



## **Cisco NCS 1010 Optical Applications Configuration Guide, IOS XR Release 7.10.x**

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# CHAPTER 1

## NCS 1010 Overview and Optical Applications

This chapter gives a brief overview of the optical apps on NCS 1010. See [NCS 1010 Overview](#) for the product overview.

NCS 1010 software has multiple optical applications to help bring up the link and maintain traffic on the link.

- [Document Objective, on page 1](#)
- [Document Organization, on page 1](#)

### Document Objective

Cisco Network Convergence System (NCS) 1010 platform has the following configuration guides.

- The *Cisco NCS 1010 System Setup and Software Installation Guide* describes how to bring up the NCS 1010 system and perform the required software installation.
- The *Cisco NCS 1010 Datapath Configuration Guide* describes how to configure various datapaths on NCS 1010.
- The *Cisco NCS 1010 Optical Applications Configuration Guide* describes multiple optical applications on NCS 1010, that help to bring up the link and maintain traffic on the link.

### Document Organization

This document is organized into the following chapters:

Chapter	Description
<a href="#">Internode Topology Discovery and Communication, on page 3</a>	NCS 1010 uses OSPF for topology discovery.
<a href="#">Span Loss, on page 5</a>	Span Loss application measures span loss between two nodes for a given direction and verifies if span loss is within the configured range.
<a href="#">Raman Tuning, on page 9</a>	Raman Tuning application sets Raman pump powers for optimum gain and spectral gain flatness.

Chapter	Description
<a href="#">Gain Estimator, on page 17</a>	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.
<a href="#">Link Tuner, on page 21</a>	Link Tuner uses actual optical measurements like span loss to compute and configure the target PSD (power spectral density) for each span.
<a href="#">Automatic Power Control, on page 27</a>	Automatic Power Control configures amplifier and attenuator setpoints to achieve target PSD across the link.
<a href="#">Band Failure Recovery, on page 45</a>	BFR compensates for the dynamic power when upgrading from C-band to the C+L band network and handles band failure with a minimum impact on the traffic.
<a href="#">Upgrade C-Band to C+L Band Without Affecting Traffic Flow, on page 57</a>	Upgrade from C-band to the C+L band network without affecting the traffic flow in the network.
<a href="#">Automatic Network Turn Up, on page 63</a>	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.
<a href="#">Configure OTDR , on page 67</a>	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

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This chapter describes how internode topology discovery and communication between NCS 1010 nodes takes place using OSPF.

- [Internode Topology Discovery and Communication, on page 3](#)

## Internode Topology Discovery and Communication

Optical applications on the NCS 1010 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 1010 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 1010 must discover the link topology, the different nodes and the node types, and the optical spectral band the nodes work on. NCS 1010 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 1010 OLT node.

```
configure  
router ospf process-name  
router-id router-id  
distribute link-state  
nsf  
network point-to-point  
redistribute connected  
area area-id
```

```
interface Loopback1
interface GigabitEthernet0/0/0/0
```

The following commands are the necessary configurations for OSPF on an NCS 1010 ILA node.

```
configure
router ospf process-name
router-id router-id
distribute link-state
nsf
network point-to-point
redistribute connected
area area-id
interface Loopback1
interface GigabitEthernet0/0/0/0
interface GigabitEthernet0/0/0/2
```



---

**Important** You must configure router ID during OSPF configuration on NCS 1010 nodes.

---

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





# CHAPTER 3

## Span Loss

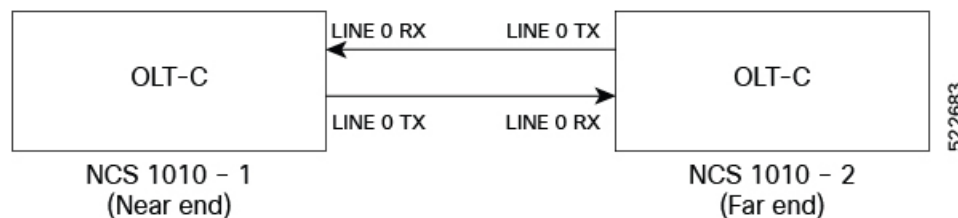
This chapter describes the Span Loss optical application for Cisco NCS 1010.

- [Overview of Span Loss, on page 5](#)

### Overview of Span Loss

The Span Loss calculation is an automatic calculation of span losses between NCS 1010 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 1010-1 is the difference in signal power between LINE 0 TX on NCS 1010-1 and LINE 0 RX on NCS 1010-2.

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 a Raman span with Raman tuning enabled, span loss verification reports the following values:

- **Span loss with pumps off:** This measurement is the difference in power values between the DFB-Tx/Rx of the remote node and the DFB-Rx/Tx of the local node. This measurement also includes a timestamp. When a Raman span is up, the span loss application latches on to the difference in power between DFB-Tx and DFB-Rx before Raman tuning turns the Raman pumps on.
- **Apparent span loss:** This measurement is based on the power values of C band, L band and Optical Service Channel (OSC). For a Raman span, the span loss application uses this span loss value to raise the *Span Loss Value Out Of Range* alarm.

- **Estimated span loss:** This value is based on Raman gain that is achieved by Raman tuning application. Estimated span loss value is based on Raman gain that is achieved when safety loop was closed and tuning was performed. Raman tuning application reports the Raman gain measurement. When you disable Raman tuning, the span loss application does not compute the Estimated span loss.

Estimated span loss = Apparent span loss + Raman gain

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.

```
RP/0/RP0/CPU0:ios#show olc span-loss
Mon Apr 11 09:33:00.398 UTC

Controller name           : Ots0/0/0/0
Neighbour RID            : 10.1.1.2
Apparent Rx Span Loss    : 7.7 dB
Rx Span Loss (with pumps off) : 23.2 dB
Rx Span Loss (with pumps off) measured at : 2022-04-11 07:42:26
Estimated Rx Span Loss   : 23.5 dB
Apparent Tx Span Loss    : 17.5 dB
Tx Span Loss (with pumps off) : 33.3 dB
Tx Span Loss (with pumps off) measured at : 2022-04-11 07:42:56
Estimated Tx Span Loss   : 33.5 dB
```

The following sample shows the output of the **show olc span-loss** command on a Raman span with Raman tuning disabled. In this sample output, Raman tuning is disabled on both Ots0/0/0/0 and Ots0/0/0/2 on the near end node. The far end nodes have Raman tuning enabled.

```
RP/0/RP0/CPU0:ios#show olc span-loss
Mon Jun 20 06:51:58.601 UTC

Controller name           : Ots0/0/0/0
Neighbour RID            : 10.1.1.5
Apparent Rx Span Loss    : 16.3 dB
Rx Span Loss (with pumps off) : 16.4 dB
Rx Span Loss (with pumps off) measured at : 2022-06-20 05:53:52
Estimated Rx Span Loss   : NA
Apparent Tx Span Loss    : 5.8 dB
Tx Span Loss (with pumps off) : 21.6 dB
Tx Span Loss (with pumps off) measured at : 2022-06-20 05:54:08
Estimated Tx Span Loss   : 18.6 dB

Controller name           : Ots0/0/0/2
Neighbour RID            : 10.1.1.3
Apparent Rx Span Loss    : 27.1 dB
Rx Span Loss (with pumps off) : 30.3 dB
Rx Span Loss (with pumps off) measured at : 2022-06-20 06:51:22
Estimated Rx Span Loss   : NA
Apparent Tx Span Loss    : 6.4 dB
Tx Span Loss (with pumps off) : 19.2 dB
Tx Span Loss (with pumps off) measured at : 2022-06-20 05:54:08
Estimated Tx Span Loss   : 19.6 dB
```

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

# Raman Tuning

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This chapter describes the Raman Tuning optical application for Cisco NCS 1010.

- [Overview of Raman Tuning, on page 9](#)
- [Raman Tuning with OTDR Lock, on page 16](#)

## Overview of Raman Tuning

Raman Tuning Algorithm calculates and sets the different pump power values across five Raman pumps to obtain the target Raman Gain on a span. Raman tuning runs in both directions of the span independently at the node level. Raman tuning requires communication between peer nodes. Hence, OSC communication between the two nodes is a prerequisite for Raman Tuning.

Raman tuning algorithm uses the following parameters to calculate the pump powers necessary to achieve the target Raman gain.

- Fiber type
- Fiber length
- Loss on the fiber at each pump wavelength
- Loss on the fiber at the signal wavelength

If you configure a span length value, Raman tuning uses this value.

Raman tuning is disabled by default. Raman tuning is enabled if automatic link bring up is enabled. You can manually trigger Raman tuning if necessary. The NCS 1010 initiates the tuning process under the following circumstances:

- During the initial link bring up
- After a fiber cut
- After a power cycle event
- After a line card cold reload event
- After a DFB shut or unshut event
- After an OTS controller shut or unshut event on near end or far end node
- After modification of span length configuration

Raman tuning is traffic impacting. When Raman tuning is in progress, the amplifier on the far end of the span is turned off to block traffic. The Optical Safety Remote Interlock (OSRI) feature allows turning off the amplifier on the peer node for Raman tuning. Only the OSC is active on the link while Raman tuning is in progress.

At the LINE-TX port on the far end of the span, the dedicated Raman probe (DFB) is combined with the transmitted optical channels. The DFB laser at 191.1 THz is used to perform a link continuity check on the Raman span for optical safety. The DFB laser is used during Raman tuning.

At the LINE-RX port, five wavelengths between 1424 nm and 1495 nm are inserted in the counter propagating direction of the signal to provide amplification using the Raman effect for both C and L band optical channels.

The system triggers Raman tuning when a link goes down and comes back up. After completing Raman tuning successfully, soft reloads, RP reloads, Raman OSRI change, and Raman Force APR change do not retrigger Raman tuning.

The following table lists and describes the different Raman Tuning Status.

Raman Tuning Status	Description
WORKING – MEASUREMENT	The algorithm is measuring the span loss on the link.
WORKING – CALCULATION	The algorithm is calculating the gain target and required pump powers.
WORKING – OPTIMIZATION	The algorithm is optimizing the pump powers.
TUNED	Raman tuning is complete.
BLOCKED	The system is unable to perform Raman tuning. This status can occur because the link is down or the system detected high Raman Back Reflection.
DISABLED	Raman tuning is disabled.

Raman tuning works in the following three modes:

- Auto mode: Raman tuning defines the target gain and sets the pump powers and DFB VOA attenuation to achieve the target gain overwriting user configuration.
- Gain mode: User defines the gain target and Raman tuning sets the pump powers and DFB VOA attenuation to achieve the target gain.
- Manual mode: User disables Raman tuning and manually configures the Raman pumps and DFB VOA attenuation.

When Raman tuning is in progress, the node performing Raman tuning triggers the RAMAN-TUNE-IN-PROGRESS alarm. From Cisco IOS XR Release 7.9.1, NCS 1010 supports C+L band networks. In a C+L band configuration, the RAMAN-TUNE-IN-PROGRESS alarm is raised at the C-band OLT or ILA node performing Raman tuning as well as the far end L-band node. OSRI disables the EDFA amplifiers on both the C and L band devices in the peer node during Raman Tuning.

**Note**

- If Raman back reflection (BR) is high, Raman tuning turns the Raman pumps off and goes into blocked state. High BR can damage the optics. When you clear the high BR and BR is at acceptable levels, the system triggers Raman tuning and turns the Raman pumps on.
- If a Raman span has a span loss value less than 14 dB, Raman tuning goes into the BLOCKED state. The NCS 1010 performs a span loss check at system startup to verify if you can use Raman amplification effectively on the span.

**View Raman Tuning Status**

You can view the Raman tuning status using **show olc raman-tuning** command. The following sample is an output of the **show olc raman-tuning** command.

```
RP/0/RP0/CPU0:ios#sh olc raman-tuning
Tue Mar 21 06:11:36.944 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
```

You can view the Raman tuning status for individual controllers using **show olc raman-tuning controller ots r/s/i/p** command. The following sample is an output of the **show olc raman-tuning controller ots r/s/i/p** command.

```
RP/0/RP0/CPU0:ios#sh olc raman-tuning controller ots 0/0/0/0
Tue Mar 21 06:13:26.535 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
```

You can view detailed Raman tuning status using **show olc raman-tuning details** command. The following sample is an output of the **show olc raman-tuning details** command.

```
RP/0/RP0/CPU0:ios#show olc raman-tuning details
Tue Mar 21 06:27:13.302 UTC

Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
Last Run Fail Reason : [ Peer node is unreachable ]
Last Run Fail Timestamp : 2023-03-19 12:20:37
Last Successful Tuning Gain : 15.7 dB
Last Successful Tuning Timestamp : 2023-03-20 07:54:00
```

You can view detailed Raman tuning status for individual controllers using **show olc raman-tuning details controller ots r/s/i/p** command. The following sample is an output of the **show olc raman-tuning details controller ots r/s/i/p** command.

```
RP/0/RP0/CPU0:ios#show olc raman-tuning details controller Ots 0/0/0/0
Tue Mar 21 06:27:58.213 UTC
```

```
Controller : Ots0/0/0/0
Raman-Tuning Status : TUNED
Tuning Complete Timestamp : 2023-03-20 07:54:00
Estimated Max Possible Gain : 19.8 dB
Raman Gain Target : 16.0 dB
Gain Achieved on Tuning Complete : 15.7 dB
Last Run Fail Reason : [ Peer node is unreachable ]
Last Run Fail Timestamp : 2023-03-19 12:20:37
Last Successful Tuning Gain : 15.7 dB
Last Successful Tuning Timestamp : 2023-03-20 07:54:00
```

To view the individual Raman pump information and other parameters, use the **show controllers ots r/s/i/p raman-info** command.

```
RP/0/RP0/CPU0:ios#show controllers ots 0/0/0/0 raman-info
Fri Apr 1 06:40:33.849 UTC
```

```
Alarm Status:
-----
Detected Alarms: None
```

```
Alarm Statistics:
-----
RAMAN-AUTO-POW-RED = 0
RAMAN-1-LOW-POW = 0
RAMAN-2-LOW-POW = 0
RAMAN-3-LOW-POW = 0
RAMAN-4-LOW-POW = 0
RAMAN-5-LOW-POW = 0
RAMAN-1-HIGH-POW = 1
RAMAN-2-HIGH-POW = 0
RAMAN-3-HIGH-POW = 0
RAMAN-4-HIGH-POW = 0
RAMAN-5-HIGH-POW = 0
```

```
Parameter Statistics:
-----
Raman Safety Control mode = auto
Raman Osri = OFF
Raman Force Apr = OFF
Composite Raman Power = 886.60 mW
```

```
RAMAN Pump Info:
-----
Instance      Wavelength(nm)  Power(mW)
1             1424.00         257.60
2             1438.00         255.10
3             1457.00         71.60
4             1470.00         127.50
5             1495.00         170.10
```

```
Configured Parameters:
-----
Raman Safety Control mode = auto
Raman Osri = OFF
Raman Force Apr = OFF
```

```
RAMAN Pump Info:
```



```
-----
Instance      Power (mW)
1             45.00
2             40.00
3             40.00
4             40.00
5             35.00
```

The following sample output



**Note** In the previous output, there are two sections for Raman Pump Info that show different values. The first Raman Pump Info section displays operational data (current pumps power values). The second Raman Pump Info section displays Raman Pump Power configuration. In this case, the default pump powers are displayed. Use the **raman-tx-power** *pumpvaluevalue* command to configure individual Raman pump powers.

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.

## Configure Raman Tuning

The following configurations are available for Raman Tuning:

### Disable Raman Tuning

You can disable Raman tuning for a controller. Use the following commands to disable Raman tuning.

```
configure
optical-line-control
controller ots Rack/Slot/Instance/Port
raman-tuning disable
commit
end
```

The following is a sample configuration that disables Raman tuning.

```
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)#raman-tuning disable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

### Enable Raman Tuning

You can enable Raman tuning for a controller. Use the following commands to enable Raman tuning.

```
configure
optical-line-control
```

**controller ots** *Rack/Slot/Instance/Port*

**raman-tuning enable**

**commit**

**end**

The following is a sample configuration that enables Raman tuning.

```
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)#raman-tuning enable
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

### Configure Raman Gain Target

You can manually set the desired Raman gain target. Use the following commands to set the Raman gain target.

**configure**

**optical-line-control**

**controller ots** *Rack/Slot/Instance/Port*

**raman-tuning raman-gain-target** *value*

**commit**

**end**

You can configure Target Raman Gain of 8.0 to 25.0 dB in multiples of 0.1 dB. The following is a sample configuration that configures the Raman gain target to 18 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)#raman-tuning raman-gain-target 180
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

### Configure Raman Pump Powers

You can set the Raman pump powers manually. Use the following commands to set the pump powers.

**configure**

**controller ots** *Rack/Slot/Instance/Port*

**raman-tx-power** *pumpvaluevalue*

**commit**

**end**

The following is a sample configuration that sets the pump power of the first Raman pump to 211 mW.

```
RP/0/RP0/CPU0:ios#configure
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
RP/0/RP0/CPU0:ios(config-olc-ots)#raman-tx-power 1 value 21100
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#end
```

### Configure DFB VOA Attenuation

Raman tuning algorithm changes the DFB VOA to adjust the DFB Tx power depending on the span loss. The following table lists the DFB TX power for different span loss ranges.

Span Loss	DFB TX Power
14-25 dB	-5 dB
25-33 dB	0 dB
>33 dB	5 dB

Use the following commands to configure DFB VOA attenuation when Raman Tuning is disabled and you want to configure the DFB manually.

**configure**

**controller dfb** *Rack/Slot/Instance/Port*

**tx-voa-attenuation** *value*

**commit**

**end**

The following is a sample configuration that sets the DFB VOA attenuation to 10 dB.

```
RP/0/RP0/CPU0:ios#conf
Wed Jul 6 04:45:47.720 UTC
RP/0/RP0/CPU0:ios(config)#controller dfb 0/0/0/0
RP/0/RP0/CPU0:ios(config-Dfb)#tx-voa-attenuation 100
RP/0/RP0/CPU0:ios(config-Dfb)#commit
RP/0/RP0/CPU0:ios(config-Dfb)#end
```

### Initiate Raman Tuning

You can trigger Raman tuning manually. Use the following exec command to trigger Raman tuning.

**olc start-raman-tuning controller ots** *Rack/Slot/Instance/Port*

The following is a sample configuration that initiates Raman tuning.

```
RP/0/RP0/CPU0:ios#olc start-raman-tuning controller ots 0/0/0/0
```

# Raman Tuning with OTDR Lock

**Table 1: Feature History**

Feature Name	Release Information	Description
Raman Tuning with OTDR Lock	Cisco IOS XR Release 7.10.1	<p>If the OTDR scan and Raman tuning are performed on the same fiber simultaneously, the OTDR reports unexpected results.</p> <p>In this release, a check is being implemented to prevent both operations from running simultaneously. The Raman tuning application imposes an OTDR lock at both ends of the fiber before the process starts and releases the same after the tuning is completed.</p>

The OTDR scan and Raman tuning cannot be simultaneously executed on the same fiber. To resolve this issue, Raman tuning application locks the OTDR at both ends of the fiber before the tuning process starts and releases the lock after the tuning completes.

If the OTDR scan is in progress, the lock request is rejected and the Raman tuning application retries every minute to acquire the OTDR lock. The Raman tuning starts only when OTDR scan lock is acquired at both ends of the fiber. If the Raman tuning application is running, user request to start OTDR scan is rejected. See [Start OTDR](#), on page 71.

The following sample shows the blocked status of the Raman Tuning due to OTDR running in remote node.

```
RP/0/RP0/CPU0:ios#show olc raman-tuning
Tue Feb 28 10:32:12.648 UTC

Controller                : Ots0/0/0/0
Raman-Tuning Status      : BLOCKED
Blocked Reason Details    : [ Raman peer response OSRI ON/OTDR LOCK ON failure ]
Tuning Complete Timestamp : N/A
Estimated Max Possible Gain : N/A dB
Raman Gain Target        : N/A dB
Gain Achieved on Tuning Complete : N/A dB
```

The following sample shows the blocked status of the Raman Tuning due to OTDR running in local node.

```
P/0/RP0/CPU0:ios#sh olc raman-tuning
Tue Feb 28 10:39:18.055 UTC
Controller                : Ots0/0/0/0
Raman-Tuning Status      : BLOCKED
Blocked Reason Details    : [ Raman local OTDR LOCK ON failure ]
Tuning Complete Timestamp : N/A
Estimated Max Possible Gain : N/A dB
Raman Gain Target        : N/A dB
Gain Achieved on Tuning Complete : N/A dB
```



## CHAPTER 5

# Gain Estimator

---

This chapter describes the Gain Estimator optical application for Cisco NCS 1010.

- [Overview of Gain Estimator, on page 17](#)

## 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 variants of NCS 1010. 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
- Raman gain (only on Raman spans)

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

NCS 1010 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
```

### 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:ios#show olc gain-estimator controller Ots 0/0/0/0
Fri Jun 10 05:47:21.119 UTC
Controller                        : Ots0/0/0/0
Ingress Gain Estimator Status      : IDLE
Ingress Estimated Gain             : 21.7 dB
Ingress Estimated Gain Mode        : Normal
Ingress Gain Estimation Timestamp  : 2022-06-10 05:46:48
```







## CHAPTER 6

# Link Tuner

---

This chapter describes the Link Tuner optical application for Cisco NCS 1010.

- [Overview of Link Tuner, on page 21](#)

## 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
- Raman gain (only on Raman spans)

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. However, it applies the new target PSDs only if it detects a change of 0.1 dB or more in the total noise value.

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.



---

### Restriction

From Cisco IOS XR Release 7.9.1, NCS 1010 supports C+L band networks. In Cisco IOS XR Release 7.9.1, Link tuner support is not available for C+L band networks. In Cisco IOS XR Release 7.9.1, Link tuner is available only for C band only networks. If you are deploying a C+L band configuration for your network, you can obtain the PSD profiles (Single Band and Dual band) from Cisco Optical Network Planner.

---

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 ta
Disabled	Link tuner is disabled.

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:ios#show olc link-tuner
Controller      : Ots0/0/0/0
Link Tuner Status : OPERATIONAL
Last PSD computation: 2022-05-06 10:59:51
-----
Setpoint          : Computed PSD
                   (dBm/12.5 GHz)
-----s-----
01                -5.7
02                -5.6
03                -5.6
04                -5.5
05                -5.5
06                -5.4
07                -5.4
08                -5.3
09                -5.3
10                -5.2
11                -5.2
12                -5.1
13                -5.1
14                -5.0
15                -5.0
16                -4.9
17                -4.9
18                -4.8
19                -4.8
20                -4.7
21                -4.7
22                -4.6
23                -4.6
24                -4.5
25                -4.4
26                -4.4
27                -4.3
28                -4.3
29                -4.2
30                -4.2
31                -4.1
32                -4.1
33                -4.0
```

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:ios#show olc link-tuner detail
Controller      : Ots0/0/0/0
Link Tuner Status : OPERATIONAL
Last PSD computation: 2022-05-06 10:59:51
```

Computed Total Noise: -35.4 dB

```
-----
Setpoint          : Computed PSD
                   (dBm/12.5 GHz)
-----
```

01	-5.7
02	-5.6
03	-5.6
04	-5.5
05	-5.5
06	-5.4
07	-5.4
08	-5.3
09	-5.3
10	-5.2
11	-5.2
12	-5.1
13	-5.1
14	-5.0
15	-5.0
16	-4.9
17	-4.9
18	-4.8
19	-4.8
20	-4.7
21	-4.7
22	-4.6
23	-4.6
24	-4.5
25	-4.4
26	-4.4
27	-4.3
28	-4.3
29	-4.2
30	-4.2
31	-4.1
32	-4.1
33	-4.0

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 (THz)	Target PSD (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

```

### 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. The default connector loss is:

- 0.25 dB for ports without Raman module
- 0.3 dB for ports with Raman module

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 7

# Automatic Power Control

This chapter describes the Automatic Power Control optical application for Cisco NCS 1010.

**Table 2: Feature History**

Feature Name	Release Information	Feature Description
APC enhancements	Cisco IOS XR Release 7.9.1	APC (Automatic Power Control) on NCS 1010 now supports C+L band networks in addition to C band only networks. Also, APC is enhanced to perform power correction even when it doesn't have end-to-end network visibility. This ensures that the operational section of the network always has power at the target PSD profile, and when the network comes up, the traffic restoration is faster.

- [Overview of Automatic Power Control, on page 27](#)

## 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.

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
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.

From Cisco IOS XR Release 7.9.1, NCS 1010 supports C+L band networks. Before Cisco IOS XR Release 7.9.1, APC did not start regulating the power levels in a link until the full topology was discovered by OSPF. From Cisco IOS XR Release 7.9.1, 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. When APC detects a partial topology, the NCS 1010 raises the PARTIAL-TOPOLOGY alarm, and after the regulation is complete APC moves to BLOCKED state.





- 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**.

```
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
```

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: <ul style="list-style-type: none"> <li>• there is an event in the network which resulted in topology failure</li> <li>• an amplifier safety event like APR or OSRI has been triggered in the network</li> <li>• APC is locally disabled on agent node</li> </ul>
PAUSED	APC is paused using the <b>apc-pause</b> 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.
-------------------------------	--

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: <ul style="list-style-type: none"> <li>• Amplifier gain is exhausted in the current gain range.</li> <li>• WSS range (0-25dB) is exhausted for a single or multiple channels.</li> <li>• DGE range (0-3dB) is exhausted for a single or multiple channels.</li> <li>• Spanloss increased and amplifier gain is insufficient to achieve target PSD</li> </ul>
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	<p>APC is unable to perform for the following reasons:</p> <ul style="list-style-type: none"> <li>• OSRI has shut down the amplifier: AMPLI-SHUT</li> <li>• APC is disabled locally on the node: USER-DISABLED</li> <li>• Gain Estimation is in progress: GAIN-ESTIMATION-IN-PROGRESS</li> <li>• Amplifier auto power reduction is enabled: AMPLI-APR-ENABLED</li> <li>• Amplifier is shut because of loss of input power: AMPLI-SHUT</li> <li>• An event in the network resulted in topology failure.</li> <li>• APC is BLOCKED as Band Failure Recovery sets Safe mode because of a band failure event in C+L network: BAND-FAILURE</li> </ul>
---------	--

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
```

The following sample is an output of **show olc apc** command when band failure has occurred and the APC manager has visibility only to a partial topology.

```
RP/0/RP0/CPU0:ios#show olc apc
Wed Jan 18 12:21:28.195 UTC
```

```
Controller : Ots0/0/0/0
APC Status : BLOCKED
Blocked Reason : [ PARTIAL-TOPOLOGY  NODE-BLOCKED ]
```

```

Node RID       : 10.1.1.1
Internal State : IDLE

Node RID       : 10.1.1.2
Internal State : BLOCKED
Blocked Reason : [ BAND-FAILURE ]

```

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.

```

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

```

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 on a C band node..

```

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

```

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

```

RP/0/RP0/CPU0:ios#sh olc apc-local target-psd-profile
Wed Jan 18 12:12:02.236 UTC
Controller      : Ots0/0/0/0
Target PSD source : Configuration
-----
Setpoint          Frequency          Target PSD
                  (THz)                (dBm/12.5 GHz)
-----
01                186.050000          -6.4
02                186.201000          -6.3
03                186.352000          -6.2
04                186.503000          -6.2
05                186.654000          -6.1
06                186.805000          -6.1
07                186.956000          -6.0
08                187.107000          -6.0
09                187.258000          -5.9
10                187.409000          -5.9
11                187.560000          -5.9
12                187.711000          -5.8
13                187.862000          -5.7
14                188.013000          -5.7
15                188.164000          -5.6
16                188.315000          -5.5
17                188.466000          -5.5
18                188.617000          -5.4
19                188.768000          -5.4
20                188.919000          -5.3
21                189.070000          -5.2
22                189.221000          -5.2
23                189.372000          -5.1
24                189.523000          -5.1
25                189.674000          -5.0
26                189.825000          -5.0
27                189.976000          -4.9
28                190.127000          -4.9
29                190.278000          -4.8
30                190.429000          -4.7
31                190.580000          -4.7
32                190.731000          -4.6
33                190.882000          -4.6

```

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

## Overview of Automatic Power Control

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.

## 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
```

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

```
configure
optical-line-control
controller ots Rack/Slot/Instance/Port
dual-band-psd <1-33> value
commit
end
```

### Example

The following is a sample configuration that sets the dual-band psd values to -50 and -49 on setpoints 1 and 2 respectively, on the 0/0/0/0 controller .

```
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)#dual-band-psd 1 -50
RP/0/RP0/CPU0:ios(config-olc-ots)#dual-band-psd 2 -49
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 1010 sets all setpoints to values in the configuration. If there is no configuration, NCS 1010 sets all setpoints to default values. Disabling APC is traffic impacting.
- For BFR to work, APC must be enabled on both C and L-band devices. We recommended to pause BFR before running the **apc-pause** or **apc disable** commands.

### Enable 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 APC

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 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 1010 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
```

### Path Loss

On a C+L band configuration, to launch correct power into the transmission fiber, optical applications need data about loss between the LINE-TX port of the L-band device to the LINE-TX port of the C-band device. This data, also known as path loss, is calculated from the following components:

- Patch cord loss between the LINE-TX port of the L-band device to the L-Band-RX port of the C-band device.
- Insertion loss between the L-Band-RX port of the C-band device and the LINE-TX port of the C-band device.
- Insertion loss due to the Raman modules inside the C-band device.

Use the **show olc partner-band-loss** command to view the Patchcord Loss and Path Loss values. The following output is a sample of the **show olc partner-band-loss** command executed on a C-band device.

```
RP/0/RP0/CPU0:P2B_DT_01#show olc partner-band-loss
Wed Feb 1 12:51:59.605 UTC

Controller                               : Ots0/0/0/0
Partner IP address                       : 10.1.1.2
Partner Controller                       : Ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX       : 2.3 dB
L-LINE-TX Patchcord Loss               : 1.0 dB
Loss Measurement Timestamp                : 2023-02-01 12:51:54
```

The following output is a sample of the **show olc partner-band-loss** command executed on an L-band device.

```
RP/0/RP0/CPU0:P1BL_DT_10#show olc partner-band-loss
Wed Feb 1 12:51:59.605 UTC

Controller                               : Ots0/0/0/0
Partner IP address                       : 10.1.1.3
Partner Controller                       : ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX       : 2.3 dB
L-LINE-TX Patchcord Loss               : 1.0 dB
Loss Measurement Timestamp                : 2023-02-01 12:51:54
```

You can view the Patchcord Loss and Path Loss values for individual controllers using the **show olc partner-band-loss controller ots r/s/i/p** command. The following output is a sample of the **show olc partner-band-loss controller ots r/s/i/p** command executed on a C-band device.

```
RP/0/RP0/CPU0:P2B_DT_01#show olc partner-band-loss controller Ots 0/0/0/0
Wed Feb 1 12:51:59.605 UTC

Controller                               : Ots0/0/0/0
Partner IP address                       : 10.1.1.2
Partner Controller                       : Ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX       : 1.9 dB
L-LINE-TX Patchcord Loss               : 1.2 dB
Loss Measurement Timestamp                : 2023-02-01 12:51:54
```

The following output is a sample of the **show olc partner-band-loss controller ots r/s/i/p** command executed on an L-band device.

```
RP/0/RP0/CPU0:P1BL_DT_10#show olc partner-band-loss controller Ots 0/0/0/0
Wed Feb 1 12:51:59.605 UTC
```

```
Controller                : Ots0/0/0/0
Partner IP address        : 10.1.1.3
Partner Controller        : Ots0/0/0/0
L-LINE-TX Path Loss at C-LINE-TX    : 1.9 dB
L-LINE-TX Patchcord Loss           : 1.2 dB
Loss Measurement Timestamp : 2023-02-01 12:51:54
```







## CHAPTER 8

# Band Failure Recovery

This chapter describes the Band Failure Recovery optical application for Cisco NCS 1010.

**Table 3: Feature History**

Feature Name	Release Information	Description
Band Failure Recovery (BFR) Pause	Cisco IOS XR Release 7.10.1	Use the new <b>bfr-pause</b> configuration command from this release to pause the BFR function. Unlike in the previous releases, the BFR pause state is now preserved during a system reload. BFR pause stays paused indefinitely until you resume it.  Command added: <a href="#">bfr-pause</a>
<b>olc bfr-pause</b> (Command deprecated)	Cisco IOS XR Release 7.10.1	The command <b>olc bfr-pause</b> is deprecated starting R7.10.1. To pause and resume BFR, use the <a href="#">bfr-pause</a> command.  To upgrade from R7.9.1 to R7.10.1 or later with BFR pause enabled, before upgrading software, pause BFR on the OLT-C band using the <b>olc bfr pause</b> command before beginning the software upgrade. Once the upgrade is finished, pause and resume BFR using the <b>bfr-pause</b> configuration command on the OLT-C and OLT-L bands.

Feature Name	Release Information	Description
Band Failure Recovery (BFR)	Cisco IOS XR Release 7.9.1	<p>During the C+L band network bring up, as both the bands travel through the same fiber, optical power is transferred from higher frequency to lower frequency due to SRS (Stimulated Raman Scattering). This degrades the C-band channel power and causes the existing C-band power profile to change.</p> <p>BFR compensates for this dynamic power change by adjusting the power profile that minimizes the impact when upgrading from C-band to the C+L band network. BFR also adjusts power during a band failure to minimize the impact on the surviving band.</p>

- [Overview of Band Failure Recovery \(BFR\)](#), on page 46

## Overview of Band Failure Recovery (BFR)

NCS1010 can be configured to operate in both C and L-band wavelengths to increase the capacity of optical fibers. This can be done by connecting the C-band OLT or ILA line cards to the L-band OLT or ILA line cards respectively. When C and L-band signals travel through the same fiber, there is a change in the optical power from higher frequencies to lower frequencies due to SRS. This causes a change in the existing C-band power profile. In this case, BFR compensates for the power transfer by applying dual-band PSD profile on both C and L-band devices.

The source OLT node acts as the BFR manager for all the nodes in the TX direction. All the other nodes in the path act as BFR agent nodes. The manager node collects information from the agent nodes and coordinates failure and recovery actions of the network.

On a C+L band network, if any band fails, the surviving band experiences either an increase or decrease in the optical power due to the absence of SRS. In this case, the BFR manager sends commands to the agent nodes to switch the PSD profile on the surviving band to single-band PSD profile. After the failure is resolved, the BFR manager sends a command to the agent nodes to initiate recovery on failed band nodes, one node at a time thereby ensuring no traffic impact on the surviving band. BFR also handles

### Enable BFR

BFR is not enabled by default and is enabled automatically if the following configurations are present on both C and L-band cards:

- Partner band IP address configuration
- Dual-band PSD configuration

To configure partner band IP and dual-band PSD profile, use the following commands:

**partner-band-port ipv4 address** *ip-address* **controller** *Ots0/0/0/x*

**dual-band-psd** *index value*

For more information about these configurations, see [partner-band-port](#) and [Configure APC](#).



**Note** Ensure that Link Tuner and Gain Estimator are disabled before BFR is automatically enabled.

### View BFR Status on All Nodes

To view the status of BFR on all the nodes, use the following command:

**show olc band-status**

#### Example 1

The following example shows the status of BFR on all the nodes of a controller. When both the bands are active, the status of BFR is displayed as *Running* and BFR ensures that dual-band PSD is used on both bands.

```
RP/0/RP0/CPU0#show olc band-status
Tue Dec 13 10:45:30.594 UTC

Controller           : Ots0/0/0/0
Self-Band            : C-Band
BFR status           : Running

Node RID             : 10.1.1.1
Self IP Address      : 192.1.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.1.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.2
Self IP Address      : 192.2.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.2.2.2
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.3
Self IP Address      : 192.3.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.3.2.2
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.4
```

```

Self IP Address      : 192.4.2.1
Self Controller     : Ots0/0/0/0
Partner IP address  : 192.4.2.2
Partner Controller  : Ots0/0/0/0
Partner link status : UP
C-Band status       : ACTIVE
C-Band PSD          : Dual Band
L-Band status       : ACTIVE
L-Band PSD          : Dual Band

Node RID            : 10.1.1.5
Self IP Address     : 192.5.2.1
Self Controller     : Ots0/0/0/0
Partner IP address  : 192.5.2.2
Partner Controller  : Ots0/0/0/0
Partner link status : UP
C-Band status       : ACTIVE
C-Band PSD          : Dual Band
L-Band status       : ACTIVE
L-Band PSD          : Dual Band

```

For more information about these commands, see [show olc band-status](#) in the Command Reference for Cisco NCS 1010 guide.




---

**Note** If the OLC process is restarted on OLT-CR while Raman tuning is in progress, the *Partner link status* might show as DOWN in the output of the **show olc band-status** command. The *Partner link status* will change to UP after Raman tuning is completed.

---

### Band Failure

Band failure can happen due to any of the following events:

- Optical connectivity failure between C and L-band devices.
- The amplifier or controller on the L or C band device is failed.
- The amplifier on the L or C band is shut down due to Optical Safety Remote Interlock (OSRI)
- The node shutdown due to power failure.
- L or C band line cards are in a cold reload state.
- L or C band card failure.
- Multiple fiber cuts and HA events.
- High back reflection



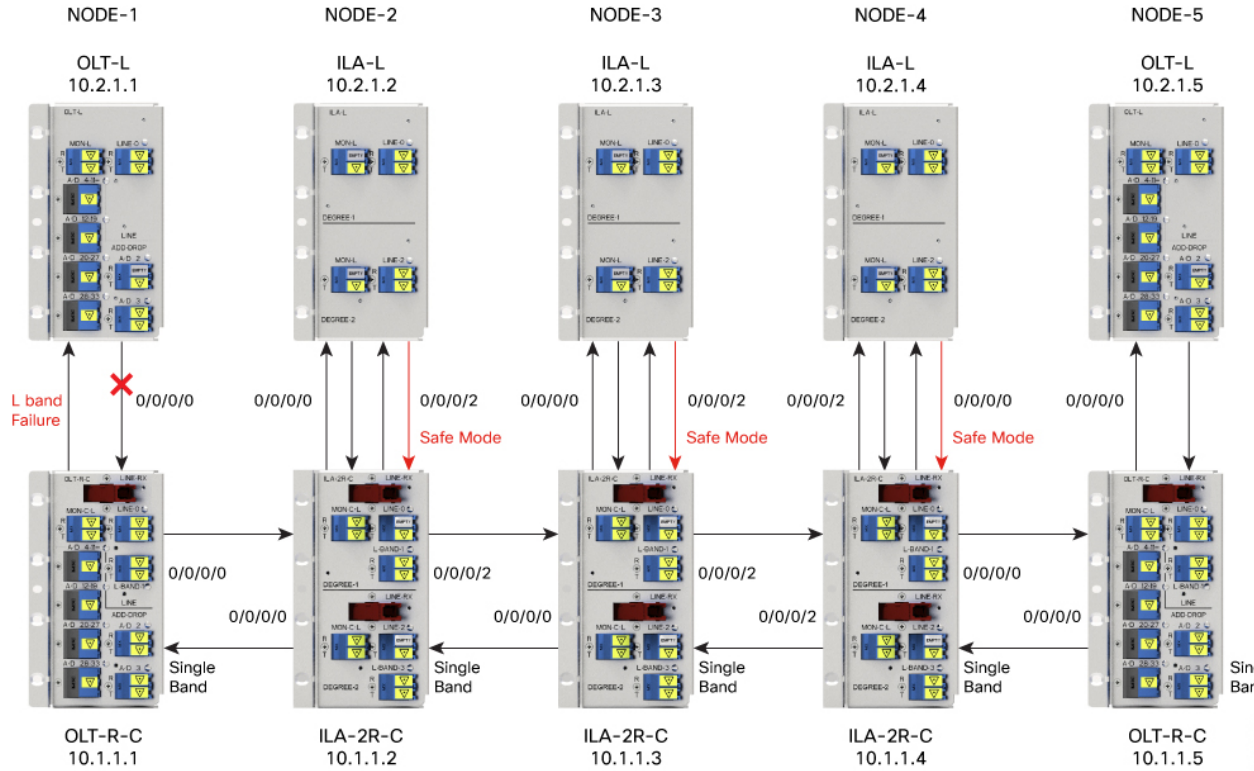

---

**Note** Span fiber failure is not considered as band failure as both bands are impacted due to the failure.

---

The following figure illustrates the BFR failure procedure in case of L-band failure. As soon as the band failure is detected, BFR sets safe mode on the failed band devices and switches the PSD profile of the surviving band devices to single-band PSD. The status of the C-band devices is ACTIVE and the PSD profile for the devices is displayed as *Single Band*.

Figure 2: Example of L-band Failure



**Example**

The following example shows the status of BFR when L-band is in the FAILED state. In this case, all the C band nodes are switched to single-band PSD profiles and L band devices are set to safe mode.

```
RP/0/RP0/CPU0#show olc band-status
```

```
Controller           : Ots0/0/0/0
Self-Band            : C-Band
BFR status           : Running
```

```
Node RID             : 10.2.1.1
Self IP Address      : 192.1.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.1.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Single Band
L-Band status        : FAILED
L-Band PSD           : NA
```

```
Node RID             : 10.2.1.2
Self IP Address      : 192.2.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.2.2.2
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
```

```

C-Band status      : ACTIVE
C-Band PSD         : Single Band
L-Band status      : FAILED
L-Band PSD         : NA

Node RID           : 10.2.1.3
Self IP Address    : 192.3.2.1
Self Controller    : Ots0/0/0/0
Partner IP address : 192.3.2.2
Partner Controller : Ots0/0/0/2
Partner link status : UP
C-Band status      : ACTIVE
C-Band PSD         : Single Band
L-Band status      : FAILED
L-Band PSD         : NA

Node RID           : 10.2.1.4
Self IP Address    : 192.4.2.1
Self Controller    : Ots0/0/0/0
Partner IP address : 192.4.2.2
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status      : ACTIVE
C-Band PSD         : Single Band
L-Band status      : FAILED
L-Band PSD         : NA

Node RID           : 10.2.1.5
Self IP Address    : 192.5.2.1
Self Controller    : Ots0/0/0/0
Partner IP address : 192.5.2.2
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status      : ACTIVE
L-Band status      : FAILED
L-Band PSD         : NA

```

### Band Failure Recovery

Once the optical fiber fault is cleared, BFR starts the recovery procedure on all the failed band nodes, one node at a time and also ensures that there is no impact on the traffic. Also, the PSD profiles on the recovered and surviving band are shifted to dual-band PSD profiles.

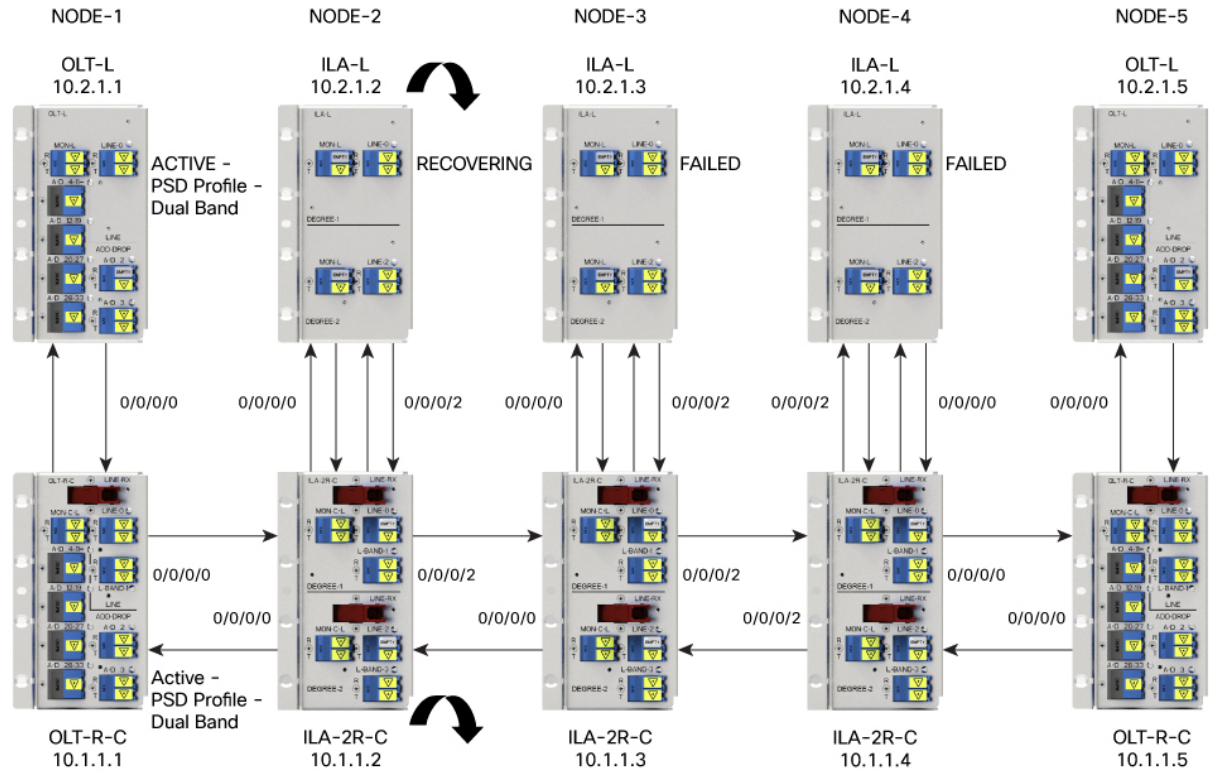


#### Note

- Recovery procedure is initiated only if all nodes (both C and L bands) are active and reachable.
- The recovery procedure on the failed band and the PSD profile shifting are carried out in parallel by BFR and APC respectively. For BFR to work, APC must be enabled on both C and L-band devices. We recommend to pause BFR before running the **apc-pause** or **apc disable** commands.

The following figure illustrates the BFR recovery procedure in case of L-band failure. After the fiber fault is cleared, BFR starts recovery on all C and L-band nodes one node at a time. The recovery procedure on Node 1 is completed and the status is displayed as ACTIVE. The recovery procedure on Node 2 is in progress hence the node status is displayed as RECOVERING. After completing the recovery on Node 2, BFR will start recovery on the remaining nodes one node at a time.

Figure 3: Example of BFR Recovering Nodes



**Example**

The following example shows status of the C and L-band as RECOVERING on the 1.1.1.2 node:

```
RP/0/RP0/CPU0:#show olc band-status

Controller           : Ots0/0/0/0
Self-Band            : C-Band
BFR status           : Running

Node RID             : 10.1.1.1
Self IP Address      : 192.1.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.1.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band

Node RID             : 10.1.1.2
Self IP Address      : 192.2.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.2.2.2
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
C-Band status      : RECOVERING
C-Band PSD           : NA
L-Band status      : RECOVERING
```

```

L-Band PSD           : NA

Node RID             : 10.1.1.3
Self IP Address      : 192.3.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.3.2.2
Partner Controller   : Ots0/0/0/2
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Single Band
L-Band status        : FAILED
L-Band PSD           : NA

Node RID             : 10.1.1.4
Self IP Address      : 192.4.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.4.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Single Band
L-Band status        : FAILED
L-Band PSD           : NA

Node RID             : 10.1.1.5
Self IP Address      : 192.5.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.5.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
L-Band status        : FAILED

```

### Single Band Failure Recovery on Non-Raman Network

In case of single band failure on a non-Raman network, after the optical fiber fault is cleared, BFR performs the following operations:

- Starts recovery on the failed band one node at a time.
- After the recovery is completed and both the bands are active, BFR switches the PSD profiles on both bands to dual-band PSD.

### Span Failure Recovery

On a C+L band network, when both bands fail, BFR does not change the PSD profile to single-band PSD. After the failure is cleared, both the bands are recovered quickly.

When a span failure is cleared on a Raman network, in case Raman tuning is disabled, BFR starts the recovery of nodes. When Raman tuning is enabled, BFR suspends recovery and resumes it only after Raman tuning is completed.

### Single Band Failure Recovery on a Raman Network

On a C+L band network without Raman amplifiers, when a band fails, Loss of Signal (LOS) is reported because the total power drops below the safe value. This shuts down the amplifiers on other nodes. On a Raman network, if a band fails on the near end node, the amplifiers on the far end nodes receive some band power because of ASE. In this case, LOS is not reported and the amplifiers on far end nodes remain active.



BFR ensures that recovery on the far end nodes is started even if the amplifiers on the nodes are active because of ASE and sets safe mode on the failed band.

Once the optical fiber fault is cleared on a Raman network, if Raman tuning is started, BFR suspends recovery and resumes it only after Raman tuning is completed. If Raman tuning is not started, BFR starts the recovery of nodes one by one.

### Band Failure Recovery Due to Device in Headless Mode

In case of a band failure on a network that has an OLT device in headless mode:

- BFR will not switch the PSD profile to single-band PSD.
- BFR will not run the recovery procedure.

In case of a band failure on a network that has an ILA device in headless mode:

- BFR switches the PSD profile to single-band PSD on all the nodes that are reachable by C band OLT.
- BFR does not run the recovery procedure on all the OLT and ILA nodes.
- If one or more nodes on the network are in headless mode, BFR is not initiated which might affect traffic recovery. In this case, perform the following tasks to restore the traffic:
  1. [Pause BFR](#)
  2. [Initialize BFR](#)
  3. [Resume BFR](#)

For more information about these commands, see the [Command Reference for Cisco NCS 1010](#) guide.

### Band Failure Recovery Due to Partner Link Status is Down

On a C+L band network, if there is a connectivity failure between the C-band and L-band ILA nodes, BFR does not start the recovery procedure. If the recovery procedure is running and the *Partner link status* is DOWN, BFR suspends recovery and resumes it only after the *Partner link status* is UP.

### Example

The following example shows the output of the **show olc band-status** command where the *Partner link status* status is UP.

```
RP/0/RP0/CPU0:#show olc band-status

Controller           : Ots0/0/0/0
Self-Band            : C-Band
BFR status           : Running

Node RID             : 10.1.1.1
Self IP Address      : 192.1.2.1
Self Controller      : Ots0/0/0/0
Partner IP address   : 192.1.2.2
Partner Controller   : Ots0/0/0/0
Partner link status  : UP
C-Band status        : ACTIVE
C-Band PSD           : Dual Band
L-Band status        : ACTIVE
L-Band PSD           : Dual Band
```

### Pause and Resume BFR

While recovering from a span failure, if one of the bands is in failed state, BFR is not initiated and the other band is not recovered. In such cases, you can pause, initialize, and resume BFR to initiate it and to bring up the other band.

#### Pause BFR

Use the following commands to pause BFR:

```
configure  
optical-line-control  
controller ots Rack/Slot/Instance/Port  
bfr-pause  
commit  
end
```

#### Example

The following is a sample configuration to pause BFR:

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

#### Resume BFR

Use the following commands to resume BFR:

```
configure  
optical-line-control  
controller ots Rack/Slot/Instance/Port  
no bfr-pause  
commit  
end
```

#### Example

The following is a sample configuration to resume BFR:

```
RP/0/RP0/CPU0:#configure  
RP/0/RP0/CPU0: (config)#optical-line-control  
RP/0/RP0/CPU0: (config-olc)#controller ots 0/0/0/0  
RP/0/RP0/CPU0: (config-olc-ots)#no bfr-pause  
RP/0/RP0/CPU0: (config-olc-ots)#commit
```

For more information about these commands, see [bfr-pause](#) in the Command Reference for Cisco NCS 1010 guide.



---

**Note** To upgrade from R7.9.1 to R7.10.1 or later with BFR pause enabled, before upgrading software, pause BFR on the OLT-C band using the `olc bfr pause` command before beginning the software upgrade. Once the upgrade is finished, pause and resume BFR using the `bfr-pause` configuration command on the OLT-C and OLT-L bands.

---





## CHAPTER 9

# Upgrade C-Band to C+L Band Without Affecting Traffic Flow

This chapter describes how to upgrade a C-band only network to C+L band network for Cisco NCS 1010 without affecting the traffic in the existing network.

- [Upgrade C-Band to C+L Band Without Affecting Traffic Flow, on page 57](#)

## Upgrade C-Band to C+L Band Without Affecting Traffic Flow

Table 4: Feature History

Feature Name	Release Information	Description
Nontraffic Affecting C+L Band Upgrade	Cisco IOS XR Release 7.10.1	Upgrading an existing C-band network to a C+L band network is now possible without impacting the traffic flow. Cisco Optical Network Planner (CONP) computes the values for relevant parameters in C+L network configuration. The upgrade benefits even those networks that were not planned for a future L-band upgrade. C+L band upgrade enables you to accommodate more bands to your network to boost network bandwidth.

Perform the following procedure to bring up the L-band node while upgrading a C-band only network to a C+L network.



**Note** Use the Cisco Optical Network Planner (CONP) to compute the following values for C-band and L-band devices in C+L network configuration:

1. Single band and Dual band target PSD values
2. Gain-range for amplifiers

**Step 1** Configure proper gain and gain-range on all L-band nodes.

**Note** Gain-Estimator (GE) must be in `DISABLED` state.

The following is a sample configuration that disables Gain Estimator.

```
RP/0/RP0/CPU0:ios#configure terminal
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
```

**Step 2** Configure Single band PSD on all L-band nodes.

**Note** Link Tuner (LT) must be in `DISABLED` state.

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
```

**Step 3** Configure Dual band configuration (dual band PSD set points that are obtained from CONP and partner-band configuration) values on all L-band nodes. For more information on L-Band dual band PSD configuration, see [Modify L-Band Amplifier Properties](#).

**Step 4** Configure proper gain and gain-range computed by gain-estimator application manually on all C-band nodes and then disable gain-estimator.

**Note** Disabling Gain estimator causes traffic impact if there is mismatch between the user-configured gain range and the gain-estimator configured gain-range.

**Step 5** Configure single band PSD set points that are obtained from Link Tuner manually on all C-band nodes and disable Link Tuner.

**Note** Link tuner is in *Enabled* state in the C-band network. Configure the same PSD values that are obtained from Link Tuner and then disable Link Tuner. Any mismatch between the user-configured PSD and Link-Tuner configured PSD values leads to traffic impact.

**Step 6** Configure dual band configuration (dual band PSD configuration set points that are obtained from CONP and partner-band configuration) values on all C-band nodes. For more information on C-Band dual band PSD configuration, see [Modify C-Band Amplifier Properties](#)

**Note** Ensure that dual band configurations are present (dual band PSD and partner-band) on all C- and L-band nodes during L-band device addition. If any one of these two configurations is not present, then BFR does not work properly, and the bands start in an uncontrolled manner which may impact traffic.

**Step 7** Bring up the Interlink connectivity between C-band and L-band devices by enabling the management interfaces for partner-band communication between C-band and L-band nodes.

**Step 8** Bring up the fiber connectivity between C-band and L-band devices and enable Gigabit Ethernet interfaces.

**Note** Fiber connectivity is the connection between the L-band port on the C-band nodes and the Line port on the L-band nodes.

**Step 9** Verify that the connectivity is fine and there are no alarms present on OSC and OTS controller.

**Step 10** After the connectivity is completed till the last terminal node, verify that the topology is *UP*, and APC cleared the *PARTIAL TOPOLOGY* alarm on all OLT C-band and L-band nodes.

The following sample is an output of `show olc apc` command.

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

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

**Step 11**

On the L-band bfr manager, band status remains *NA* until end-to-end connectivity is up. After end-to-end terminal (OLT-OLT) is discovered, band status populates all the agent nodes. BFR initiates the BRING UP (RECOVERY) procedure and recovers one node at a time.

The following example shows the output of the **show olc band-status** command where the L-Band recovery is not initiated and *BFR status* is *NA*.

```
RP/0/RP0/CPU0:#show olc band-status
```

```
Thu Dec 15 13:54:25.703 UTC
```

```
Controller      : Ots0/0/0/0
Self-Band      : None
BFR status     : NA
```

The following example shows the output of the **show olc band-status** command where the L-Band recovery is in progress and *BFR status* is *Running*.

```
RP/0/RP0/CPU0:#show olc band-status
```

```
Thu Dec 15 13:54:25.703 UTC
```

```
Controller      : Ots0/0/0/0
Self-Band      : None
BFR status     : Running
```

```
Node RID       : 10.1.1.1
Self IP address : 10.9.1.2
Self Controller : Ots0/0/0/0
Partner IP address : 10.9.1.1
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status  : ACTIVE
C-Band PSD     : Dual Band
L-Band status  : ACTIVE
L-Band PSD     : Dual Band
```

```
Node RID       : 10.2.1.2
Self IP address : 10.9.2.2
Self Controller : Ots0/0/0/0
Partner IP address : 10.9.2.1
Partner Controller : Ots0/0/0/2
Partner link status : UP
C-Band status  : RECOVERING
C-Band PSD     : NA
L-Band status  : RECOVERING
L-Band PSD     : NA
```

```
Node RID       : 10.2.1.3
Self IP address : 10.9.3.2
Self Controller : Ots0/0/0/0
Partner IP address : 10.9.3.1
Partner Controller : Ots0/0/0/2
Partner link status : UP
C-Band status  : RECOVERING
C-Band PSD     : NA
L-Band status  : RECOVERING
L-Band PSD     : NA
```

```

Node RID           : 10.2.1.4
Self IP address    : 10.9.4.2
Self Controller    : Ots0/0/0/0
Partner IP address : 10.9.4.1
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status    : RECOVERING
C-Band PSD      : NA
L-Band status    : RECOVERING
L-Band PSD      : NA

```

```

Node RID           : 10.2.1.5
Self IP address    : 10.9.5.2
Self Controller    : Ots0/0/0/0
Partner IP address : 10.9.5.1
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status    : RECOVERING
L-Band status    : RECOVERING

```

**Step 12** Wait for the recovery to complete on all nodes. When recovery completes, check the PSD status of the C-band and partner L-band nodes, and verify that the PSD profile is *DUAL BAND PSD*.

**Step 13** Verify that BFR converged on all nodes and the state on the agent nodes are *ACTIVE* with *DUAL BAND PSD*.

The following example shows the output of the **show olc band-status** command where the L-Band bring up is complete, PSD profile is *DUAL BAND PSD*, and band status of all agent nodes is *Active*.

```

RP/0/RP0/CPU0:#show olc band-status

Thu Dec 15 13:54:25.703 UTC

Controller         : Ots0/0/0/0
Self-Band          : None
BFR status       : Running

Node RID           : 10.2.1.1
Self IP address    : 10.9.1.2
Self Controller    : Ots0/0/0/0
Partner IP address : 10.9.1.1
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status    : ACTIVE
C-Band PSD      : Dual Band
L-Band status    : ACTIVE
L-Band PSD      : Dual Band

Node RID           : 10.2.1.2
Self IP address    : 10.9.2.2
Self Controller    : Ots0/0/0/0
Partner IP address : 10.9.2.1
Partner Controller : Ots0/0/0/2
Partner link status : UP
C-Band status    : ACTIVE
C-Band PSD      : Dual Band
L-Band status    : ACTIVE
L-Band PSD      : Dual Band

Node RID           : 10.2.1.3
Self IP address    : 10.9.3.2
Self Controller    : Ots0/0/0/0
Partner IP address : 10.9.1.1
Partner Controller : Ots0/0/0/2
Partner link status : UP

```



```
C-Band status      : ACTIVE
C-Band PSD        : Dual Band
L-Band status     : ACTIVE
L-Band PSD        : Dual Band

Node RID          : 10.2.1.4
Self IP address   : 10.9.4.2
Self Controller   : Ots0/0/0/0
Partner IP address : 10.9.4.1
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status     : ACTIVE
C-Band PSD        : Dual Band
L-Band status     : ACTIVE
L-Band PSD        : Dual Band

Node RID          : 10.2.1.5
Self IP address   : 10.9.5.2
Self Controller   : Ots0/0/0/0
Partner IP address : 10.9.5.1
Partner Controller : Ots0/0/0/0
Partner link status : UP
C-Band status     : ACTIVE
L-Band status     : ACTIVE
```

**Step 14** Check the traffic status on C-band nodes and verify that traffic was not impacted during L-band addition.

---





## CHAPTER 10

# Automatic Network Turn Up

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This chapter describes the Automatic Network Turn Up workflow for Cisco NCS 1010.

- [Overview of Automatic Link Bring Up, on page 63](#)

## Overview of Automatic Link Bring Up

You can bring up an NCS 1010 DWDM link without using any external tools. NCS 1010 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 1010 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 1010 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 NCS1010 device you want to configure. The NCS 1010 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. See [Remote Node Management in NCS 1010](#) for more information. 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 1010 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 1010 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.




---

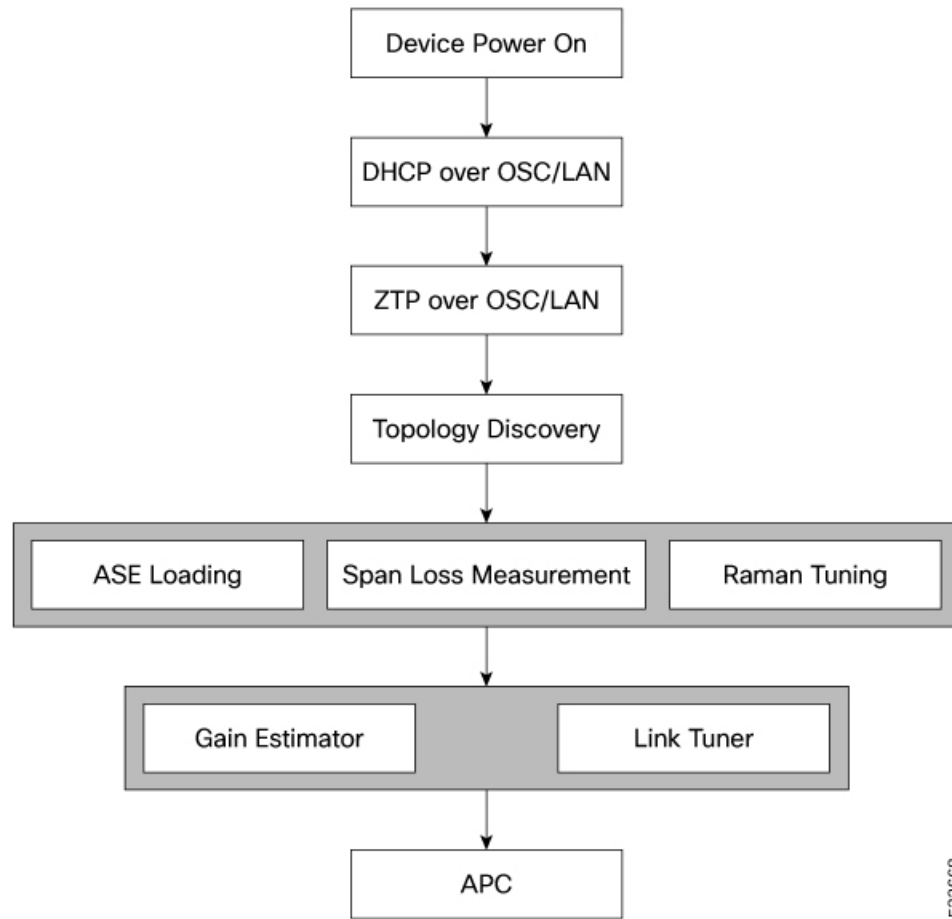
**Note** **Startup Gain Estimation** analyses the span loss and sets the gain mode of the EDFA amplifier and provides the initial target gain for the amplifier. EDFA amplifiers are present in both OLT and ILA variants of NCS 1010. These EDFA amplifiers are variable-gain optical amplifiers capable of 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 1010 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 automatic link bring up.

Figure 4: 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$7motIAh93vG/I...$iM64ZfsZ5ciiocdsdsewHdEIVLTq0YEc1G1NMpauwJUiEnkV8LwMJUDZnnTkVj9RPgf4wffWJYe1PN7jqIN3q/

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 11

## Configure OTDR

This chapter describes how to configure the Optical Time Domain Reflectometer (OTDR) module in NCS 1010.

- [Overview of OTDR](#) , on page 67
- [Configure OTDR](#) , on page 68
- [Start OTDR](#) , on page 71
- [Stop OTDR](#) , on page 72
- [Display OTDR Scan Measurements](#) , on page 72

## Overview of OTDR

The NCS 1010 OLT and ILA 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, whereas in the ILA device, the OTDR port can switch among LINE-1-TX, LINE-1-RX, LINE-2-TX, and LINE-2-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 1010.

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 1010, 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 1010 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 auto back-scattering** *value*

**otdr rx auto 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 auto back-scattering** *value*

**otdr tx auto refractive-index** *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 5: OTDR Configuration Parameters**

Parameter	Description	Range	Unit	Default
<b>otdr rx auto reflectance-threshold</b>	Threshold beyond which a reflective anomaly is reported as an event in the RX direction.	-50 to -10	dB	-40
<b>otdr rx auto splice-loss-threshold</b>	Threshold beyond which a loss anomaly is reported as an event in RX direction.	0.2 to 5	dB	0.35
<b>otdr rx auto excess-reflection-threshold</b>	Threshold beyond which a reflective event is reported as an excessive reflection event in the RX direction.	-50 to -10	dB	-20
<b>otdr rx auto back-scattering</b>	The back scattering value in the RX direction.	-90 to -70	dB	-81.87

Parameter	Description	Range	Unit	Default
<b>otdr rx auto refractive-index</b>	The refractive-index value in the RX direction.	1.000 to 2.000	-	1.4682
<b>otdr tx auto reflectance-threshold</b>	Threshold beyond which a reflective anomaly is reported as an event in Tx direction.	-50 to -10	dB	-40
<b>otdr tx auto splice-loss-threshold</b>	Threshold beyond which a loss anomaly is reported as an event in TX direction.	0-2.5	dB	0.35
<b>otdr tx auto excess-reflection-threshold</b>	Threshold beyond which a reflective event is reported as an excessive reflection event in the TX direction.	-50 to -10	dB	-20
<b>otdr tx auto back-scattering</b>	Back-scattering value in the TX direction.	-90 to -70	dB	-81.87
<b>otdr tx auto refractive-index</b>	Refractive-index value in the TX direction.	1.0000 to 2.0000	Unit less	1.4682
<b>otdr rx expert pulse-width</b>	Pulse width to be used during the expert scan in the RX direction.	5 to 2000	nanoseconds	20
<b>otdr rx expert capture-end</b>	OTDR capture endpoint during the expert scan in the RX direction.	15000000	cm	15000000
<b>otdr rx expert capture-start</b>	OTDR capture start point during expert scan in the RX direction	0 to 10000000	cm	0

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

## Start OTDR

NCS 1010 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_NCS1010_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)
1	R	50.4709	52.47	-39.87
2	NR	50.4709	52.47	1.17
3	R	100.9261	102.92	-37.73

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.

---

