization dependent loss) threshold or TCA reporting status.
RX-SIG	Sets the RX-SIG (receiving signal power) threshold or TCA reporting status in uW or dbm.

PM Parameters	Description
SNR	Sets the SNR (signal-to-noise ratio) threshold or TCA reporting status.
SOPMD	Sets the SOPMD (second order polarization mode dispersion) threshold or TCA reporting status.

Table 10: PM Thresholds TCA Report Status for Coherent DSP Controllers

PM Parameters	Description
Q	Sets the Q threshold or TCA reporting status.
Q-margin	Sets the Q margin threshold or TCA reporting status.
EC-BITS	Sets the EC-BITS (error corrected bits) threshold or TCA reporting status.
PostFEC BER	Sets the post-FEC BER threshold or TCA reporting status.
PreFEC BER	Sets the pre-FEC BER threshold or TCA reporting status.
UC-WORDS	Sets the UC-WORDS (uncorrected words) threshold or TCA reporting status.

Performance Monitoring Configuration Example

This example shows how to enable performance monitoring and set PM thresholds on the optics controller:

```
Router#config
Router(config)#controller optics 0/2/0/16
Router(config-Optics)#perf-mon enable
Router(config-Optics)#pm 30-sec optics threshold cd max 100
Router(config-Optics)#pm 30-sec optics threshold cd min -100
Router(config-Optics)#commit
```

Running Configuration

This example shows the running configuration on optics controllers:

```
Router#show run controller optics 0/2/0/16
Thu May 13 20:18:55.957 UTC
controller Optics0/2/0/16
pm 30-sec optics threshold cd max 100
pm 30-sec optics threshold cd min -100
 perf-mon enable
!
```

Verification

This example shows how to verify the PM parameters on optics controllers. Verify the configuration changes in the Configured Threshold fields:

```
Router#show controller optics 0/2/0/16 pm current 30-sec optics 1
  Thu May 27 17:58:49.889 UTC
Optics in the current interval [17:58:30 - 17:58:49 Thu May 27 2021]
Optics current bucket type : Valid
```

```
            MIN       AVG       MAX      Operational      Configured      TCA   Operational
      Configured     TCA
                                          Threshold(min)   Threshold(min) (min) Threshold(max)
   Threshold(max) (max)
LBC[mA ]       : 0.0       0.0       0.0      0.0               NA              NO   100.0
          NA               NO
OPT[dBm]      : -9.98     -9.98     -9.98    -15.09            NA              NO   0.00
          NA               NO
OPR[dBm]      : -40.00    -40.00    -40.00   -30.00            NA              NO   8.00
          NA               NO
CD[ps/nm]     : 0         0         0        -80000          -100          NO   100
    100          NO
DGD[ps ]      : 0.00      0.00      0.00     0.00              NA              NO   80.00
          NA               NO
SOPMD[ps^2]   : 0.00      0.00      0.00     0.00              NA              NO   2000.00
          NA               NO
OSNR[dB]      : 0.00      0.00      0.00     0.00              NA              NO   40.00
          NA               NO
PDL[dB]       : 0.00      0.00      0.00     0.00              NA              NO   7.00
          NA               NO
PCR[rad/s]    : 0.00      0.00      0.00     0.00             NA              NO   2500000.00
       NA              NO
RX_SIG[dBm]   : -40.00    -40.00    -40.00   -30.00            NA              NO   1.00
          NA               NO
FREQ_OFF[Mhz]: 0          0         0        -3600             NA              NO   3600
          NA               NO
SNR[dB]       : 0.00      0.00      0.00     7.00              NA              NO   100.00
          NA               NO

Last clearing of "show controllers OPTICS" counters never
!
```

Performance Monitoring Configuration Example

This example shows how to enable performance monitoring and set PM thresholds and TCA reporting status on the coherent DSP controller:

```
Router#config
Router(config)#controller CoherentDSP0/2/0/16
Router(config-CoDSP)#perf-mon enable
Router(config-CoDSP)#pm 30-sec fec report Q max-tca enable
Router(config-CoDSP)#pm 30-sec fec report Q-margin max-tca enable
Router(config-CoDSP)#pm 30-sec fec report Q min-tca enable
Router(config-CoDSP)#pm 30-sec fec report Q-margin min-tca enable
Router(config-CoDSP)#pm 30-sec fec threshold Q max 1200
Router(config-CoDSP)#pm 30-sec fec threshold Q-margin max 500
Router(config-CoDSP)#pm 30-sec fec threshold Q min 900
Router(config-CoDSP)#pm 30-sec fec threshold Q-margin min 280
Router(config-CoDSP)#commit
```

Running Configuration

This example shows the running configuration on coherent DSP controllers:

```
Router#show run controller coherentdsp 0/2/0/16
Thu May 13 19:56:09.136 UTC
controller CoherentDSP0/2/0/16
 pm 30-sec fec report Q max-tca enable
 pm 30-sec fec report Q-margin max-tca enable
 pm 30-sec fec report Q min-tca enable
 pm 30-sec fec report Q-margin min-tca enable
 pm 30-sec fec threshold Q max 1200
 pm 30-sec fec threshold Q-margin max 500
 pm 30-sec fec threshold Q min 900
```

```
 pm 30-sec fec threshold Q-margin min 280
 perf-mon enable
 !
```

Verification

This example shows how to verify the PM parameters on coherent DSP controllers. Verify the configuration changes in the highlighted fields:

```
Router#show controllers coherentdsp 0/2/0/16 pm current 30-sec fec
Thu May 27 23:04:54.167 UTC
g709 FEC in the current interval [23:04:30 - 23:04:54 Thu May 27 2021]
FEC current bucket type : Valid
    EC-BITS   : 0                       Threshold : 111484000000          TCA(enable)  :
YES
    UC-WORDS  : 0                       Threshold : 5                     TCA(enable)  :
YES
                                      MIN       AVG        MAX      Threshold      TCA
 Threshold     TCA
                                                                        (min)     (enable)
   (max)     (enable)
PreFEC BER                    :     0E-15     0E-15     0E-15      0E-15        NO
0E-15        NO
PostFEC BER                   :     0E-15     0E-15     0E-15      0E-15        NO
0E-15        NO
Q[dB]                         :      0.00      0.00      0.00      9.00  YES 120.00  YES
Q_Margin[dB]                  :      0.00      0.00      0.00      2.80  YES  5.00   YES
 !
```

Configuring Loopback

You can configure internal or line loopback on coherent DSP controllers. Loopback can be performed only in the maintenance mode.

Loopback Configuration Example

This example shows how to enable internal loopback configuration on coherent DSP controllers:

```
Router#config
Router(config)#controller coherentDSP 0/0/0/4
Router(config-CoDSP)#secondary-admin-state maintenance
Router(config-CoDSP)#loopback internal
Router(config-CoDSP)#commit
```

Running Configuration

This example shows the running configuration on coherent DSP controllers:

```
Router#show run controller coherentdsp 0/0/0/4
controller CoherentDSP0/0/0/4
 secondary-admin-state maintenance
 loopback internal
!
```

Verification

This example shows how to verify the loopback configuration on coherent DSP controllers:

```
Router#show controller coherentdsp 0/0/0/4
Thu May 27 17:28:51.960 UTC
Port                                          : CoherentDSP 0/0/0/4
Controller State                              : Down
Inherited Secondary State                     : Normal
```

```
Configured Secondary State                    : Maintenance
Derived State                                    : Maintenance
Loopback mode                                 : Internal
BER Thresholds                                   : SF = 1.0E-5  SD = 1.0E-7
Performance Monitoring                           : Enable
Bandwidth                                        : 400.0Gb/s
Alarm Information:
LOS = 6 LOF = 0 LOM = 0
OOF = 0 OOM = 0 AIS = 0
IAE = 0 BIAE = 0        SF_BER = 0
SD_BER = 0      BDI = 0 TIM = 0
FECMISMATCH = 0 FEC-UNC = 0     FLEXO_GIDM = 0
FLEXO-MM = 0    FLEXO-LOM = 0   FLEXO-RDI = 0
FLEXO-LOF = 5
Detected Alarms                                  : LOS
Bit Error Rate Information
PREFEC  BER                                      : 5.0E-01
POSTFEC BER                                      : 0.0E+00
Q-Factor                                         : 0.00 dB
Q-Margin                                         : -7.20dB
OTU TTI Received
FEC mode                                         : C_FEC
```

Laser Squelching

Table 11: Feature History Table

Feature Name	Release Information	Description
Disable Auto-Squelching	Release 24.4.1	Introduced in this release on: Fixed Systems(8200, 8700); Modular Systems (8800 [LC ASIC: P100]) (select variants only*). *This feature is now supported on: • 8212-32FH-M • 8711-32FH-M • 88-LC1-12TH24FH-E

Feature Name	Release Information	Description
Disable Auto-Squelching	Release 7.10.1	This release introduces support to disable Auto squelching. This helps to detect weak signals that are hidden within the laser source noise. By disabling Auto squelch, you can reduce the processing overhead in systems that have stable laser sources and minimal noise, helping you optimize the performance of your system. When the Auto squelch function is enabled, the optical module will generate a local fault signal on the host side if it detects a fault on the media side. By default, Auto squelch is enabled. The feature introduces these changes: **CLI:** • The **controller optics** command is modified to support a new optional keyword, **host auto-squelch disable** **YANG DATA models:** • New XPaths for `Cisco-IOS-XR-controller-optics-cfg` (see Github, YANG Data Models Navigator)

This release introduces the support to disable auto-squelch functionality on the module on the host side. When enabled, the output squelch function is activated on the module when no suitable media-side input signal from the remote end is available to be forwarded to the host-side output (example: Rx LOS is asserted). Auto squelching is commonly used to suppress unwanted noise from laser sources in communication systems. When disabled and no valid signal is detected on the module from the remote end, the module will generate a Local Fault towards the NPU. However, disabling auto-squelching provides you with expanded signal detection. This enables you to detect extremely weak signals that are embedded within the laser source noise. Also, by eliminating the need to continuously monitor and suppress unwanted noise, system resources can be allocated more efficiently, leading to improved performance.

In this feature, we introduced the **host auto-squelch disable** command to disable the auto-squelch functionality when there is an invalid input signal from the remote end. This feature provides you with the flexibility to customize the system's behavior according to your requirements.

Disabling Laser Squelching Configuration Example

This example shows how to disable laser squelching for a host on controller optics:

```
router#config
router(config)#controller 0/0/0/0
router(config-Optics)#host auto-squelch disable
router(config-Optics)#commit
```

Verification

This example shows how to verify the laser squelching disabled configuration:

```
router#show controllers optics 0/0/0/0
    Host Squelch Status: disable
```

Small Frame Padding

Table 12: Feature History Table

Feature Name	Release Information	Description
Small Frame Padding	Release 7.10.1	Small frame padding prevents packet drops caused by network congestion. If the minimum frame size requirement isn't met, the frames drop, this enhancement ensures that your hardware ASIC adds extra bytes to the payload, thereby fulfilling the 68-byte minimum frame size requirement. By doing so, small frame padding significantly enhances network reliability and minimizes the risk of dropped frames due to congestion-related issues. Previously, this feature was supported on the second and third generations of the ASR 9000 Series Ethernet line cards. Starting from this release, we extend this feature support to the fourth and fifth generations of the ASR 9000 Series Ethernet line cards.

Small frame padding refers to the technique of adding extra bytes to a transmitted data frame to ensure that the frame meets a minimum size requirement. In an ethernet based data transmission, a minimum of 68 bytes frame size is required to ensure reliable transmission and reception of data. If the minimum Ethernet frame length requirement isn't met, the frames are treated as runt frames and dropped. This feature enables the Cisco ASR 9000 routers to add frames to meet the transmission requirement of 68 bytes on the egress interface to seamlessly work with other interconnected networks.

Implementing small frame padding offers several key benefits:

- Enhances network reliability: Small frame padding ensures that the minimum frame size is met, thereby helping to prevent data loss or corruption caused by network congestion, which can result in dropped frames.
- Enhances network security: Small frame padding obscures the true size of data frames, making it difficult for attackers to identify patterns in network traffic, thereby contributing to a more secure network.
- Improves performance: Small frame padding ensures more frequent transmission of frames, actively utilizing communication channels more often and optimizing network resource usage.

Small frame padding is supported on the following line cards:

- Second generation of the ASR 9000 Series Ethernet line cards
- Third generation of the ASR 9000 Series Ethernet line cards
- Fourth generation of the ASR 9000 Series Ethernet line cards
- Fifth generation of the ASR 9000 Series Ethernet line cards

Configuring small frame padding

This example shows how to configure the small-frame-padding command:

```
router(config)# interface HundredGigE 0/1/0/0
router(config-if)# small-frame-padding
```

Verification

This example shows how to verify the small-frame-padding configuration:

```
router(config)# show controller asic ls-np instance 0 76 register location 0/1/CPU0 | i
HexPad
0x010480580  elf1Reg_elf1Sf0Cfg_elf1HexPadCfg 0x00000001 (4 bytes)
0x010480780  elf1Reg_elf1Sf1Cfg_elf1HexPadCfg 0x00000000 (4 bytes)
```

The NPU registers contain configurations for physical port numbers.

- For 'elf1Reg_elf1Sf0Cfg', bits 0–19 are for physical port numbers ranging 0–19.
- For 'elf1Reg_elf1Sf1Cfg', the bits 0–19 are for physical port numbers ranging from 20 to 39.

In the given example, HundredGigE 0/1/0/0 has a physical port number of 0. Hence, bit 0 on 'elf1Reg_elf1Sf0Cfg' is set to 1 after the small-frame-padding configuration.

Configuring Alarms Threshold

The alarms threshold can be configured for monitoring alarms on optics controllers:

Table 13: Alarms Threshold Parameters for Optics Controllers

Alarm Threshold Parameters	Description
CD	Sets the CD (chromatic dispersion) alarm threshold (cd-low-threshold and cd-high-threshold).

Alarm Threshold Parameters	Description
DGD	Sets the DGD (differential group delay) alarm threshold.
LBC	Sets the LBC (laser bias current) threshold in mA.
OSNR	Sets the OSNR (optical signal-to-noise ratio) alarm threshold.

Alarm Threshold Configuration Example

This example shows how to configure alarm threshold on the optics controller:

```
Router#config
Router(config)#controller optics 0/2/0/16
Router(config-Optics)#cd-low-threshold -5000
Router(config-Optics)#cd-high-threshold 5000
Router(config-Optics)#commit
```

Running Configuration

This example shows the running configuration on the optics controller:

```
Router#show run controller optics 0/2/0/16
controller Optics0/2/0/16
 cd-low-threshold 5000
 cd-high-threshold 5000
!
```

Verification

This example shows how to verify the alarm threshold on optics controllers:

```
Router#show controller optics 0/2/0/16
Fri May 28 01:04:33.604 UTC
 Controller State: Up
 Transport Admin State: In Service
 Laser State: Off
 LED State: Off
 FEC State: FEC OFEC
 Optics Status
         Optics Type:  400G QSFP-DD ZRP
         DWDM carrier Info: C BAND, MSA ITU Channel=61, Frequency=193.10THz,
         Wavelength=1552.524nm
         Alarm Status:
         -------------
         Detected Alarms: None
         LOS/LOL/Fault Status:
         Alarm Statistics:
         -------------
         HIGH-RX-PWR = 0            LOW-RX-PWR = 0
         HIGH-TX-PWR = 0            LOW-TX-PWR = 0
         HIGH-LBC = 0               HIGH-DGD = 0
         OOR-CD = 0                 OSNR = 0
         WVL-OOL = 0                MEA  = 0
         IMPROPER-REM = 0
         TX-POWER-PROV-MISMATCH = 0
         Laser Bias Current = 0.0 mA
         Actual TX Power = -40.00 dBm
         RX Power = -40.00 dBm
         RX Signal Power = -40.00 dBm
         Frequency Offset = 0 MHz
```

```
        Laser Temperature = 0.00 Celsius
        Laser Age = 0 %
        DAC Rate = 1x1.25
        Performance Monitoring: Enable
        THRESHOLD VALUES
        ----------------
        Parameter                 High Alarm  Low Alarm  High Warning  Low Warning
        ------------------------  ----------  ---------  ------------  -----------
        Rx Power Threshold(dBm)         13.0      -24.0          10.0        -22.0
        Tx Power Threshold(dBm)          0.0      -16.0          -2.0        -14.0
        LBC Threshold(mA)               0.00       0.00          0.00         0.00
        Temp. Threshold(celsius)       80.00      -5.00         75.00         0.00
        Voltage Threshold(volt)         3.46       3.13          3.43         3.16
        LBC High Threshold = 98 %
        Configured Tx Power = -10.00 dBm
        Configured CD High Threshold = -5000 ps/nm
        Configured CD lower Threshold = -5000 ps/nm
        Configured OSNR lower Threshold = 9.00 dB
        Configured DGD Higher Threshold = 80.00 ps
        Baud Rate =  60.1385459900 GBd
        Modulation Type: 16QAM
        Chromatic Dispersion 0 ps/nm
        Configured CD-MIN -26000 ps/nm  CD-MAX 26000 ps/nm
        Second Order Polarization Mode Dispersion = 0.00 ps^2
        Optical Signal to Noise Ratio = 0.00 dB
        Polarization Dependent Loss = 0.00 dB
        Polarization Change Rate = 0.00 rad/s
        Differential Group Delay = 0.00 ps
        Temperature = 21.00 Celsius
        Voltage = 3.42 V
 Transceiver Vendor Details

        Form Factor            : QSFP-DD
        Optics type            : QSFP-DD 400G-ZRP-S
        Name                   : CISCO-ACACIA
        OUI Number             : 7c.b2.5c
        Part Number            : DP04QSDD-E30-19E
        Rev Number             : 01
        Serial Number          : ACA2503003X
        PID                    : QDD-400G-ZRP-S
        VID                    : ES03
        Firmware Version       : 61.20 (Build : 13)
        Date Code(yy/mm/dd)    : 21/01/22
!
```

Application select code provisioning

Application select code, also known as AppSel code, is a feature that

- allows the host device to choose the operating mode of a QDD module
- allows you to configure the media code, and
- specifies how to configure the optical side of a module.

Table 14: Feature History Table

Feature Name	Release Information	Feature Description
Application select code provisioning	Release 25.4.1	You can now configure application select codes directly on a QDD module by using a CLI. This simplifies provisioning by allowing the selection of advertised application modes such as 400ZR, OpenZR+ and others. The router activates the selected code to ensure compatibility and reduce configuration complexity. This feature introduces these changes: CLI : • The **appsel simple code** keyword is introduced in the Controller optics command. • The **appsel** keyword is introduced in the show controller optics command. This feature is supported on the following hardware variants: • A9K-20HG-FLEX-SE/TR • A9K-8HG-FLEX-SE/TR • A99-10X400GE-X-SE/TR • A9903-20HG-PEC

The Common Management Interface Specification (CMIS) specifications set rules for how QDD modules work and how a host device sets them up. CMIS provides a consistent way for host devices, such as routers or switches, to communicate with and control optical modules, regardless of the module manufacturer.

Each QDD module can work in different modes, and these modes are identified by a special code called an AppSel code. This code acts like a unique ID for each mode. Each mode has an application descriptor, which explains how the module handles data. It describes how signals are processed between the connections on the host side and the optical side. The optical side is also known as the media side of the module. The AppSel code also includes a media code, which tells the module how to set up its optical side. The host software uses this media code to control the module's optical interface. The host software also sets up other components, like the physical layer (PHY), SerDes, and MacPort, to complete the data path.

Modules store a list of the AppSel codes they support in their EEPROM memory. This helps the host system or device know which settings the module can use. Some codes, like 400G-OIF-ZR and 400G-OpenZR+, are standard and follow industry rules. Other codes are custom, made by third-party vendors to give users more options with one module. However, these custom codes can cause problems. For example, Cisco routers may not work well with modules using custom codes if the host system doesn't recognize them.

This feature allows users to select application modes advertised by the optical module. You can choose all application modes a module supports.

AppSel supports operation modes based on these parameters:

- Data rate, such as 100GbE or 400GbE
- Signal type
- Signal processing between host side and media side
- Optical configuration, based on the media code, which is part of the AppSel code.

Benefits of AppSel code provisioning

These are the benefits of provisioning AppSel code:

- Enables you to choose any application mode supported by the optical module for greater flexibility.
- Enables direct configuration of the NPU, PHY, and optics to match the selected application's datapath.
- Removes the need for Cisco IOS XR software to implement new proprietary modes for each vendor, simplifying software requirements.
- Allows you to directly specify the desired AppSel code, enabling straightforward configuration without requiring Cisco IOS XR software to interpret the mode.
- Eliminates the extra step of mapping custom vendor codes, reducing delays in supporting new module vendors.

Guidelines for AppSel code provisioning

These configurations apply for AppSel code provisioning:

- This feature is not enabled by default. You must configure it to take effect.
- If you configure a non-default application ID and later remove the configuration, the selected application ID falls back to the default.
- If you configure a non-default application ID and later overwrite it with an invalid application ID, the selected application ID falls back to default. The system raises an alarm indicating the invalid configuration.
- The maximum number of applications supported depends upon the module as advertised in the AppSel list.

Restrictions for AppSel code provisioning

These restrictions apply to AppSel code provisioning:

- The Cisco ASR 9000 series routers do not support In Service Software Upgrade (ISSU) or In Service Software Downgrade (ISSD).
- Optical Transport Network (OTN) is not supported.
- AppSel is only supported on 4x100G and 1x400G muxponder modes.

How AppSel code provisioning works

Summary

The key components that are involved in the AppSel code provisioning are:

- Optical side: The optical side or the media side refers to the part of a pluggable module, such as a QDD or other optical transceiver that connects to and communicates with the optical network. It is the interface responsible for converting electrical signals, from the host device, into optical signals for transmission over fiber optic cables, and vice versa for receiving signals.
- Host side: The host side refers to the part of a pluggable module, such as a QDD or other optical transceiver that interfaces with the host device. A host device is typically a network device like a router, switch, or server. It is responsible for handling and processing electrical signals exchanged between the module and the host device.
- Optics Driver: The entity that collects all supported application codes from the module. Users can see all supported application codes and select any one of the supported application codes. The optics driver programs the valid application code to the module.
- Application Codes: The unique codes that represent operational modes of the optical module.
- Optics Management Agent (MA): The entity that sends the default configuration to the optics driver if no user configuration is provided. It also manages fallback behavior when no application code is selected.

Workflow

1. AppSel code identifies the optical module modes when the modules are plugged into a router.
2. AppSel code points to application descriptor. In this stage, the AppSel code acts as a sequence number for an application descriptor.
3. The application descriptor defines the configuration. In this stage, the application descriptor describes a functional transmission configuration, including signal processing between host lanes and media lanes.
4. The AppSel code that contains the media code configure the media side of the optical module.
5. The router software or the host software applies the media code to configure the optical interface of the optical module.
6. Based on the module's host side interface, you can configure PHY, NPU SerDes, and MacPort.
7. The host side and media side configurations complete, establishing the datapath.

Result

The router enables AppSel code provisioning as the datapath is complete between the host side and media side. This ensures that the optical module operates correctly and efficiently in the desired mode, with proper coordination between the host side interface and the media side.

Configure an AppSel code on an optical module

Enable an optical module to operate in a specific application mode (such as 400ZR or OpenZR+) by configuring the appropriate AppSel (Application Selector) code.

AppSel codes specify the application mode for an optical module. The module advertises supported AppSel codes, which must be validated for host compatibility before configuration. This ensures optimal performance and interoperability between the host and the module.

Before you begin

Ensure the router is running Cisco IOS XR Software Release 25.4.1 or later.

Procedure

Step 1 Identify the AppSel code that needs to be configured on a particular port from the list of available appcodes.

Example:

```
Router#show controllers optics 0/0/0/0 appsel advertised
Router#show controllers optics 0/0/0/0 appsel detailed
```

Step 2 Enter configuration mode on the router.

Example:

```
Router#configure terminal
```

Step 3 (Optional) Identify the controller optics interface and configure breakout to match with the AppSel code that you want to configure.

Example:

```
Router(config)#controller optics 0/0/0/0 breakout 4x100
```

Step 4 Configure the AppSel code.

Example:

```
Router(config)#controller optics 0/0/0/0
appsel simple code 4
 !
!
```

Step 5 Verify the configuration.

Example:

```
Router#show controllers optics 0/0/0/0 appsel advertised
```

```
-------------------------------------------------------------------------------------------------------------------------

            App-ID  |  Host-ID |  Media-ID            |                                    |Standard
       |  Host     |  Power          |
                    |                                 |                                    |
       |  Supported|  Consumption(W) |
                    |                                 |                                    |
       |           |                 |

-------------------------------------------------------------------------------------------------------------------------

            1       |  17    ETH 400GAUI-8 C2M (Annex |  62    OIF 400ZR, DWDM, amplifi |  OIF
       |  Yes      |  n/a            |
            2       |  13    ETH 100GAUI-2 C2M (Annex |  62    OIF 400ZR, DWDM, amplifi |  OIF
       |  Yes      |  n/a            |
            3       |  17    ETH 400GAUI-8 C2M (Annex |  70    OpenZR+ ZR400-OFEC-16QAM |  OpenZR+
       |  Yes      |  n/a            |
            4       |  13    ETH 100GAUI-2 C2M (Annex |  70    OpenZR+ ZR400-OFEC-16QAM |  OpenZR+
       |  Yes      |  n/a            |
            5       |  17    ETH 400GAUI-8 C2M (Annex |  199   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
      |  Yes       |  n/a            |
            6       |  15    ETH 200GAUI-4 C2M (Annex |  199   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
```

```
|  Yes      |  n/a           |
      7       |  13    ETH 100GAUI-2 C2M (Annex |  199   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      8       |  17    ETH 400GAUI-8 C2M (Annex |  196   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      9       |  15    ETH 200GAUI-4 C2M (Annex |  196   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      10      |  13    ETH 100GAUI-2 C2M (Annex |  196   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      11      |  17    ETH 400GAUI-8 C2M (Annex |  200   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      12      |  15    ETH 200GAUI-4 C2M (Annex |  200   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      13      |  13    ETH 100GAUI-2 C2M (Annex |  200   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
      14      |  17    ETH 400GAUI-8 C2M (Annex |  83    OTN-ITU-T FOIC4.8-DO (G. |  OTN-ITU-T
|  Yes      |  n/a           |
      15      |  254   0xC0-0xFE  Vendor Specif |  254   0xC0-0xFE  Vendor Specif |  0xC0-0xFE
|  Yes      |  n/a           |
```

```
Router# show controllers optics 0/0/0/0 appsel detailed
```

```
            App-ID  |  Host-ID     |  Media-ID    |  Host Lane |  Media Lane|  Host Lane   |  Media
 Lane  |  Host      |
                    |              |              |  Count     |  Count     |  Assign      |  Assign
      |  Supported |
                    |              |              |            |            |              |
       |            |
```

```
            1       |  17          |  62          |  8         |  1         |  1           |  1
      |  Yes       |
            2       |  13          |  62          |  2         |  1         |  85          |  1
      |  Yes       |
            3       |  17          |  70          |  8         |  1         |  1           |  1
      |  Yes       |
            4       |  13          |  70          |  2         |  1         |  85          |  1
      |  Yes       |
            5       |  17          |  199         |  8         |  1         |  1           |  1
      |  Yes       |
            6       |  15          |  199         |  4         |  1         |  17          |  1
      |  Yes       |
            7       |  13          |  199         |  2         |  1         |  85          |  1
      |  Yes       |
            8       |  17          |  196         |  8         |  1         |  1           |  1
      |  Yes       |
            9       |  15          |  196         |  4         |  1         |  17          |  1
      |  Yes       |
            10      |  13          |  196         |  2         |  1         |  85          |  1
      |  Yes       |
            11      |  17          |  200         |  8         |  1         |  1           |  1
      |  Yes       |
            12      |  15          |  200         |  4         |  1         |  17          |  1
      |  Yes       |
            13      |  13          |  200         |  2         |  1         |  85          |  1
      |  Yes       |
            14      |  17          |  83          |  8         |  1         |  1           |  1
      |  Yes       |
```

```
            15      |  254         |  254         |  8         |  1         |  255         |  1
       |  Yes       |
-------------------------------------------------------------------------------------------------------------------


Router#show controllers optics 0/0/0/0 appsel active
Instance           : 1
App-ID             : 3
Host-ID            : 17    ETH 400GAUI-8 C2M (Annex
Media-ID           : 70    OpenZR+ ZR400-OFEC-16QAM
Host Lane Count    : 8
Media Lane Count   : 1
Host Lane Assign   : 0x1
Media Lane Assign  : 0x1
```

The optical module operates in the selected application mode, ensuring compatibility and optimal performance.

What to do next

- Monitor the interface status and confirm the active AppSel code.
- Ensure alarms are cleared, and the interface is operational.