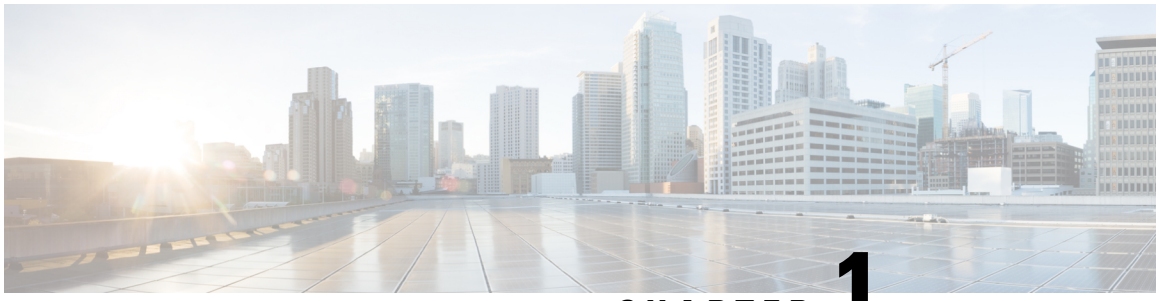
Cisco NCS 1020 Optical Applications Configuration Guide, IOS XR Release 24.3.x

First Published: 2024-09-04

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

CONTENTS



CHAPTER 1

NCS 1020 Overview and Optical Applications

This chapter gives a brief overview of the optical apps on NCS 1020.

NCS 1020 software has multiple optical applications to help bring up the link and maintain traffic on the link.

Document Objective

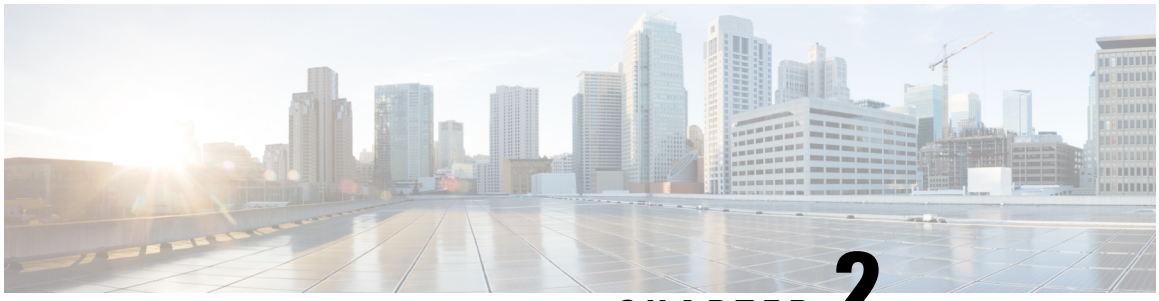
The Cisco NCS 1020 Configuration Guide describes how to configure various card modes for the line cards that are supported in the Cisco NCS 1020 chassis.

Document Organization

This document is organized into the following chapters:

Chapter	Description
Internode Topology Discovery and Communication, on page 3	NCS 1020 uses OSPF for topology discovery.
Span Loss, on page 7	Span Loss application measures span loss between two nodes for a given direction and verifies if span loss is within the configured range.
Gain Estimator, on page 9	Gain Estimator computes power that is transmitted from the upstream node, analyzes incoming span loss, sets the gain mode of the EDFA amplifier, and provides the initial target gain for the amplifier.
Link Tuner, on page 13	Link Tuner uses actual optical measurements like span loss to compute and configure the target PSD (power spectral density) for each span.
Automatic Power Control, on page 29	Automatic Power Control configures amplifier and attenuator setpoints to achieve target PSD across the link.

Chapter	Description
Automatic Network Turn Up, on page 45	All the optical applications work together to bring up the DWDM link. This chapter describes the link bring up process and how the applications working together.
Configure OTDR , on page 49	OTDR application scans and determines loss in signal power and location on the fiber path where the loss occurs.



CHAPTER 2

Internode Topology Discovery and Communication

This chapter describes how internode topology discovery and communication between NCS 1020 nodes takes place using OSPF.

Internode Topology Discovery and Communication

Optical applications on the NCS 1020 nodes must discover the OLT-OLT link topology. Span level applications must discover the adjacent nodes. Link level applications must learn the complete OLT-OLT link topology. NCS 1020 uses OSPF to discover the link topology and communicate topology information.

The networking devices running OSPF detect topological changes in the network, flood link-state updates to neighbors, and quickly converge on a new view of the topology. Each OSPF router in the network soon has the same topological view again.

Optical applications on NCS 1020 must discover the link topology, the different nodes and the node types, and the optical spectral band the nodes work on. NCS 1020 uses an enhanced version of OSPF that supports a new link-state advertisement attribute that advertises the node type and band.

Configure OSPF

The following commands are the necessary configurations for OSPF on an NCS 1020 OLT node.

configure

router ospf *process-name*

router-id *router-id*

distribute link-state

network point-to-point

area *area-id*

interface Loopback0

interface GigabitEthernet0/0/0/0

The following commands are the necessary configurations for OSPF on an NCS 1020 ILA node.

configure

router ospf *process-name*

router-id *router-id*

distribute link-state

network point-to-point

area *area-id*

interface Loopback0

interface GigabitEthernet0/0/0/0

interface GigabitEthernet0/0/0/2

Important You must configure router ID during OSPF configuration on NCS 1020 nodes.

See Implementing OSPF, for a description of the concepts and tasks necessary to implement OSPF on Cisco IOS XR.

Configure OSPF cost

Cost is the metric, you can use the cost command to explicitly specify the interface (network) for OSPF path calculation.

configure

router ospf *process-name*

router-id *router-id*

area *area-id*

interface Loopback0

interface GigabitEthernet0/0/0/0

cost *cost*

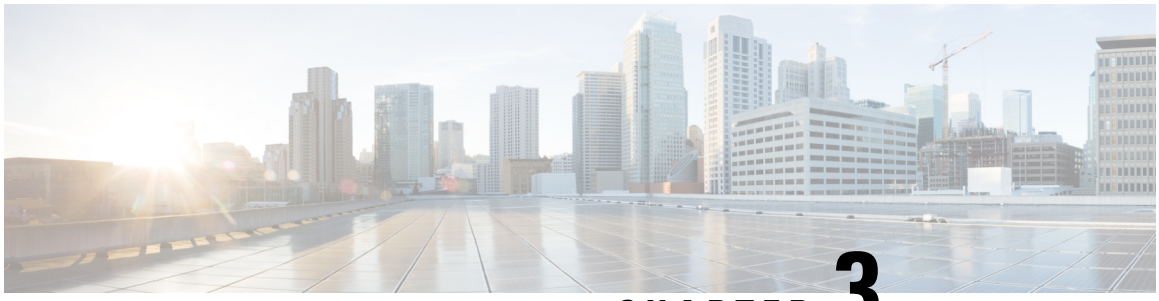
See cost (OSPF) for different command modes and usage guidelines to implement **cost** OSPF on Cisco IOS XR.

Note The cost of the link is inversely proportional to the bandwidth of the link.

The following example shows a sample **cost** configuration.

```
P/0/RP0/CPU0:ios(config)#router ospf 1

RP/0/RP0/CPU0:ios(config-ospf)#area 0
RP/0/RP0/CPU0:ios(config-ospf-ar)#interface Loopback0
RP/0/RP0/CPU0:ios(config-ospf-ar-if)#interface GigabitEthernet0/0/0/0
```

```
RP/0/RP0/CPU0:ios(config-ospf-ar-if)#cost 20
RP/0/RP0/CPU0:ios(config-ospf-ar-if)#commit
```



CHAPTER 3

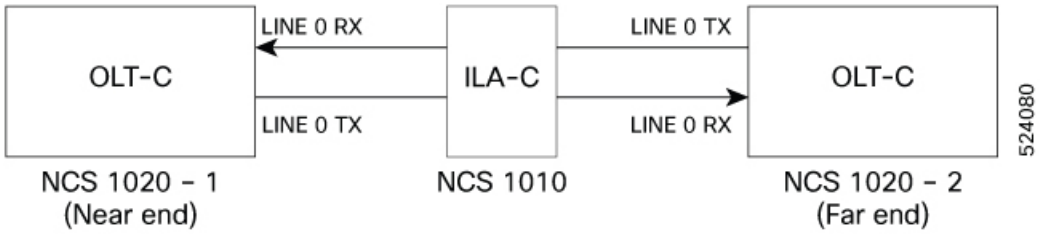
Span Loss

This chapter describes the Span Loss optical application for Cisco NCS 1020.

Overview of Span Loss

The Span Loss calculation is an automatic calculation of span losses between NCS 1020 and NCS 1010(amplifer) nodes. The span loss verification algorithm calculates span loss by comparing power measurements at line Tx/Rx port at far end and line Rx/Tx port at near end. The algorithm raises the *Span Loss Value Out Of Range* alarm if span loss is not within configured thresholds.

Figure 1: Sample two node topology



For example, in the previous figure, the **Tx Span Loss** on NCS 1020-1 is the difference in signal power between LINE 0 Tx on NCS 1020-1 and LINE 0 Rx on NCS 1010.

The span loss application reports the span loss value for a span every 90 seconds. If span loss changes, for example when a change in fiber loss occurs, the span loss application typically takes 90 seconds to update the span loss.

On non-Raman spans, span loss verification reports the Span Loss value:

- **Span loss**: The span loss algorithm calculates span loss by comparing Tx/Rx power measurement at line port at far end and Rx/Tx power measurement at line port at near end.

View Span Loss Values

Use the **show olc span-loss** command to view the Tx span loss and Rx span loss.

The following sample shows the output of the **show olc span-loss** command on a Raman span with Raman tuning enabled.

The following sample shows the output of the **show olc span-loss** command on a non-Raman span.

```
RP/0/RP0/CPU0:ios#show olc span-loss
Mon Apr 11 09:37:31.950 UTC

Controller name                          : Ots0/0/0/0
Neighbour RID                            : 10.91.1.90
Rx Span Loss                             : 10.2 dB
Rx Span Loss (with pumps off)            : NA
Rx Span Loss (with pumps off) measured at : NA
Estimated Rx Span Loss                   : NA
Tx Span Loss                             : 9.7 dB
Tx Span Loss (with pumps off)            : NA
Tx Span Loss (with pumps off) measured at : NA
Estimated Tx Span Loss                   : NA
```

Configure Span Loss Thresholds

The system raises a Span Loss Value Out Of Range alarm under the following conditions:

- Span loss is greater than the maximum threshold.
- Span loss is less than the minimum threshold.

You can configure the span loss thresholds using the following commands.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

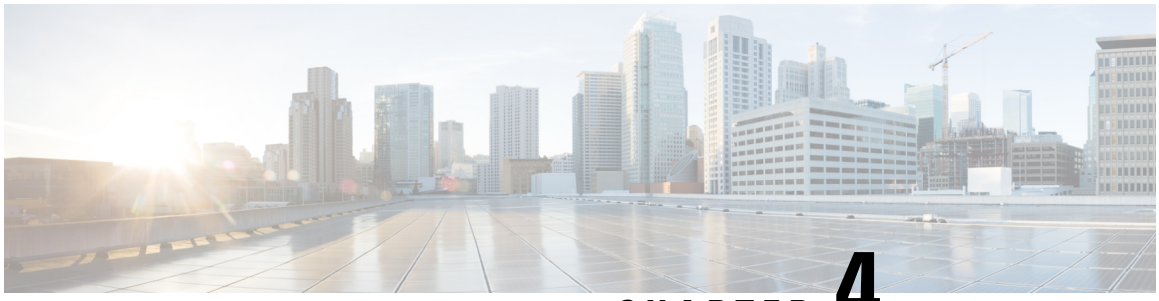
span-loss min *value*

span-loss max *value*

commit

end

Note The minimum and maximum threshold values must be in the range 0.0 to 42.0 dB in multiples of 0.1 dB (0-420). The minimum threshold must be lower than the maximum threshold.



CHAPTER 4

Gain Estimator

This chapter describes the Gain Estimator optical application for Cisco NCS 1020.

Overview of Gain Estimator

Gain Estimator analyses the span loss and sets the gain mode of the EDFA amplifier and provides the initial target gain for the amplifier. EDFA amplifiers are present in both OLT and ILA line cards of NCS 1020. These EDFA amplifiers are variable-gain optical amplifiers capable of working at two different gain ranges or modes. The modes are normal mode and extended mode. Extended mode provides higher gain than the normal mode. Running the Gain Estimator is a traffic-impacting operation.

Gain Estimator uses the following parameters to estimate the gain necessary on a span.

- Ingress span loss
- Span length
- Tx connector loss
- Spectrum density
- Fiber type

Gain estimator uses the estimated gain to set the gain range.

NCS 1020 automatically triggers gain estimator:

- During automatic link bring up
- After Line Card cold reload
- After device power cycle

Start Gain Estimator

Use the **olc start-gain-estimation controller ots** *Rack/Slot/Instance/Port* command to trigger the gain estimation operation.

The following output is a sample of the **olc start-gain-estimation controller ots 0/0/0/0** command.

```
RP/0/RP0/CPU0:ios#olc start-gain-estimation controller ots 0/0/0/0
Thu May 12 09:32:05.414 UTC

Gain Estimation: is running

RP/0/RP0/CPU0:ios#olc start-gain-estimation controller ots 0/0/0/0
```

Start Gain Estimator Manually

Use the **olc start-gain-estimation controller ots** *Rack/Slot/Instance/Port* command to trigger the gain estimation operation.

Use the following commands to sets the Gain Estimator to manual mode:

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

gain-estimator manual

commit

end

The following output is a sample configuration sets the Gain Estimator to manual mode:

```
RP/0/RP0/CPU0:ios#configure terminal
Mon Jun 13 05:35:20.510 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#gain-estimator manual
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

The following sample output diplays Gain Estimator Manual satus:

```
RP/0/RP0/CPU0:SOLN-ILA-1#show olc gain-estimator controller Ots 0/0/0/0
Tue Jun 11 10:35:38.808 IST
Controller                          : Ots0/0/0/0
Egress  Gain Estimator Status       : MANUAL
Egress  Estimated Gain              : 15.8 dB
Egress  Estimated Gain Mode         : Normal
Egress  Gain Estimation Timestamp   : 2024-06-03 17:03:38
```

Disable Gain Estimator

Use the following commands to disable Gain Estimator.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

gain-estimator disable

commit

end

The following output is a sample configuration that disables Gain Estimator.

```
RP/0/RP0/CPU0:ios#configure terminal
Mon Jun 13 05:35:20.510 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control
```

```
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#gain-estimator disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

Enable Gain Estimator

Use the following set of commands to enable Gain Estimator.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

gain-estimator enable

commit

end

The following output is a sample configuration that enables Gain Estimator.

```
RP/0/RP0/CPU0:ios#configure terminal
Mon Jun 13 05:35:27.511 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#gain-estimator enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

View Gain Estimator Status

Use the **show olc gain-estimator** command to view the gain estimation details.

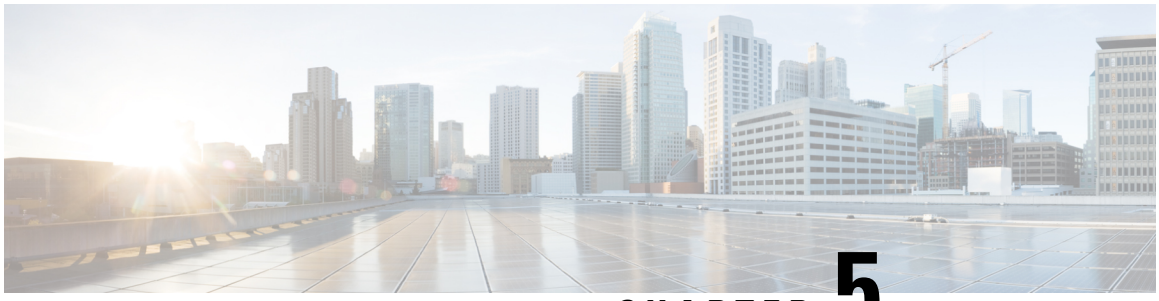
The following output is a sample of the **show olc gain-estimator** command.

```
RP/0/RP0/CPU0:ios#show olc gain-estimator
Thu May 12 09:30:39.987 UTC
Controller                          : Ots0/0/0/0
Egress  Gain Estimator Status       : IDLE
Egress  Estimated Gain              : 25.9 dB
Egress  Estimated Gain Mode         : Extended
Egress  Gain Estimation Timestamp   : 2022-05-07 09:16:53

Controller                          : Ots0/0/0/2
Egress  Gain Estimator Status       : IDLE
Egress  Estimated Gain              : 11.7 dB
Egress  Estimated Gain Mode         : Normal
Egress  Gain Estimation Timestamp   : 2022-05-07 10:13:53
```

Use the **show olc gain-estimator controller ots** *Rack/Slot/Instance/Port* command to view the gain estimation details for a specific controller.

The following output is a sample of the **show olc gain-estimator controller ots** *Rack/Slot/Instance/Port* command.

```
RP/0/RP0/CPU0:SOLN-OLT-1#show olc gain-estimator
Tue Jun 11 10:36:30.944 IST
Controller                          : Ots0/0/0/0
Ingress Gain Estimator Status       : MANUAL
Ingress Estimated Gain              : 26.1 dB
Ingress Estimated Gain Mode         : Extended
Ingress Gain Estimation Timestamp   : 2024-06-03 17:04:25
```



CHAPTER 5

Link Tuner

This chapter describes the Link Tuner optical application for Cisco NCS 1020.

- Overview of Link Tuner, on page 13

Overview of Link Tuner

Link tuner computes the target Power Spectral Densities (PSD) for APC by calculating the optimal PSDs for a span. Power Spectral Density represents power per 12.5 GHz of spectrum. Link tuner is enabled if automatic link bring up is enabled. Link tuner is span-specific and computes the target PSDs for channels entering the span. Link tuner uses the following parameters to compute the target PSD:

- Fiber-type
- Span loss measurement
- Spectral density
- Connector losses
- Span length

The link tuner application finds the target PSD for the best performance for channels entering a span. You have to manually configure drop-psd. The drop-psd is the target PSD for OLT drop ports.

Link tuner monitors the span loss and total noise in the link. When link tuner detects changes in the span loss, span length, or connector loss, link tuner recomputes the target PSDs.

Link tuner computes the target PSDs and total noise whenever a link goes down and comes back up. All traffic impacting actions trigger link tuner.

The following table describes the different link tuner status.

Status	Description
Operational	Link tuner is active and operational.
Blocked	Link tuner is active but unable to compute target PSDs and noise.
Disabled	Link tuner is disabled.
Manual	User has to manually run

To view link tuner status and PSD computation information, use **show olc link-tuner** command.

The following sample is an output of **show olc link-tuner** command.

```
RP/0/RP0/CPU0:SOLN-OLT-1#show olc link-tuner
Tue Jun 11 10:40:30.667 IST
Controller          : Ots0/0/0/0
Link Tuner Status   : MANUAL
Last PSD computation: 2024-06-03 16:49:34
------------------------------------------------------------------------
Single Band
------------------------------------------------------------------------
Setpoint            : Computed PSD
                       (dBm/12.5 GHz)
------------------------------------------------------------------------
01                      -6.1
02                      -6.0
03                      -6.0
04                      -5.9
05                      -5.8
06                      -5.7
07                      -5.7
08                      -5.6
09                      -5.5
10                      -5.4
11                      -5.4
12                      -5.3
13                      -5.2
14                      -5.2
15                      -5.1
16                      -5.0
17                      -4.9
18                      -4.9
19                      -4.8
20                      -4.7
21                      -4.6
22                      -4.6
23                      -4.5
24                      -4.4
25                      -4.3
26                      -4.3
27                      -4.2
28                      -4.1
29                      -4.1
30                      -4.0
31                      -3.9
32                      -3.8
33                      -3.8
```

To view link tuner status, PSD computation information, and computed total noise, use **show olc link-tuner detail** command.

The following sample is an output of **show olc link-tuner detail** command.

```
RP/0/RP0/CPU0:SOLN-OLT-1#show olc link-tuner details
Tue Jun 11 10:43:48.998 IST
Controller          : Ots0/0/0/0
Link Tuner Status   : MANUAL
Last PSD computation: 2024-06-03 16:49:34
Computed Total Noise: NA
------------------------------------------------------------------------
Setpoint            : Computed PSD
                       (dBm/12.5 GHz)
------------------------------------------------------------------------
01                      -6.1
```

```
02                    -6.0
03                    -6.0
04                    -5.9
05                    -5.8
06                    -5.7
07                    -5.7
08                    -5.6
09                    -5.5
10                    -5.4
11                    -5.4
12                    -5.3
13                    -5.2
14                    -5.2
15                    -5.1
16                    -5.0
17                    -4.9
18                    -4.9
19                    -4.8
20                    -4.7
21                    -4.6
22                    -4.6
23                    -4.5
24                    -4.4
25                    -4.3
26                    -4.3
27                    -4.2
28                    -4.1
29                    -4.1
30                    -4.0
31                    -3.9
32                    -3.8
33                    -3.8
```

You can view the target PSDs configured for all setpoints using the **show olc apc-local target-psd-profile** command. The output shows the source of the PSD configuration also. The target PSD source can be Link Tuner or Configuration.

The following sample is an output of **show olc apc-local target-psd-profile** command.

```
RP/0/RP0/CPU0:ios#show olc apc-local target-psd-profile
Mon Jun 20 06:40:32.779 UTC
Controller          : Ots0/0/0/0
Target PSD source   : Link Tuner
--------------------------------------------------------------------------------
Setpoint                Frequency                        Target PSD
                          (THz)                       (dBm/12.5 GHz)
--------------------------------------------------------------------------------
01                    191.337494                          -6.3
02                    191.488495                          -6.3
03                    191.639496                          -6.2
04                    191.790497                          -6.2
05                    191.941498                          -6.2
06                    192.092499                          -6.1
07                    192.243500                          -6.1
08                    192.394501                          -6.1
09                    192.545502                          -6.0
10                    192.696503                          -6.0
11                    192.847504                          -5.9
12                    192.998505                          -5.9
13                    193.149506                          -5.8
14                    193.300507                          -5.8
15                    193.451508                          -5.8
16                    193.602493                          -5.7
17                    193.753494                          -5.7
```

```
18                  193.904495                  -5.7
19                  194.055496                  -5.6
20                  194.206497                  -5.6
21                  194.357498                  -5.5
22                  194.508499                  -5.5
23                  194.659500                  -5.5
24                  194.810501                  -5.4
25                  194.961502                  -5.4
26                  195.112503                  -5.3
27                  195.263504                  -5.3
28                  195.414505                  -5.3
29                  195.565506                  -5.2
30                  195.716507                  -5.2
31                  195.867493                  -5.1
32                  196.018494                  -5.1
33                  196.169495                  -5.1
```

Configure Link Tuner

The following configurations are available for the link tuner:

Enable Link Tuner

You can enable link tuner for a controller. Use the following commands to enable link tuner.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

link-tuner enable

commit

end

The following is a sample configuration that enables link tuner.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Manual Link Tuner

You can enable link tuner for a controller. Use the following commands to set the link tuner to manual mode.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

link-tuner manual

commit

end

The following is a sample configuration sets the link tuner to manual mode.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner manual
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Disable Link Tuner

You can disable link tuner for a controller. Use the following commands to disable link tuner.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

link-tuner disable

commit

end

The following is a sample configuration that disables link tuner.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Link Parameters

Configure fiber-type, spectrum density, connector losses, and span length for accurate link tuning.

To configure fiber type, use **fiber-type** command. SMF is the default fiber-type.

You can configure the following fiber types using **fiber-type** command:

- E-LEAF
- FREE-LIGHT
- METRO-CORE
- SMF
- SMF-28E
- TERA-LIGHT
- TW-RS
- TW-Reach
- TW-minus
- TW-plus
- ULL-SMF28

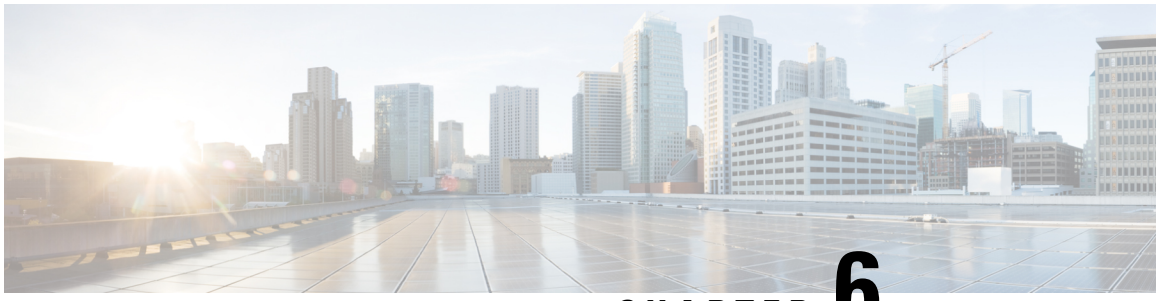
To configure spectrum density, use **link-tuner spectrum-density** command. You can configure a spectrum density as a percentage value in the range of 1-100. The default spectrum density is 81.

To configure connector loss, use the **connector-loss** command. You can configure Tx and Rx connector loss in the range 0–20 dB.

To configure span length, use the **span-length** command. You can configure span length in the range of 0.1 to 200 km as multiples of 0.1 km. In the absence of span length configuration, link tuner computes span length using span loss.

The following example is a sample configuration that configures the link tuner parameters.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#fiber-type SMF
RP/0/RP0/CPU0:ios(config-olc-ots)#link-tuner spectrum-density 80
RP/0/RP0/CPU0:ios(config-olc-ots)#connector-loss rx 1
RP/0/RP0/CPU0:ios(config-olc-ots)#connector-loss tx 1
RP/0/RP0/CPU0:ios(config-olc-ots)#span-length 100
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```



CHAPTER 6

Automatic Link Calibration

Automatic Link Calibration brings up your NCS 1000 optical line system. By identifying and addressing potential issues during the calibration process, ALC can enhance the overall reliability of the network, reducing downtime and ensuring consistent performance.

Automatic Link Calibration Overview

From Cisco IOS XR Release 7.11.1, NCS 1020 supports Automatic Link Calibration (ALC). ALC is an alternate to automatic link bring-up. When using ALC, the optical applications except APC remain idle when operating conditions change. After turning up the network, ALC saves optical parameters on all nodes as a baseline. ALC saves the following parameters as a baseline:

- Span loss data
- APC data
- C-band and OSC power measurements
- Link tuner data
- Gain estimator data
- OCM data

ALC is a link level application. ALC is initiated by the ALC manager which is the source OLT. The manager manages the downstream link. Similarly, the OLT at the other end of the link manages the upstream link.

ALC is a nework bring up operation. Link calibration is traffic impacting. When you are turning up a link

Prerequisites for ALC

- **OLT to OLT Topology**: OLT-OLT topology must be up and running from end to end. You should not have a Loss of Signal-Path (LOS-P) or a Loss of Channel (LOC) alarm on any node.
- **Channel Map Configuration**: You must configure channel maps on all nodes to align all nodes with the correct frequencies. Use **hw-module location 0/0/NXR0 grid-mode flex[inline-ampli |**

terminal-ampli] channel-id*id***centre-freq***frequency***width***width* command to configure the channel map for all 32 channels.

- **XC Creation**: You must create Optical Cross-Connects (OXCs) on OLT nodes. These OXCs should cover the entire spectrum to ensure the correct routing of optical signals.
- **Application Modes**: You must set all applications to either manual mode or disabled mode, except for Automatic Power Control (APC). We recommend, all control loop applications should be in manual mode.
- **Span-mode APC**: You must configure APC in span mode on all nodes.

Note If you use Cisco Optical Network Planner to design your network, the prerequisite configurations can be imported to the NCS 1020 nodes as an XML file. See Design and Analyze Networks for more information.

ALC Process

The following sequence of events takes palce when ALC is initiated.

1. The source Optical Line Terminal (OLT) starts the ALC procedure in the transmitting direction. The source OLT is the ALC manager for this direction. The ALC manager raises the **Automatic-link-calibration procedure is running** to indicate that the process is running.
2. The OLT drops all user channels and forces the ASE channels from the Noise Loader (NL). These ASE channels are used for the ALC calibration.

Note The Automatic Link Calibration (ALC) process needs a stable and reliable C-band source which covers entire spectrum. When the ALC process begins, it drops all active user channels and forces ASE noise channels from the noise loader. This is done to ensure that the calibration isn't affected by user traffic, which can fluctuate and cause inconsistencies. This allows the ALC process to accurately calibrate the power levels across the entire C-band spectrum, ensuring optimal performance of the optical network.

3. ALC initiates an OTDR scan on the receive (Rx) and transmit (Tx) interfaces in the downstream direction. After the scan is completed, the location of the sor file is saved.
4. ALC enables the Automatic Power Control (APC), Link Tuner, and Gain Estimator applications to run in parallel.
5. The Power Spectral Density (PSD) and gain are initially calculated using the Optical Supervisory Channel (OSC) span loss. This step is temporary and is used to bring the C-band up.
6. Once the C-band is up, the C-band based span loss is measured and the PSD and Gain are recalculated.
7. Using the PSD computed by the LinkTuner and the gain-range computed by the Gain Estimator, the APC regulates the channels. Once this is completed, the APC moves to the IDLE state.
8. After APC moves to the IDLE state on all nodes, ALC initiates the baseline.
9. After saving the optical parameters, ALC completes the procedure and the ALC status changes to IDLE.
10. The ALC Manager clears the **Automatic-link-calibration procedure is running**alarm.

11. The ALC manager rleases the ASE channels, and user channels become active.
12. ALC changes APC mode from Centralized-mode to Span-mode.

Restrictions for ALC

- ALC impacts network traffic, and the time it takes to converge depends on the number of nodes in the network.
- ALC does not support Raman networks.
- ALC saves baseline data only if the procedure completes successfully. If the ALC procedure fails due to network errors, the collected baseline data is not saved.
- Do not enable or disable any optical applications or initiate gain estimator after ALC is complete.
- Do not initiate ALC on a link without cross connect configuration across the entire spectrum.
- Baseline data is preserved across reloads.

Note To clear the baseline data, you must either perform a **commit replace** on the respective nodes or configure the **no** option of all the applications, for example, **no apc-span-mode RX** and **no apc-span-mode TX** to clear the APC baseline data on a node.

Configure Automatic Link Caliberation

Prerequisite configuration

The following commands are mandatory configurations for ALC onm an OLT node.

optical-line-control

controller Ots *R/S/I/P*

apc manual

gain-estimator manual

link-tuner manual

apc-span-mode RX

apc-span-mode TX

The following commands are mandatory configurations for ALC onm an ILA node.

optical-line-control

controller Ots0/0/0/0

gain-estimator manual

link-tuner manual

apc-span-mode TX

controller Ots0/0/0/2

gain-estimator manual

link-tuner manual

apc-span-mode TX

Configure APC in Span-mode

Use the following commands to configure APC in span-mode on an OLT node.

On an OLT node

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-span-mode RX

apc-span-mode TX

commit

end

Use the following commands to configure APC in span-mode on an ILA node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-span-mode TX

commit

end

Note APC runs in centralized mode during Automatic Link Calibration. At the completion of ALC, ALC saves a baseline of the system. After saving the baseline, if the span-mode configurations are present, ALC changes APC mode to span-mode.

Pause Span-mode APC

Use the following commmands to pause span-mode APC

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-span-mode-pause [TX | RX]

commit

end

The following is a sample configuration that pauses span-mode APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-span-mode-pause tx
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Turn Up a Link Using ALC

Perform the following steps to turn up a link using ALC.

1. Configure all nodes with base configurations and bring up the topology end to end. This involves setting up the basic configurations on all nodes in the network. These configurations include interface configurations, OSPF configurations, hostname, telemetry, and Cisco Optical Site Manager (COSM).
2. Import the XML file generated by Cisco Optical Network Planner (CONP) comprising required configurations for network turn up on all nodes. The CONP configuration file includes specific settings for the network, such as channel configuration, cross-connect (XC) configuration, optical application configuration in manual mode, and span mode Automatic Power Control (APC) configuration. Importing this file applies these settings to all nodes in the network.
3. Initiate the ALC procedure at the near-end Optical Line Terminal (OLT) using the exec command **olc alc-start controller ots 0/0/0/0**. The ALC status shows "IN-PROGRESS". The following sample shows the alc status after running the exec CLI.

```
RP/0/RP0/CPU0:ios#olc alc-start controller ots 0/0/0/0
RP/0/RP0/CPU0:ios#show olc alc status
Tue Sep 26 16:54:57.934 IST

Controller               : Ots0/0/0/0
ALC Status               : IN-PROGRESS
ALC-Procedure started at : 2023-09-26 16:04:07

Node RID                 : 10.3.3.3
ALC State                : IN-PROGRESS

Node RID                 : 10.2.2.2
ALC State                : IN-PROGRESS

Node RID                 : 10.1.1.1
ALC State                : IN-PROGRESS
```

4. After completing the ALC in one direction, initiate the ALC in the other direction. Exexcute the **olc alc-start controller ots 0/0/0/0** command on the far-end Optical Line Terminal (OLT), which acts as the ALC manager for the upstream direction.

Restriction Do not initiate ALC in a direction while ALC is in progress on the other direction. ALC procedure involves OTDR scans. NCS 1010 nodes perform OTDR scans in one direction at a time.

View Automatic Link Caliberation Status

Use the **show olc alc status** command to see the status of ALC. The following sample shows ALC status when ALC is in progress.

```
RP/0/RP0/CPU0:ios#show olc alc status
Tue Sep 26 16:54:57.934 IST

Controller               : Ots0/0/0/0
ALC Status               : IN-PROGRESS
ALC-Procedure started at : 2023-09-26 16:04:07

Node RID                 : 10.3.3.3
ALC State                : IN-PROGRESS

Node RID                 : 10.2.2.2
ALC State                : IN-PROGRESS

Node RID                 : 10.1.1.1
ALC State                : IN-PROGRESS
```

The following sample shows ALC status when ALC is IDLE after the completion of the ALC process.

```
RP/0/RP0/CPU0:ios#show olc alc status
Tue Sep 26 16:54:57.934 IST

Controller               : Ots0/0/0/0
ALC Status               : IDLE
ALC-Procedure started at : 2023-09-26 16:04:07

Node RID                 : 10.3.3.3
ALC State                : COMPLETE

Node RID                 : 10.2.2.2
ALC State                : COMPLETE

Node RID                 : 10.1.1.1
ALC State                : COMPLETE
```

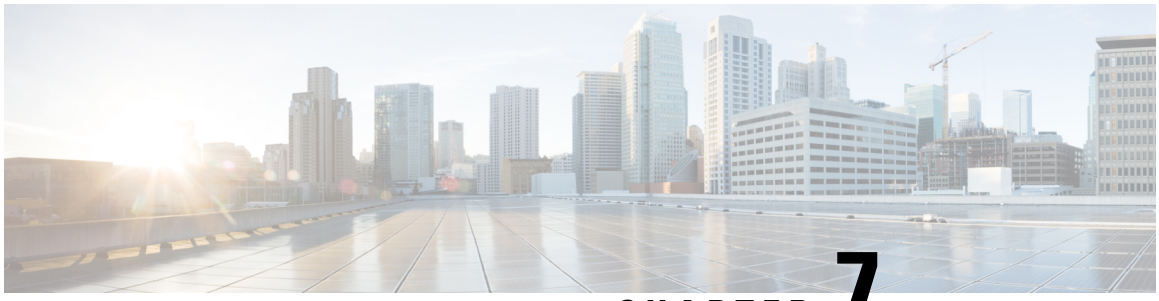
Use the **show olc alc-local baseline controller ots** *R/S/I/P*command to view the saved baseline. The output of this command shows the baseline info saved for OTDR, Link Tuner, Gain Estimator, Span Loss, APC Regulation, and Power measurements. The following sample is a truncated output of the**show olc alc-local baseline** command.

```
RP/0/RP0/CPU0:ios#show olc alc-local baseline controller ots 0/0/0/0

OTDR
====
Controller   : Ots0/0/0/0
OTDR RX File : /harddisk:/otdr/PROD1_NCS1010_OTDR_Ots0_0_0_0_RX_20230926-192505.sor
OTDR TX File : /harddisk:/otdr/PROD1_NCS1010_OTDR_Ots0_0_0_0_TX_20230926-213923.sor

Link Tuner
==========
Controller          : Ots0/0/0/0
Config Mode         : Manual
Last PSD computation: 2023-09-26 16:11:40
Target PSD:
------------------------------------------------------------------------
Setpoint            : Computed PSD
                      (dBm/12.5 GHz)
------------------------------------------------------------------------
```

```
01                      -8.2
.
33                      -7.3

Gain Estimator
===============
Controller                          : Ots0/0/0/0
Config Mode                         : Manual
Ingress Estimated Gain              : 23.0 dB
Ingress Estimated Gain Mode         : Extended
Ingress Gain Estimation Timestamp   : 2023-09-26 13:59:44

Span Loss Computation
===============
Controller                                : Ots0/0/0/0
Neighbour RID                             : 10.2.2.2
Rx Span Loss                              : 16.8 dB
Rx Span Loss (with pumps off)             : NA
Estimated Rx Span Loss                    : NA
Tx Span Loss                              : 10.2 dB
Tx Span Loss (with pumps off)             : NA
Estimated Tx Span Loss                    : NA

APC Regulation Info
==================
Config Mode                               : Centralized APC
Controller                                : Ots0/0/0/0
Domain Manager                            : 10.3.3.3
Status                                    : IDLE
Direction                                 : Tx
PSD Minimum                               : -24.0 (dBm/12.5 GHz)
Gain Range                                : Normal
Last Correction                           : 2023-09-26 16:09:52
Residual Discrepancy from Previous Node   : NA
Residual Discrepancy Input Timestamp      : NA

  Device Parameters                       Min           Max           Configuration
    Operational
=============================================================================================

  Egress Ampli Gain (dB)           :      16.0          30.0          20.9
    20.9
  Egress Ampli Tilt (dB)           :      -5.0          2.5           -0.8
    -0.8
  Tx Ampli Power (dBm)             :       -            23.0           -
    22.8
  Tx VOA Attenuation (dB)          :      0.0           15.0          5.3
    5.3
  Egress WSS/DGE Attenuation (dB)  :      0.0           25.0           -
     -


  Channel Center    Channel     Channel     Channel     Spectrum      Ampli-Input
Target         Current        Discrepancy    Channel Slice
    Frequency        Width        ID        Source      Slice Num         PSD
PSD             PSD                          Attn Config
      (THz)          (GHz)                                        (dBm/12.5 GHz) (dBm/12.5
 GHz)   (dBm/12.5 GHz)         (dB)           (dB)
=============================================================================================

   191.412500       150.00        1          ASE          25             -23.4
-8.2            -8.1             -0.0          9.3
.
```

```
.
   196.062500       150.00        35         ASE           1513           -23.8
-7.4            -7.2             -0.0          9.5


Controller          : Ots0/0/0/0
Target PSD source   : Link Tuner
-------------------------------------------------------------------------------
Setpoint                Frequency                       Target PSD
                          (THz)                       (dBm/12.5 GHz)
-------------------------------------------------------------------------------
01                    191.375000                          -8.2
.
.
33                    196.175000                          -7.3


APC Regulation Info
==================
Config Mode                              : Centralized APC
Controller                               : Ots0/0/0/0
Domain Manager                           : 10.1.1.1
Status                                   : IDLE
Direction                                : Rx
PSD Minimum                              : -24.0 (dBm/12.5 GHz)
Gain Range                               : Extended
Last Correction                          : 2023-09-26 14:00:07
Residual Discrepancy from Previous Node  : NA
Residual Discrepancy Input Timestamp     : NA


  Device Parameters                          Min           Max           Configuration
     Operational
=============================================================================================


  Ingress Ampli Gain (dB)           :      20.0          38.0          22.2
     22.2
  Ingress Ampli Tilt (dB)           :      -5.0          5.0           0.9
     0.9
  Rx  Ampli Power (dBm)             :       -            25.0           -
     24.7
  Rx  VOA Attenuation (dB)          :      0.0           0.0           0.0
     0.0
  Ingress WSS/DGE Attenuation (dB)  :      0.0           25.0           -
      -


  Channel Center    Channel     Channel     Channel     Spectrum      Ampli-Input
Target         Current        Discrepancy    Channel Slice
    Frequency        Width        ID        Source      Slice Num         PSD
PSD             PSD                          Attn Config
      (THz)          (GHz)                                        (dBm/12.5 GHz) (dBm/12.5
 GHz)  (dBm/12.5 GHz)        (dB)            (dB)
=============================================================================================


   191.412500       150.00        1          ASE           25             -23.3
-8.0            -8.0             0.0           3.7
.
.
   196.062500       150.00        35         ASE           1513           -22.0
-8.0            -8.0             0.0           4.0
```

```
Power Measurements
==================

Controller                              : Ots0/0/0/0
C-Band Total Tx Power on Ots0/0/0/0     : 17.50 dBm
OSC Total Tx Power on Osc0/0/0/0        : 1.00 dBm
Measured at                             : 2023-09-26 16:13:47

 Spectrum Slices Spacing        :            3.125 Ghz
 Spectrum Slices Range          :            1 - 1548
 Slice Start Wavelength         :            1566.82 nm
 Slice Start Frequency          :            191337.50 GHz

 Spectrum power information :
 Tx power :
 ------------------------------------------------------------------------------------
 spectrum-slice num                        Ots0/0/0/0 Tx-power values (dBm)
 ------------------------------------------------------------------------------------
   1 - 12               -12.9  -10.7   -9.3   -8.5       -8.2   -8.2   -8.2   -8.2
-8.2   -8.1   -8.1   -8.1
.
.
 1537 - 1548             -28.6  -30.0  -31.0  -31.8      -32.4  -32.8  -33.2  -33.5
-33.7  -33.9  -34.1  -34.3

Controller                              : Ots0/0/0/0
C-Band Total Rx Power on Ots0/0/0/0     : 2.51 dBm
OSC Total Rx Power on Osc0/0/0/0        : -16.10 dBm
Measured at                             : 2023-09-26 14:01:51

 Spectrum Slices Spacing        :            3.125 Ghz
 Spectrum Slices Range          :            1 - 1548
 Slice Start Wavelength         :            1566.82 nm
 Slice Start Frequency          :            191337.50 GHz

 Spectrum power information :
 Rx power :
 ------------------------------------------------------------------------------------
 spectrum-slice num                        Ots0/0/0/0 Rx-power values (dBm)
 ------------------------------------------------------------------------------------
   1 - 12               -29.2  -26.4  -24.7  -23.7      -23.2  -23.2  -23.2  -23.3
-23.3  -23.3  -23.3  -23.3
.
.
 1537 - 1548             -42.6  -90.0  -90.0  -90.0      -90.0  -90.0  -90.0  -90.0
-90.0  -90.0  -90.0  -90.0
```



CHAPTER 7

Automatic Power Control

This chapter describes the Automatic Power Control optical application for Cisco NCS 1020.

Overview of Automatic Power Control

On a fiber, the power level may vary between channels. Over long distances and multiple amplifications, these differences in power levels can result in deterioration of the quality of some channels. Automatic Power Control (APC) corrects the power level differences and ensures that power for different channels is according to the target power profile for the spectrum. APC compensates for the degradation of the network over time. APC is enabled if automatic link bring up is enabled.

APC is a network-level feature that is distributed among different nodes. An APC domain is a set of nodes that is controlled by the same instance of APC at the network level. An APC domain identifies a portion of the network that can be independently regulated. The source OLT node acts as the APC Manager or Domain Manager for all the nodes in the path. The subsequent nodes in the path act as APC agent nodes. The manager node enables APC on agent nodes, monitors DISCREPANCY and initiates regulation if correction is required. To avoid large power fluctuations, APC adjusts power levels incrementally. APC performs power correction in steps of +/-0.8dB. This is applied to each iteration until the optimal power level is reached.

You can use APC as a span level application by using span-mode APC.

APC is direction-specific. You can enable APC for each direction at the transmitting OLT node. The source node enables and controls different parameters in all ILA nodes on the path and the far-end OLT ingress EDFA.

The following table lists the parameters that APC configures and controls in different nodes.

Node	Parameters
Transmitting OLT	EDFA Gain EDFA Tilt VOA Attenuation WSS Attenuation

Node	Parameters
ILA	EDFA Gain EDFA Tilt VOA Attenuation DGE Attenuation
Receiving OLT	EDFA Gain EDFA Tilt WSS Attenuation

When you enable APC, APC controls these parameters. APC overrides any manual configuration. When you disable APC, user configuration is applied.

APC divides the C band spectrum into 32 equal parts. APC uses 33 frequencies across the C band to divide the band. We call these 33 frequencies, **setpoints**. Each setpoint is 150 GHz apart from the adjacent setpoints. You can configure a power profile across the spectrum using these setpoints. You can configure the target PSD for each OLT and ILA node on a link.

APC applies amplification and attenuation as required at channel level and composite signal level to ensure that the channels are at the target power level. You can configure the target power spectral densities for 33 points across the band. If you enable link tuner, link tuner sets the target PSDs for APC on all nodes in the path.

APC performs the following functions:

- APC monitors the current PSD against the target PSD for each channel (ASE and user channel) and changes the amplifier parameters including VOA, WSS, and DGE to achieve the target PSD.
- APC detects optical network changes on the path and alters the amplifier parameters on the nearest nodes to compensate for the changes. APC performs these alterations in multiple steps.
- APC collects measurements from other link nodes at the transmitting OLT to precisely locate optical network changes.

APC regulation begins as soon as it discovers any part of the topology. At a transmitting OLT, it starts power correction at the OLT and subsequent ILA nodes even if the complete OLT-OLT link has not been discovered.

Note

- If the input slice power of a channel is below psd-min and APC is unable to bring the channel above psd-min even after setting the WSS attenuation to 0dB, APC declares the channel as failed.
- After APC regulation, all channel powers must be above psd-min (-24-dBm default) and at least one channel should be within 0.5 dB of psd-min.

View APC Status and Information

Use the **show olc apc** command to view APC status.

The following sample is an output of **show olc apc** command when APC is in Centralized mode.

```
RP/0/RP0/CPU0:OLT1#show olc apc

Controller      : Ots0/0/0/0
APC Status      : WORKING

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.99.1.2
Internal State  : IDLE

Node RID        : 10.99.2.2
Internal State  : IDLE

Node RID        : 10.99.4.1
Internal State  : IDLE

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

The following sample is an output of **show olc apc** command when APC is in span-mode.

```
RP/0/RP0/CPU0:ios#show olc apc

Controller      : Ots0/0/0/0
APC Status      : MANUAL
```

APC Status is the status of APC in the complete path. The following table lists and describes the APC Statuses.

APC Status	Description
BLOCKED	APC moves to BLOCKED state if: • there is an event in the network which resulted in topology failure • an amplifier safety event like APR or OSRI has been triggered in the network • APC is locally disabled on agent node
PAUSED	APC is paused using the **apc-pause** command.
IDLE	APC regulation has been completed successfully. All the channels in the network have achieved the target PSD provided by Link-tuner or configured by user
WORKING	APC detected a DISCREPANCY between current and target PSD. APC regulation is in progress to converge the power to target PSD.
DISABLED	APC is disabled.
PARTIAL-TOPOLOGY NODE-BLOCKED	APC has limited visibility. APC manager does not have visibility to the full OLT-OLT topology. APC manager tries to correct the power levels on the agent nodes that are reachable and after the regulation is complete, APC moves to BLOCKED state.
Manual	

Internal State is the state of APC on each individual node. The following table lists and describes the internal states.

APC Internal State	Description
DISCREPANCY	The APC manager flags an agent node which needs correction when there is a discrepancy between target PSD and current PSD. This state is temporary and lasts until APC starts power correction and goes into CORRECTING state.
CORRECTING	APC correction is in progress on the node
OOR	APC-OUT-OF-RANGE condition is raised on an agent node when APC fails to regulate and achieve the target PSD power level because the requested gain or attenuation setpoint cannot be set due to one of the following conditions: • Amplifier gain is exhausted in the current gain range. • WSS range (0-25dB) is exhausted for a single or multiple channels. • DGE range (0-3dB) is exhausted for a single or multiple channels. • Spanloss increased and amplifier gain is insufficient to achieve target PSD
IDLE	APC regulation has been completed successfully. All the channels in the network have achieved the target PSD provided by Link-tuner or configured by user
BLOCKED	APC is unable to perform for the following reasons: • OSRI has shut down the amplifier: AMPLI-SHUT • APC is disabled locally on the node: USER-DISABLED • Gain Estimation is in progress: GAIN-ESTIMATION-IN-PROGRESS • Amplifier auto power reduction is enabled: AMPLI-APR-ENABLED • Amplifier is shut because of loss of input power: AMPLI-SHUT • An event in the network resulted in topology failure.

The following sample is an output of **show olc apc** command when OSRI has shut down an amplifier in the link.

```
RP/0/RP0/CPU0:ios#sh olc apc
Thu Jul  7 13:21:05.807 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.1.1.2
Internal State  : BLOCKED
Blocked Reason  : [ AMPLI-SHUT ]

Node RID        : 10.1.1.3
Internal State  : DISCREPANCY

Node RID        : 10.1.1.4
Internal State  : DISCREPANCY

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

The following sample is an output of **show olc apc** command when APC is disabled locally on a node.

```
RP/0/RP0/CPU0:ios#sh olc apc
Thu Jul  7 13:22:44.145 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.1.1.2
Internal State  : BLOCKED
Blocked Reason  : [ USER-DISABLED ]

Node RID        : 10.1.1.3
Internal State  : DISCREPANCY

Node RID        : 10.1.1.4
Internal State  : DISCREPANCY

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

The following sample is an output of **show olc apc** command when Gain Estimation is in progress on a node.

```
RP/0/RP0/CPU0:ios#sh olc apc
Tue Jun 7 11:43:10.801 UTC

Controller : Ots0/0/0/0
APC Status : BLOCKED

Node RID : 10.1.1.1
Internal State : DISCREPANCY

Node RID : 10.1.1.2
Internal State : DISCREPANCY

Node RID : 10.1.1.3
Internal State : BLOCKED
Blocked Reason : [ GAIN-ESTIMATION-IN-PROGRESS ]
```

The following sample is an output of **show olc apc** command when amplifier auto power reduction is enabled on a node.

```
RP/0/RP0/CPU0:ios#sh olc apc
Thu Jul  7 13:21:49.530 UTC

Controller      : Ots0/0/0/0
APC Status      : BLOCKED

Node RID        : 10.1.1.1
Internal State  : IDLE

Node RID        : 10.1.1.2
Internal State  : BLOCKED
Blocked Reason  : [ AMPLI-APR-ENABLED ]

Node RID        : 10.1.1.3
Internal State  : DISCREPANCY

Node RID        : 10.1.1.4
Internal State  : DISCREPANCY

Node RID        : 10.1.1.5
Internal State  : DISCREPANCY
```

You can view the local status of APC on each node using the **show olc apc-local** command. This command shows if APC is enabled or disabled on the node.

The following sample is an output of **show olc apc-local** command when APC is in centralized mode.

```
RP/0/RP0/CPU0:ios#show olc apc-local
Mon Apr 11 06:59:14.679 UTC

Controller : Ots0/0/0/0

TX Status : ENABLED
RX Status : ENABLED
```

The following sample is an output of **show olc apc-local** command when APC is in spam mode.

```
RP/0/RP0/CPU0:SOLN-OLT-1#show olc apc-local
Tue Jun 11 10:57:00.797 IST

Controller :  Ots0/0/0/0

Tx Status : SPAN-MODE
Rx Status : SPAN-MODE
```

You can view the target PSDs configured for all setpoints using the **show olc apc-local target-psd-profile** command. The output shows the source of the PSD configuration also. The target PSD source can be Link Tuner or Configuration.

The following sample is an output of **show olc apc-local target-psd-profile** command.

```
RP/0/RP0/CPU0:ios#show olc apc-local target-psd-profile
Tue Apr 26 10:19:24.910 UTC
Controller          : Ots0/0/0/0
Target PSD source   : Configuration
--------------------------------------------------------------------------------
Setpoint                Frequency                       Target PSD
                          (THz)                       (dBm/12.5 GHz)
--------------------------------------------------------------------------------
01                    191.337494                          15.0
02                    191.488678                          15.0
```

```
03                  191.639847                  -4.1
04                  191.791016                  -4.1
05                  191.942184                  -4.1
06                  192.093353                  -4.1
07                  192.244537                  -4.1
08                  192.395706                  -4.1
09                  192.546875                  -4.1
10                  192.698044                  -4.1
11                  192.849213                  -4.1
12                  193.000397                  -4.1
13                  193.151566                  -4.1
14                  193.302734                  -4.1
15                  193.453903                  -4.1
16                  193.605072                  -4.1
17                  193.756256                  -4.1
18                  193.907425                  -4.1
19                  194.058594                  -4.1
20                  194.209763                  -4.1
21                  194.360931                  -4.1
22                  194.512115                  -4.1
23                  194.663284                  -4.1
24                  194.814453                  -4.1
25                  194.965622                  -4.1
26                  195.116791                  -4.1
27                  195.267975                  -4.1
28                  195.419144                  -4.1
29                  195.570312                  -4.1
30                  195.721481                  -4.1
31                  195.872650                  -4.1
32                  196.023834                  -4.1
33                  196.175003                  -4.1
```

You can view the detailed information about APC on each node using the **show olc apc-local regulation-info** command. This command provides the following information:

- Controller
- APC Domain Manager
- Internal Status
- Minimum PSD
- Last correction timestamp
- Gain range
- Amplifier and attenuation parameters: Configured and current values and available ranges
- Detailed information on the channels

  The following details are available:

  - Center frequency of each channel
  - Channel width
  - Channel ID
  - Channel Source (ASE or user channel)
  - Slice number of the center frequency of the channel in the WSS
  - PSD of the channel at the input of the amplifier

- Target PSD for the channel
- Current PSD of the channel
- Discrepancy between current and target PSD
- The configured attenuation on the WSS (OLT) or DGE (ILA) for the channel

You can view the APC information for only the Tx or Rx direction using the **tx|rx** keyword with the **show olc apc-local regulation-info controller ots** *R/S/I/P* command.

The following sample is an output of **show olc apc-local regulation-info** command.

```
RP/0/RP0/CPU0:ios#show olc apc-local regulation-info controller ots 0/0/0/0 tx
Wed Jul  6 05:01:45.177 UTC
Controller            : Ots0/0/0/0
Domain Manager        : 10.1.1.1
Internal Status       : OOR
Direction            : TX
PSD Minumum          : -24.0 (dBm/12.5 GHz)
Gain Range           : Normal
Last Correction      : 2022-07-06 05:01:28

  Device Parameters                 Min   Max  Configuration Operational
=============================================================================
  Egress Ampli Gain (dB)           :15.4  29.4 19.5          19.5
  Egress Ampli Tilt (dB)           :-5.0  3.1  -2.2          -2.2
  TX Ampli Power (dBm)             : -    22.4  -            21.4
  TX VOA Attenuation (dB)          :0.0   20.0 0.0           0.0
  Egress WSS/DGE Attenuation (dB)  :0.0   25.0  -            -


Channel Center Channel Channel Channel Spectrum   Ampli-Input      Target       Current
 Discrepancy Channel Slice
  Frequency     Width    ID    Source  Slice Num      PSD           PSD           PSD
             Attn Config
    (THz)       (GHz)                             (dBm/12.5 GHz)(dBm/12.5 GHz)(dBm/12.5 GHz)
    (dB)        (dB)
=============================================================================================

 191.375000    75.00     1      OCh       13          -23.2         -4.6          -4.9
     0.2        7.1
 191.449997    75.00     -      ASE       37          -23.0         -4.6          -4.7
     0.1        9.2
 191.524994    75.00     -      ASE       61          -23.1         -4.6          -4.7
     0.1        9.3
 191.600006    75.00     4      OCh       85          -23.1         -4.5          -4.7
     0.1        8.0
 191.675003    75.00     -      ASE       109         -23.0         -4.5          -4.5
     0.0        9.1
 191.750000    75.00     6      OCh       133         -23.0         -4.4          -4.6
     0.1        8.0
 191.824997    75.00     -      ASE       157         -23.1         -4.4          -4.6
     0.1        9.3
 191.899994    75.00     8      OCh       181         -23.0         -4.4          -4.4
     0.0        8.0
 191.975006    75.00     -      ASE       205         -23.0         -4.3          -4.5
     0.1        9.1
 192.050003    75.00     10     OCh       229         -23.0         -4.3          -4.5
     0.1        8.2
 192.125000    75.00     -      ASE       253         -22.9         -4.3          -4.3
     0.0        9.0
 192.199997    75.00     12     OCh       277         -22.8         -4.2          -4.3
```

0.0	8.3						
192.274994	75.00	-	ASE	301	-22.9	-4.2	-4.4
0.1	9.0						
192.350006	75.00	14	OCh	325	-22.6	-4.2	-4.2
0.0	8.3						
192.425003	75.00	-	ASE	349	-22.8	-4.2	-4.3
0.1	8.7						
192.500000	75.00	16	OCh	373	-22.4	-4.1	-3.9
-0.2	8.1						
192.574997	75.00	-	ASE	397	-22.7	-4.1	-4.2
0.1	8.6						
192.649994	75.00	18	OCh	421	-22.6	-4.1	-4.2
0.1	8.1						
192.725006	75.00	-	ASE	445	-22.7	-4.0	-4.2
0.1	8.6						
192.800003	75.00	20	OCh	469	-22.7	-4.0	-4.1
0.1	7.9						
192.875000	75.00	-	ASE	493	-22.6	-4.0	-4.0
0.0	8.4						
192.949997	75.00	22	OCh	517	-22.6	-3.9	-4.1
0.1	7.6						
193.024994	75.00	-	ASE	541	-22.5	-3.9	-4.0
0.1	8.2						
193.100006	75.00	24	OCh	565	-22.7	-3.8	-4.0
0.1	7.5						
193.175003	75.00	-	ASE	589	-22.7	-3.8	-4.0
0.1	8.2						
193.250000	75.00	26	OCh	613	-22.5	-3.8	-3.9
0.1	7.2						
193.324997	75.00	-	ASE	637	-22.6	-3.8	-4.0
0.2	8.1						
193.399994	75.00	28	OCh	661	-22.7	-3.7	-3.9
0.1	7.2						
193.475006	75.00	-	ASE	685	-22.5	-3.7	-3.8
0.1	8.0						
193.550003	75.00	30	OCh	709	-22.7	-3.7	-3.8
0.1	7.0						
193.625000	75.00	-	ASE	733	-22.7	-3.6	-3.8
0.1	8.1						
193.699997	75.00	32	OCh	757	-22.7	-3.6	-3.7
0.1	6.7						
193.774994	75.00	-	ASE	781	-22.7	-3.5	-3.7
0.1	8.2						
193.850006	75.00	34	OCh	805	-22.7	-3.5	-3.7
0.1	6.6						
193.925003	75.00	-	ASE	829	-22.7	-3.5	-3.6
0.1	8.1						
194.000000	75.00	36	OCh	853	-22.8	-3.5	-3.7
0.2	6.6						
194.074997	75.00	-	ASE	877	-22.8	-3.4	-3.6
0.1	8.3						
194.149994	75.00	38	OCh	901	-22.7	-3.4	-3.5
0.1	10.9						
194.225006	75.00	-	ASE	925	-22.8	-3.3	-3.5
0.1	8.2						
194.300003	75.00	40	OCh	949	-22.9	-3.3	-3.5
0.1	7.1						
194.375000	75.00	-	ASE	973	-22.8	-3.3	-3.4
0.1	8.4						
194.449997	75.00	42	OCh	997	-22.9	-3.2	-3.5
0.2	7.3						
194.524994	75.00	-	ASE	1021	-22.9	-3.2	-3.4
0.1	8.4						
194.600006	75.00	44	OCh	1045	-22.8	-3.2	-3.3

```
    0.1        7.2
194.675003    75.00      -      ASE       1069        -22.8          -3.2          -3.3
    0.1        8.4
194.750000    75.00     46      OCh       1093        -22.9          -3.1          -3.4
    0.2        7.3
194.824997    75.00      -      ASE       1117        -22.8          -3.1          -3.2
    0.1        8.2
194.899994    75.00     48      OCh       1141        -22.8          -3.0          -3.3
    0.2        6.9
194.975006    75.00      -      ASE       1165        -22.9          -3.0          -3.2
    0.1        8.3
195.050003    75.00     50      OCh       1189        -22.8          -3.0          -3.1
    0.1        6.6
195.125000    75.00      -      ASE       1213        -22.9          -3.0          -3.1
    0.1        8.3
195.199997    75.00     52      OCh       1237        -22.9          -2.9          -3.1
    0.1        6.3
195.274994    75.00      -      ASE       1261        -23.0          -2.9          -3.0
    0.1        8.1
195.350006    75.00     54      OCh       1285        -23.1          -2.8          -3.0
    0.1        6.4
195.425003    75.00      -      ASE       1309        -23.2          -2.8          -3.0
    0.1        8.3
195.500000    75.00     56      OCh       1333        -23.1          -2.8          -2.9
    0.1        6.2
195.574997    75.00      -      ASE       1357        -23.4          -2.8          -3.0
    0.2        8.2
195.649994    75.00     58      OCh       1381        -23.4          -2.7          -2.9
    0.1        6.4
195.725006    75.00      -      ASE       1405        -23.4          -2.7          -2.8
    0.1        8.5
195.800003    75.00     60      OCh       1429        -23.6          -2.7          -2.8
    0.1        6.6
195.875000    75.00      -      ASE       1453        -23.7          -2.6          -2.9
    0.2        8.7
195.949997    75.00     62      OCh       1477        -23.7          -2.6          -2.8
    0.2        6.9
196.024994    75.00      -      ASE       1501        -23.6          -2.5          -2.7
    0.1        9.0
196.100006    75.00     64      OCh       1525        -23.7          -2.5          -2.7
    0.1        7.1


ASE - Noise Loaded Channel
OCh - Optical Channel
```

Note

- In the previous sample output, the channel source is ASE for channels that are empty and for channels that failed due to power level dropping below psd-min. For dropped channels, channel ID is present and the channel source is ASE. ASE or Noise loader fills noise across the spectrum with a spacing of 75 GHz for wherever optical cross connects are not present.
- When APC is in span-mode, the apc regulation info output does not show the channel source on ILA nodes

Configure APC

If you enable link tuner, the link tuner sets the target PSDs for APC on all nodes in the path.

You can configure the target power spectral densities for 33 points across the band. The 33 PSD values divide the entire spectrum into 150-GHz steps. APC uses the corresponding PSD value if the channel frequency corresponds to a configured point. If the central frequency is not on a configured position, APC computes the target PSD for a channel by extrapolating from the two adjacent steps.

Use the following commands to set the target PSDs for single-band for each node on a C-band network.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

psd *<1-33> value*

commit

end

The following is a sample configuration that sets the psd to 15 dBm/12.5 GHz for the setpoints 1 and 2.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#psd 1 150
RP/0/RP0/CPU0:ios(config-olc-ots)#psd 2 150
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Disable APC

To disable APC for a link, execute the following commands on the transmitting OLT node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc disable

commit

end

The following is a sample configuration that disables APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Important

- When you disable APC, NCS 1020 sets all setpoints to values in the configuration. If there is no configuration, NCS 1020 sets all setpoints to default values. Disabling APC is traffic impacting.

Enable Centralized APC

To enable APC for a link, execute the following commands on the transmitting OLT node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc enable

commit

end

The following is a sample configuration that enables APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Pause CentralizedAPC

If you want to modify the network without APC compensating for the changes, you can pause APC. Use the following commands to pause APC.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-pause

commit

end

The following is a sample configuration that pauses APC.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-pause
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Note

- If you run the **apc-pause** command when APC is in idle state, APC remains in the idle state until APC detects changes in the network that requires power correction. APC changes the status to paused after it detects changes, but does not perform power correction.
- Running the **apc-pause** command, does not pause channel startup.

Disable Centralized APC on an ILA Node

If you want to manually disable APC on a particular node. For example, consider a scenario where the headend OLT encounters a headless event. For any power correction required at agent nodes, APC manager is unavailable to initiate regulation. Also, you cannot perform any adjustments as APC is enabled and user-configuration of target-psd does not take effect. This command gives you an option to disable APC locally on an agent node to perform the parameter adjustments manually. Use the **apc-local disable** command to disable APC on an agent node.

Use the following commands to disable APC on an ILA node.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-local [RX | TX] disable

commit

end

The following is a sample configuration that disables APC locally.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-local RX disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Target Drop PSD

Link Tuner does not set the target PSD for drop ports. The default target PSD for drop ports is -8.0 dBm/12.5 GHz. The NCS 1020 applies drop PSD configuration for channels with cross connect configurations. Use the **drop-psd** command to set the desired drop-psd.

Use the following commands to set the desired drop-psd.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

drop-psd *value*

commit

end

The following is a sample configuration that sets the target PSD at drop ports to –25 dBm/12.5 GHz.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#drop-psd -250
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure Minimum PSD

If the PSD of a channel with minimum attenuation at the amplifier input on an OLT is less than the minimum PSD, APC marks the channel as failed and replaces the channel using ASE source. The default minimum PSD is –24 dBm/12.5 GHz. Use the **psd-min** command to set the desired minimum PSD.

Use the following commands to set the desired minimum PSD.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

psd-min *value*

commit

end

The following is a sample configuration that sets the minimum PSD to –25 dBm/12.5 GHz.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#psd-min -250
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure APC Alarm Hold-off Timer

You can configure an interval before APC-TARGET-PSD-NOT-MET alarm is raised after APC detects a discrepancy. The default value is 90 seconds. Use the following commands to configure the timer.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-alarm-hold-off-timer*time*

commit

end

The following is a sample configuration that sets the APC alarm hold-off timer to 45 seconds.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-alarm-hold-off-timer 45
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Configure APC Alarm Discrepancy Threshold

You can configure the discrepancy allowed before APC-TARGET-PSD-NOT-MET alarm is raised. The default value is 1dB. Use the following commands to configure the threshold.

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

apc-alarm-discrepancy-threshold *discrepancy*

commit

end

The following is a sample configuration that sets the APC alarm discrepancy threshold to 1.5 dB.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#apc-alarm-discrepancy-threshold 15
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
Tue Apr 26 09:50:12.055 UTC
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

Switch Between APC Modes

Switch from Centralized APC to Span Mode APC

1. Configure APC in manual mode on OLT nodes.
2. Configure apc-span-mode on all nodes.
3. Initiate ALC and wait for ALC process to complete.

   After ALC baseline is saved, APC switches to span mode.

Switch from Span Mode APC to Centralized APC

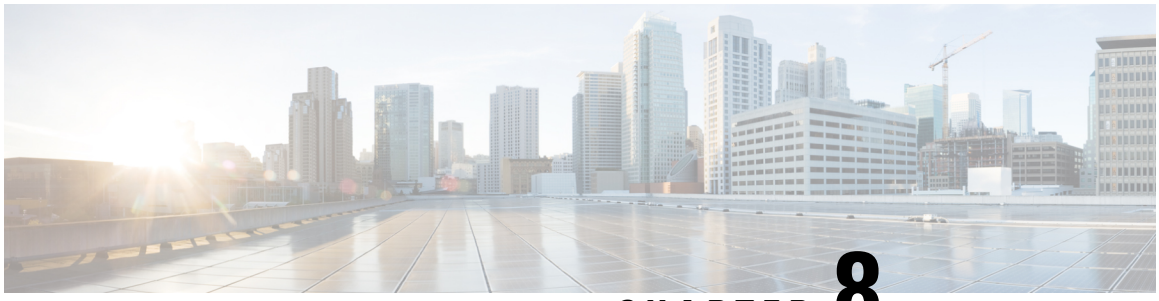
You can switch from span-mode APC to centralized APC in two different ways.

- Commit replace
  1. Reset all nodes to default configuration using the **commit replace** command.
  2. Reload all nodes.
  3. Configure the nodes with required configuration for link bring up.
  4. Configure automatic link bringup or enable APC.

     APC starts regulation in centralized mode.

- **no** configuration of optical applications
  1. Remove the optical applications cobnfigurations using the **no** form of APC, Link Tuner, and Gain estimator.
  2. Configure the nodes with required configuration for link bring up.
  3. Configure automatic link bringup or enable APC.

     APC starts regulation in centralized mode.



CHAPTER 8

Automatic Network Turn Up

This chapter describes the Automatic Network Turn Up workflow for Cisco NCS 1020.

Overview of Automatic Link Bring Up

You can bring up an NCS 1020 DWDM link without using any external tools. NCS 1020 measures optical parameters for all the spans at power-up. It then computes different setpoints for each of the spans to ensure optimal link performance for end-to-end traffic to pass through. The following optical applications enable Automatic Link Bring Up:

- Span loss measurement
- Gain Estimator
- Link Tuner
- Automatic Power Control
- Raman Tuning

Automatic Link Bring Up uses the following user configurations if they are available:

- Measured span loss
- Fiber type
- Spectral Density
- Span length

Automatic Link Bring Up works under the following assumptions:

- The fiber connections are proper. There are no fiber cuts or faulty connectors blocking link bring up.
- OSC link comes up without need of Raman gain. If span length is high and NCS 1020 is not able to turn up OSC without Raman Gain, you must disable Raman tuning and manually configure Raman amplification.

You need Automatic Link Bring Up after physically installing your device and connecting the fibers as necessary. Automatic Link Bring Up process starts when you turn on a device. The new device that you turn on does not have any configuration on it. First, the device must join the network and get an IP address.

The NCS 1020 device uses DHCP to get an IP address. After receiving an IP address using DHCP, the device gets ZTP configuration file from the DHCP server or a separate ZTP server. Configure the DHCP server with the desired IP address and configuration file for each NCS1020 device you want to configure. The NCS 1020 uses the configuration file and configures itself.

In optical networks with long spans, it is not always practical for all nodes to have direct connectivity to a DHCP server. In such cases, the OLT node that has server connectivity acts as a DHCP relay and provides the next node with DHCP connectivity. The ILA node that connects to the OLT then acts as a DHCP relay for the next ILA node in the link. Each subsequent node then acts as a DHCP relay and provides DHCP connectivity to the adjacent nodes down the link. As this process completes, all nodes get network connectivity and receive the ZTP configuration files. ZTP allows you to provision the network device with day 0 configurations.

The ZTP configuration file must contain the following configurations:

- Host configuration
- DHCP relay configuration (only if there are nodes further down the link)
- Interface configuration
- OSPF configuration
- SSH configuration

See Boot Using Zero Touch Provisioning for more information on configuring and using ZTP.

After ZTP configuration is complete, the NCS 1020 device uses OSPF to perform topology discovery. During topology discovery, each node finds out about its adjacent node and the entire topology. After discovering neighbor nodes, the device initiates span loss measurement. If the span is a Raman span, the device initiates Raman tuning. Simultaneously, the OLT begins ASE loading to load all the channels with noise.

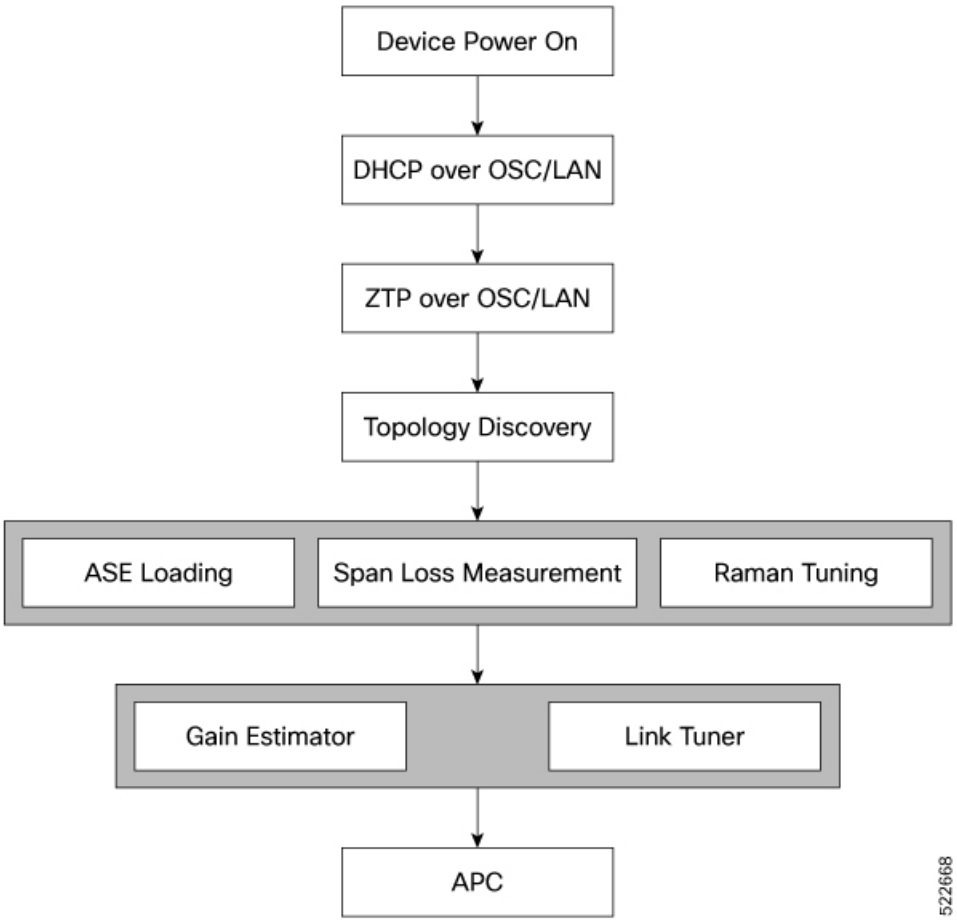
After ASE loading, span loss measurement, and Raman tuning are complete, the NCS 1020 device initiates Startup Gain Estimation and Link tuner. Startup Gain Estimation sets the target gain and gain mode for the EDFA amplifier. Link tuner provides the target PSDs for the channels.

Note **Startup Gain Estimation** analyses the span loss and sets the gain mode of the EDFA amplifier and provides the initial target gain for the amplifier. EDFA amplifiers are present in both OLT and ILA variants of NCS 1020. These EDFA amplifiers are variable-gain optical amplifiers capable of working at two different gain ranges or modes. The modes are normal mode and extended mode. Extended mode provides higher gain than the normal mode. Changing the gain mode of an amplifier is traffic impacting. Therefore, Automatic Power Correction (APC) is unable to change the gain mode of an amplifier.

After Startup Gain Estimation and Link tuner operations are complete, the NCS 1020 initiates APC. APC uses the target PSDs that Link tuner sets and regulates the power output for all channels. Automatic Link Bring Up is complete and the optical link is up with all ASE loaded noise channels with the target PSDs set by link tuner. Create and configure optical cross connects to get traffic up and running on the link.

The following flowchart shows the sequence of the optical applications during automaticlink bring up.

Figure 2: Automatic Link Bring-up



The following example shows a sample ZTP configuration file with the minimum required configuration.

```
!! IOS XR Configuration
!
hostname ios
username cisco
group root-lr
group cisco-support
secret 10
$6$7motIAh93vG/I...$iM64ZfsZ5ciicdcsdsewHdEIvLTq0YEc1G1NMpauwJUiEnkV8LwMJUDZnnTkVj9RPgf4wffWJYelPN7jqiN3q/

dhcp ipv4
profile r1 relay
  helper-address vrf default 10.33.0.51 giaddr 10.7.3.2
!
profile r2 relay
  helper-address vrf default 10.33.0.51 giaddr 10.7.2.2
!
interface GigabitEthernet0/0/0/0 relay profile r2
interface GigabitEthernet0/0/0/2 relay profile r1
!
call-home
service active
contact smart-licensing
profile CiscoTAC-1
```

```
  active
  destination transport-method email disable
  destination transport-method http
!
!
interface Loopback0
ipv4 address 10.3.3.13 255.255.255.255
!
interface GigabitEthernet0/0/0/0
ipv4 address 10.7.2.2 255.255.255.0
!
interface GigabitEthernet0/0/0/2
ipv4 address 10.7.3.2 255.255.255.0
!
router ospf 1
router-id 10.3.3.13
distribute link-state
nsf
network point-to-point
redistribute connected
area 0
  interface Loopback0
  !
  interface GigabitEthernet0/0/0/0
  !
  interface GigabitEthernet0/0/0/2
  !
!
!
ssh server v2
ssh server vrf default
ssh server netconf vrf default
!
end
```

Enable Automatic Link Bring Up

Use the following commands to enable automatic link bring up.

configure

optical-line-control

automatic-link-bringup

commit

end

Disable Automatic Link Bring Up

Use the following commands to disable automatic link bring up.

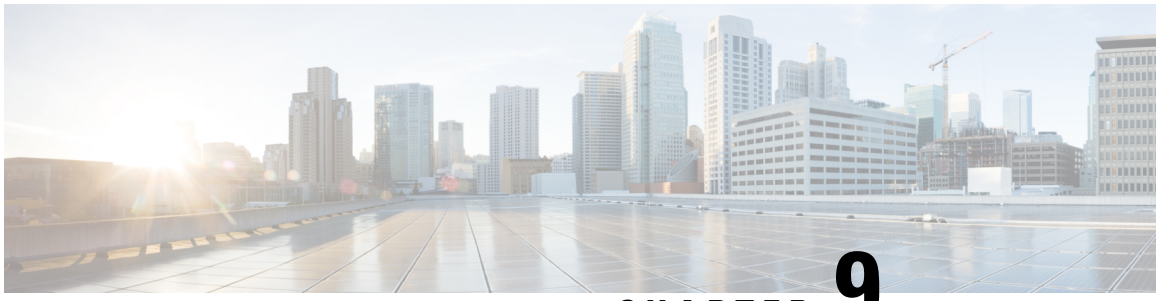
configure

optical-line-control

no automatic-link-bringup

commit

end



CHAPTER 9

Configure OTDR

This chapter describes how to configure the Optical Time Domain Reflectometer (OTDR) module in NCS 1020.

Overview of OTDR

The NCS 1020 OLT nodes have an in-built bidirectional Optical Time Domain Reflectometer (OTDR) functionality that can run in line with DWDM channels. The OTDR captures real-time measurements of loss and back reflection of the fiber pair linked to the Tx and Rx ports.

Note For the OLT device, the OTDR port can switch between LINE-TX and LINE-RX ports.

You can use this feature to check the fiber quality during system installation (before traffic is active), especially in case RAMAN is used. It can also be used to monitor the fiber during the system operation (live traffic) and to check the fiber if cable cut and repair events.

You can view the OTDR measurement result in the SOR file that is exported from NCS 1020.

You can determine the following characteristics using OTDR:

- The attenuation (dB) of the whole fiber link and the attenuation of separate sections of fiber.
- The distance and magnitude of insertion loss, reflection loss.
- Fiber events such as concentrated loss events (with value and position), reflection events (with value and position), events at the end of the fiber, and discontinuities or defects on the fiber including loss events.

OTDR Modes

In NCS 1020, you can configure OTDR in the following two modes:

- Auto—The device selects the optimal values for OTDR pulse width, scan duration, capture start time, and capture end time parameters.
- Expert—You must configure all the OTDR scan parameters with valid values required for the OTDR measurement.

Note Automatic adjustments are not performed in the expert mode configuration.

Measurement and Data Processing are the two fully automated internal phases in both auto and expert modes that proceed in sequence.

Configure OTDR

The NCS 1020 device uses the default values for OTDR scan parameters before the OTDR configuration.

You can configure the OTDR on the OTS controller. Use the following commands to configure the various OTDR parameters:

configure

controller ots *R/S/I/P*

otdr scan-mode expert

otdr rx auto reflectance-threshold *value*

otdr rx auto splice-loss-threshold *value*

otdr rx auto excess-reflection-threshold *value*

otdr rx back-scattering *value*

otdr rx refractive-index *value*

otdr tx auto reflectance-threshold *value*

otdr tx auto raman-setpoint *value*

otdr tx auto excess-reflection-threshold *value*

otdr tx auto splice-loss-threshold *value*

otdr tx back-scattering *value*

otdr tx refractive-index *value*

otdr rx auto excess-orl-threshold *value*

otdr tx auto excess-orl-threshold *value*

otdr rx auto excess-reflectance-threshold *value*

otdr tx auto excess-reflectance-threshold *value*

otdr rx auto excess-attenuation-threshold *value*

otdr tx auto excess-attenuation-threshold *value*

otdr rx expert pulse-width *value*

otdr rx expert capture-end *value*

otdr rx expert capture-start *value*

otdr rx expert scan duration *value*

otdr tx expert pulse-width *value*

otdr tx expert capture-end *value*

otdr tx expert capture-start *value*

otdr tx expert scan duration *value*

otdr tx expert scan duration *value*

Example:

```
RP/0/RP0/CPU0:ios#config
RP/0/RP0/CPU0:ios(config)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx auto reflectance-threshold -50
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx auto splice-loss-threshold 200
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx expert pulse-width 6000
RP/0/RP0/CPU0:ios(config-Ots)#otdr tx auto reflectance-threshold -50
RP/0/RP0/CPU0:ios(config-Ots)#otdr tx auto splice-loss-threshold 200
RP/0/RP0/CPU0:ios(config-Ots)#otdr scan-mode expert
RP/0/RP0/CPU0:ios(config-Ots)#otdr scan-mode expert
RP/0/RP0/CPU0:ios(config-Ots)#commit
```

```
RP/0/RP0/CPU0:ios#config
RP/0/RP0/CPU0:ios(config)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx auto reflectance-threshold -50
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx auto splice-loss-threshold 200
RP/0/RP0/CPU0:ios(config-Ots)#otdr rx expert pulse-width 6000
RP/0/RP0/CPU0:ios(config-Ots)#otdr tx auto reflectance-threshold -50
RP/0/RP0/CPU0:ios(config-Ots)#otdr tx auto splice-loss-threshold 200
RP/0/RP0/CPU0:ios(config-Ots)#otdr scan-mode expert
RP/0/RP0/CPU0:ios(config-Ots)#otdr scan-mode expert
RP/0/RP0/CPU0:ios(config-Ots)#commit
```

Table 1: OTDR Configuration Parameters

Parameter	Description	Range	Unit	Default
otdr rx auto reflectance-threshold	Threshold beyond which a reflective anomaly is reported as an event in the Rx direction.	–50 to –10	dB	–40

Parameter	Description	Range	Unit	Default
otdr rx auto splice-loss-threshold	Threshold beyond which a loss anomaly is reported as an event in Rx direction.	0.2 to 5	dB	0.35
otdr rx excess-reflection-threshold	Threshold beyond which a reflective event is reported as an excessive reflection event in the Rx direction.	–50 to –10	dB	–20
otdr rx back-scattering	The back scattering value in the Rx direction.	–90 to –70	dB	–81.87
otdr rx refractive-index	The refractive-index value in the Rx direction.	1.000 to 2.000	-	1.4682
otdr tx auto reflectance-threshold	Threshold beyond which a reflective anomaly is reported as an event in Tx direction.	-50 to -10	dB	–40
otdr tx auto splice-loss-threshold	Threshold beyond which a loss anomaly is reported as an event in Tx direction.	0–2.5	dB	0.35
otdr tx auto excess-reflection-threshold	Threshold beyond which a reflective event is reported as an excessive reflection event in the Tx direction.	–50 to –10	dB	–20
otdr rx auto excess-orl-threshold	Threshold below which an excessive ORL event is reported in the Rx direction.	10 to 60	dB	60

Parameter	Description	Range	Unit	Default
otdr tx auto excess-orl-threshold	Threshold below which an excessive ORL event is reported in the Tx direction.	10 to 60	dB	60
otdr rx auto excess-attenuation-threshold	Threshold beyond which a Non-Reflective event is reported as an excessive attenuation event in the Rx direction.	0.5 to 5	dB	5
otdr tx auto excess-attenuation-threshold	Threshold beyond which a Non-Reflective event is reported as an excessive attenuation event in the Tx direction.	0.5 to 5	dB	5
otdr tx back-scattering	Back-scattering value in the Tx direction.	–90 to –70	dB	–81.87
otdr tx refractive-index	Refractive-index value in the Tx direction.	1.0000 to 2.0000	Unit less	1.4682
otdr rx expert pulse-width	Pulse width to be used during the expert scan in the Rx direction.	5 to 2000	ns	20
otdr rx expert capture-end	OTDR capture endpoint during the expert scan in the Rx direction.	15000000	cm	15000000
otdr rx expert capture-start	OTDR capture start point during expert scan in the Rx direction	0 to 10000000	cm	0

Parameter	Description	Range	Unit	Default
otdr rx expert scan duration	OTDR scan duration during expert scan in the Rx direction.	0 to 180	Seconds	60
otdr tx expert pulse-width	Pulse width to be used during the expert scan in the Tx direction.	5 to 20000	ns	20
otdr tx expert capture-end	OTDR capture endpoint during expert scan in the Tx direction.	0 to 15000000	cm	15000000
otdr tx expert capture-start	OTDR capture start point during expert scan in the Tx direction.	0 to 10000000	cm	0
otdr tx expert scan duration	OTDR scan duration during expert scan in the Tx direction.	0 to 180	Seconds	60

Start OTDR

NCS 1020 software does not support automatic start of OTDR scan. You have to start the OTDR scan manually using the **otdr-start controller ots** *R/S/I/P direction* command to perform the following procedures:

1. Identify the defect after the fiber has been cut.
2. Check the fiber quality after correcting the fiber defect.
3. Initiate an OTDR scan at the time of installation.

Example:

```
RP/0/RP0/CPU0:ios#otdr-start controller ots 0/0/0/0 rx
Wed Feb  9 05:49:39.178 UTC
OTS OTDR Scan Started at RX
RP/0/RP0/CPU0:ios#
```

The Raman tuning application locks the OTDR scan at both fiber ends before the tuning starts, and releases the lock after the tuning completes. Therefore, when you try to start the OTDR scan when Raman tuning is running, your request gets rejected. The following example explains the OTDR start request rejection. The OTDR scan request that has been rejected already does not run automatically after the lock is released, so you have to create a new request to start the OTDR again.

```
RP/0/RP0/CPU0:ios#otdr-start controller ots 0/0/0/0 rx
Tue Feb 28 10:25:43.379 UTC
```

```
OTDR Scan cannot be started as it is locked by Another Entity/Application.
RP/0/RP0/CPU0:ios#

RP/0/RP0/CPU0:ios#otdr-start controller ots 0/0/0/0 tx
Tue Feb 28 10:25:53.379 UTC
OTDR Scan cannot be started as it is locked by Another Entity/Application.
RP/0/RP0/CPU0:ios#
```

Stop OTDR

To stop the OTDR scan function, use the following **otdr-stop controller ots** *R/S/I/P direction* command:

Example:

```
RP/0/RP0/CPU0:ios#otdr-stop controller ots 0/0/0/0 rx
Wed Feb  9 06:03:37.406 UTC
OTS OTDR Scan Stopped at RX
RP/0/RP0/CPU0:ios#
```

Display OTDR Scan Measurements

You can use the **show controllers ots** *R/S/I/P* **otdr-info** *direction* command to view the OTDR scan events and the location of the SOR file.

The SOR file contains the fiber trace details such as the distance, reflectance, loss, and fiber attenuation measurements. You can export the SOR file.

Note To transfer the SOR file from the source to the destination, use the following command: **scp username@device-ip:filename_with_source_location destination-location**

Example:

```
scp test@192.168.0.1:/harddisk:/otdr/ios_OTDR_Ots0_0_0_0_RX_20230301-101927.sor /users/test/
```

OTDR can detect typical fiber events such as loss due to fiber splicing, patch panel, and coupler connections, single and multiple loss events, single and multiple reflective events, fiber pinch, and fiber cut.

The following is the sample to display the OTDR scan information in the RX direction.

```
RP/0/RP0/CPU0:ios#show controllers ots 0/0/0/0 otdr-info rx
Wed Feb  9 05:55:19.791 UTC
       Scan Direction: RX
       Scan Status: Data Ready
       SOR file: /harddisk:/otdr/IOS_NCS1020_OTDR_Ots0_0_0_0_RX_20220209-055045.sor
       Total Events detected: 11
       Scan Timestamp: Wed Feb  9 05:50:45 2022 UTC
      Event Type Legend:  NR:Non-Reflective  R:Reflective  FE:Fiber-End  ER:Excess-Reflection

      Event#  | Detected Event(s) | Location(km) | Accuracy(m) | Magnitude(dB)|
Attenuation/km(dB)
      1       | R                 | 50.4709      | 52.47       | -39.87       |  0.18

      2       | NR                | 50.4709      | 52.47       | 1.17         |  0.18

      3       | R                 | 100.9261     | 102.92      | -37.73       |  0.21
```

```
4       | NR                | 100.9261     | 102.92       | 1.01          |  0.21

5       | R                 | 105.9500     | 107.94       | -38.52        |  0.24

6       | NR                | 105.9500     | 107.94       | 0.85          |  0.24

7       | R                 | 112.7458     | 114.74       | -40.56        |  0.00

8       | NR                | 112.7458     | 114.74       | 1.48          |  0.00

9       | NR                | 117.9873     | 119.98       | 0.66          |  -0.02

10      | R FE              | 120.1206     | 122.12       | -35.55        |  0.00

11      | NR FE             | 120.1206     | 122.12       | 21.65         |  0.00
```

Note After the FPD upgrade of the line card, the results of previous OTDR scans may not be available using the CLI command **show controllers ots** *Rack/Slot/Instance/Port* **otdr-info** *direction*. However, you can get the results of previous OTDR scans in the form of .SOR files that are stored in the hard disk.

Optical Return Loss (ORL) is measured during the OTDR scan and displayed as part of the OTDR results. The ORL represents the total reflected optical power from a complete fiber link, while considering the attenuation. This includes the natural backscattered power of the fiber and the reflected power coming from optical connectors, fiber splicing, or other discontinuities along the link. ORL is expressed with a positive number. Higher ORL values are desirable for the fiber because they indicate lower back reflection. For example, an ORL of 40 dB is better than 20 dB.

The following sample displays the ORL value as part of OTDR status:

```
RP/0/RP0/CPU0:ios#show controllers Ots 0/0/0/2 otdr-info rx
Mon Oct 2 11:55:48.552 UTC
Scan Direction: RX
Scan Status: Data Ready
Optical Return Loss: 39.0 dB
SOR file: /harddisk:/otdr/NCS1020_NCS1020_OTDR_Ots0_0_0_2_RX_20231001-110754.sor
Total Events detected: 8
Scan Timestamp: Sun Oct  1 11:07:54 2023 UTC
Event Type Legend:NR:Non-Reflective R:Reflective FE:Fiber-End ER:Excess-Reflection
EA:Excess-Attenuation
Event# | Detected Event(s) | Location(m) | Accuracy(m) | Magnitude(dB)| Attenuation/km(dB)
1      | NR EA             | 4.4100      | 2.00        | 0.69         | 0.00
2      | NR                | 664.3200    | 2.66        | 0.21         | 0.00
3      | R ER              | 18222.3900  | 20.22       | -33.78       | 0.19
4      | NR                | 18222.3900  | 20.22       | 0.35         | 0.19
5      | R ER              | 68674.4800  | 70.67       | -32.25       | 0.20
6      | NR                | 68674.4800  | 70.67       |  0.36        | 0.20
7      | R FE ER           | 118765.2600 | 120.76      | -28.55       | 0.23
8      | NR FE             | 118765.2600 | 120.76      | 25.86        | 0.23
```

Automatic OTDR Scan

The OTDR scan begins automatically whenever the events such as span fault, span restore, device power cycle, and line card cold reload occur. By default, this feature is disabled. You can enable this feature.

The OTDR autoscan takes less than three minutes to complete. When the autoscan is running the OTDR-SCAN-IN-PROGRESS-RX alarm is raised and this alarm gets cleared after completion of the scan.

The following table explains how the span fault and span restore events are detected:

Table 2: Definition of Span Up and Span Down Events

Events	Non-Raman Span	Raman Span	Raman Span with Dual Safety Configured
Span Down	Raise of RX-LOS-P alarm at OSC controller	Raise of RX-LOS-P alarm at DFB controller	Raise of RX-LOS-P alarm at both OSC and DFB controllers
Span Up	Clearing of RX-LOS-P alarm at OSC controller	Clearing of RX-LOS-P alarm at DFB controller	Clearing of RX-LOS-P alarm at OSC or DFB controller

Note

- The autoscan locks the OTDR resource to avoid manual trigger of scan using the **start-otdr** command. However, if the manual scan is ongoing, the autoscan waits for its completion.
- The autoscan terminates any ongoing scan triggered by another applications such as Raman turn-up.
- During autoscan, if a change in Span Status is detected the ongoing scan will be terminated, and a new autoscan will be triggered.

Configure Automatic OTDR Scan

You can enable or disable Automatic OTDR scan using the following commands:

configure

optical-line-control

controller ots *Rack/Slot/Instance/Port*

otdr auto-scan [enable | disable]

commit

end

The following are the sample configurations that enable and disable the automatic OTDR scan:

```
RP/0/RP0/CPU0:ios#configure
Mon Sep 18 13:11:53.812 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control controller Ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#otdr auto-scan enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

```
RP/0/RP0/CPU0:ios#configure
Mon Sep 3 13:28:34.631 UTC
RP/0/RP0/CPU0:ios(config)#optical-line-control controller Ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#otdr auto-scan disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
```

View Automatic OTDR Results

The following samples display the status of autoscan in a non-Raman span.

```
RP/0/RP0/CPU0:ios#show olc otdr-status
Mon Sep 18 13:10:57.733 UTC
Controller                                  : Ots0/0/0/0
Auto-scan Start Time                        : NA
OTDR Auto-scan Status                       : DiSABLED
Status Detail                               : NA
Optical Span Status                         : UP
Trigger Event                               : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:11:00.565 UTC
Controller                                  : Ots0/0/0/0
Auto-scan Start Time                        : NA
OTDR Auto-scan Status                       : DISABLED
Status Detail                               : NA
Optical Span Status                         : UP
Trigger Event                               : NA
Last Trigger Event                          : NA
```

The following samples display the various status of OTDR automatic scan during span restore:

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:12:40.430 UTC
Controller                                  : Ots0/0/0/0
Auto-scan Start Time                        : NA
OTDR Auto-scan Status                       : RUNNING
Status Detail                               : Starting on Span Up
Optical Span Status                         : Up
Trigger Event                               : Span Restore
Last Trigger Event                          : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:15:06.153 UTC
Controller                                  : Ots0/0/0/0
Auto-scan Start Time                        : 2023-09-18 13:12:42
OTDR Auto-scan Status                       : RUNNING
Status Detail                               : Waiting Scan Completion on Span Up
Optical Span Status                         : Up
Trigger Event                               : Span Restore
Last Trigger Event                          : NA

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:15:06.153 UTC
Controller                                  : Ots0/0/0/0
Auto-scan Start Time                        : 2023-09-18 13:12:42
OTDR Auto-scan Status                       : COMPLETED
Status Detail                               : Completed on Span Up
Optical Span Status                         : Up
Trigger Event                               : Span Restore
Last Trigger Event                          : Span Restore
```

The following samples display the various status of OTDR automatic scan during span fault:

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:16:16.461 UTC
Controller                                  : Ots0/0/0/0
Auto-scan Start Time                        : NA
OTDR Auto-scan Status                       : RUNNING
Status Detail                               : Starting on Span Down
Optical Span Status                         : Down
```

```
Trigger Event                                  : Span Fault
Last Trigger Event                             : Span Restore

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:16:33.304 UTC
Controller                                     : Ots0/0/0/0
Auto-scan Start Time                           : 2023-09-18 13:16:27
OTDR Auto-scan Status                          : RUNNING
Status Detail                                  : Waiting Scan Completion on Span Down
Optical Span Status                            : Down
Trigger Event                                  : Span Fault
Last Trigger Event                             : Span Restore

RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 13:18:54.154 UTC
Controller                                     : Ots0/0/0/0
Auto-scan Start Time                           : 2023-09-18 13:16:27
OTDR Auto-scan Status                          : COMPLETED
Status Detail                                  : Completed on Span Down
Optical Span Status                            : Down
Trigger Event                                  : Span Fault
Last Trigger Event                             : Span Fault
```

The following sample displays the status detail of autoscan when autoscan is not able to lock OTDR resource after 30 minutes. The status detail is reported as ‘Failed due to Timeout’, and the autoscan will not trigger.

```
RP/0/RP0/CPU0:ios# show olc otdr-status details
Wed Sep 20 14:09:37.011 UTC
Controller                                      : Ots0/0/0/0
Auto-scan Start Time                            : 2023-09-20 13:58:17
OTDR Auto-scan Status                           : COMPLETED
Status Detail                                   : Failed due to Timeout
Optical Span Status                             : UP
Trigger Event                                   : Span Restore

Last Trigger Event                              : NA
```

The following sample explains the status detail of the autoscan where the ongoing autoscan is stopped by the user.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 15:08:27.370 UTC
Controller                                      : Ots0/0/0/0
Auto-scan Start Time                            : 2023-09-18 15:08:09
OTDR Auto-scan Status                           : COMPLETED
Status Detail                                   : Stopped by User
Optical Span Status                             : DOWN
Trigger Event                                   : Span Fault
Last Trigger Event                              : Span Restore
```

The following sample displays the status detail where the autoscan in one port is waiting for the OTDR resource, because the autoscan is running on another port.

```
RP/0/RP0/CPU0:ios#show olc otdr-status details
Mon Sep 18 15:57:43.671 UTC
Controller                                      : Ots0/0/0/0
Auto-scan Start Time                            : 2023-09-18 15:57:43
OTDR Auto-scan Status                           : COMPLETED
Status Detail                                   : Waiting for OTDR Resource

Optical Span Status                             : UP
Trigger Event                                   : Span Restore
Last Trigger Event                              : NA
```