Automatic Power Control

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

Table 1: 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.
Span-mode APC	Cisco IOS XR Release 7.11.1	Span-mode APC is a decentralized approach to APC.Span-mode APC Span-mode APC allows for faster network convergence as power correction is performed independently for each span.

Automatic Power Control

On a fiber, the power level may vary between channels. Over long distances and with multiple amplifications, these power level differences can reduce the quality of some channels. 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 activates if automatic link bringup is enabled.

Automatic Power Control (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 plus or minus 0.8 dB. This incremental correction continues until the optimal power level is reached.

Starting with R7.11.1, you can use APC as a span-level application by using span-mode APC.

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

Parameters configured by APC

This 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.

Functions of APC

APC divides the C band spectrum into 32 equal parts. APC uses 33 frequencies across the C band to perform this division. 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 these functions:

- 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.
- 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.
- 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, APC 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. APC moves to BLOCKED state after regulation is complete.

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.

PSD regulation states of APC channels

The APC channel PSD regulation feature operates in these ways:

- **Monitoring:** The APC system periodically checks the Power Spectral Density (PSD) discrepancy for each channel.
- **Trigger:** If the measured discrepancy exceeds the configured PSD correction tolerance, the regulation process is initiated.
- **Regulation action:** The Line Controller (LC) applies changes to reduce the discrepancy below the defined tolerance, ensuring a flat spectrum before the Erbium-Doped Fiber Amplifier (EDFA) at the LINE port.
- **Status states:** During regulation, the APC status transitions through various states before reaching the final state, IDLE.

- **Command usage:** The **show olc channel-apc controller Ots0/0/0/0 regulation-info** command displays the LC state.
- **State interpretation:** When regulation is in progress, some displayed values may represent final values, while others may not yet be updated.

Operation of span-mode APC

Starting with R7.11.1, you can configure APC in span-mode. span-mode APC is a decentralized automatic power control method used in optical networks, where each node independently adjusts its power levels based on changes in span loss.

If there is a discrepancy in the network without any change in span-loss, instead of triggering APC regulation, the system raises the corresponding alarm. For centralized APC, the power correction threshold is 0.7 dB. The threshold for span-mode APC is 0.5 dB.

Unlike centralized power control mode, where the manager node controls power adjustments across the network, each node in span-mode adjusts its own power based on the conditions of its direct connections or spans. There are no APC manager nodes in span-mode. Regulation in span-mode APC takes place when a node detects a change in Rx span loss. Span-mode APC does not perform regulation when there is a change in Rx power as a result of other changes. There are two exceptions to this:

- Span-mode APC compensates for power changes in the channels that an OLT receives on the ADD ports.
- Span-mode APC performs power correction when you change the DROP PSD configuration

When a node is unable to compensate for changes that require power correction, it raises the OOR (Out-of-Range) alarm and informs the receiving node of the discrepancy. The receiving node then performs power correction to address the issue.

If there is a power change in the network due to another cause, APC does not perform power correction. However, APC raises the APC-TARGET-PSD-NOT-MET alarm after a configured interval. You can investigate the cause of the change in the network and fix the issues.

APC behavior before R7.11.1 is Centralized APC.

Restrictions for span-mode APC

- Do not delete channels when APC is in span mode.
- Do not disable or enable APC, link tuner, or gain estimator after the ALC process is complete and span-mode APC is active.
- Do not initiate gain estimator application using exec CLI after ALC process is complete and span-mode APC is active.
- You must configure channel maps on all ILA nodes. Use **hw-module location 0/0/NXR0 grid-mode flex[inline-ampli | terminal-ampli] channel-id***id***centre-freq***frequency***width***width* command to configure the channel map for all 32 channels.
- You must pause span-mode APC before deleting or creating cross-connects.

APC status and internal states

APC status refers to the current state of APC throughout the entire path.

Description of APC status

This table lists and describes the APC status.

Table 2: Description of APC status

APC status	Description
BLOCKED	APC moves to the BLOCKED state if: • there is an event in the network which resulted in topology failure, • an amplifier safety event like APR or OSRI has been triggered in the network, and • APC is locally disabled on the agent node.
PAUSED	APC is paused using the **apc-pause** command.
IDLE	APC regulation has been completed successfully. All channels in the network have achieved the target PSD provided by the link tuner or configured by the user.
WORKING	When APC detects a discrepancy between the current and target PSD, it regulates to converge the power to the 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.

Description of APC internal states

Internal state is the state of APC on each individual node.

This table lists and describes the internal states of APC.

Table 3: Description of APC 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 these conditions: • Amplifier gain is exhausted in the current gain range. • WSS range (0 to 25dB) is exhausted for a single or multiple channels. • DGE range (0 to 3dB) is exhausted for a single or multiple channels. • Span loss has increased, and amplifier gain is insufficient to achieve the target PSD.
IDLE	APC regulation has been completed successfully. All channels in the network have achieved the target PSD, either provided by the link tuner or configured by the user.
BLOCKED	APC is unable to perform for these reasons: • OSRI has shut down the amplifier: AMPLI-SHUT. • APC is disabled locally on the node: USER-DISABLED. • Gain Estimation is in progress: GAIN-ESTIMATION-IN-PROGRESS. • Amplifier auto power reduction is enabled: AMPLI-APR-ENABLED. • Amplifier is shut because of loss of input power: AMPLI-SHUT. • An event in the network resulted in topology failure. • APC is BLOCKED as Band Failure Recovery sets Safe mode because of a band failure event in C+L network: BAND-FAILURE.

View APC status and information

Use this task to verify whether APC is working, blocked, idle, or paused. You can also view detailed parameters such as target PSDs, amplifier gain, attenuation settings, and discrepancies between current and target power levels for each node in the APC domain.

Procedure

Step 1 Use the **show olc apc** command to view the APC status.

This sample shows the output of the **show olc apc** command when APC is in Centralized mode

Example:

```
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
```

This sample shows the output of the **show olc apc** command when APC is in span-mode.

Example:

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

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

For information about APC statuses and APC internal states, see APC status and internal states, on page 5.

This sample shows the output of the **show olc apc** command when OSRI has shut down an amplifier in the link.

Example:

```
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
```

This sample shows the output of the **show olc apc** command when APC is disabled locally on a node.

Example:

```
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
```

This sample shows the output of the **show olc apc** command when Gain Estimation is in progress on a node.

Example:

```
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 ]
```

This sample shows the output of the **show olc apc** command when amplifier auto power reduction is enabled on a node.

Example:

```
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
```

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

Example:

```
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 ]
```

Step 2 Use the **show olc apc-local** command to view the local status of APC on each node.

This command shows if APC is enabled or disabled on the node.

This sample shows the output of the**show olc apc-local** command.

Example:

```
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
```

Step 3 Use the **show olc apc-local target-psd-profile** command to view the target PSDs configured for all the setpoints.

This sample shows the output of the **show olc apc-local target-psd-profile** command on a C band node. The output also displays the PSD configuration source and indicates whether the target PSD source is the link tuner or a configuration.

Example:

```
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
```

This sample shows the output of the **show olc apc-local target-psd-profile** command on an L band node.

Example:

```
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
```

Step 4 Use the **show olc apc-local regulation-info** command to view the detailed information about APC on each node.

This command provides this 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

This command also provides detailed information on the channels:

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

Step 5 Use the **tx|rx** keyword with the **show olc apc-local regulation-info controller ots** *R/S/I/P* command to view the APC information for only the Tx or Rx direction.

This sample shows the output of the**show olc apc-local regulation-info** command.

Example:

```
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 Minimum          : -24.0 (dBm/12.5 GHz)
Gain Range           : Normal
Last Correction      : 2022-07-06 05:01:28

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


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

 191.375000    75.00     1      OCh       13          -23.2         -4.6          -4.9          0.2
       7.1
 191.449997    75.00     -      ASE       37          -23.0         -4.6          -4.7          0.1
       9.2
 191.524994    75.00     -      ASE       61          -23.1         -4.6          -4.7          0.1
       9.3
 191.600006    75.00     4      OCh       85          -23.1         -4.5          -4.7          0.1
       8.0
 191.675003    75.00     -      ASE       109         -23.0         -4.5          -4.5          0.0
       9.1
 191.750000    75.00     6      OCh       133         -23.0         -4.4          -4.6          0.1
       8.0
 191.824997    75.00     -      ASE       157         -23.1         -4.4          -4.6          0.1
       9.3
 191.899994    75.00     8      OCh       181         -23.0         -4.4          -4.4          0.0
       8.0
 191.975006    75.00     -      ASE       205         -23.0         -4.3          -4.5          0.1
       9.1
 192.050003    75.00     10     OCh       229         -23.0         -4.3          -4.5          0.1
       8.2
 192.125000    75.00     -      ASE       253         -22.9         -4.3          -4.3          0.0
       9.0
 192.199997    75.00     12     OCh       277         -22.8         -4.2          -4.3          0.0
       8.3
 192.274994    75.00     -      ASE       301         -22.9         -4.2          -4.4          0.1
       9.0
 192.350006    75.00     14     OCh       325         -22.6         -4.2          -4.2          0.0
       8.3
 192.425003    75.00     -      ASE       349         -22.8         -4.2          -4.3          0.1
       8.7
 192.500000    75.00     16     OCh       373         -22.4         -4.1          -3.9          -0.2
       8.1
 192.574997    75.00     -      ASE       397         -22.7         -4.1          -4.2          0.1
       8.6
```

192.649994	75.00	18	OCh	421	-22.6	-4.1	-4.2	0.1
8.1								
192.725006	75.00	-	ASE	445	-22.7	-4.0	-4.2	0.1
8.6								
192.800003	75.00	20	OCh	469	-22.7	-4.0	-4.1	0.1
7.9								
192.875000	75.00	-	ASE	493	-22.6	-4.0	-4.0	0.0
8.4								
192.949997	75.00	22	OCh	517	-22.6	-3.9	-4.1	0.1
7.6								
193.024994	75.00	-	ASE	541	-22.5	-3.9	-4.0	0.1
8.2								
193.100006	75.00	24	OCh	565	-22.7	-3.8	-4.0	0.1
7.5								
193.175003	75.00	-	ASE	589	-22.7	-3.8	-4.0	0.1
8.2								
193.250000	75.00	26	OCh	613	-22.5	-3.8	-3.9	0.1
7.2								
193.324997	75.00	-	ASE	637	-22.6	-3.8	-4.0	0.2
8.1								
193.399994	75.00	28	OCh	661	-22.7	-3.7	-3.9	0.1
7.2								
193.475006	75.00	-	ASE	685	-22.5	-3.7	-3.8	0.1
8.0								
193.550003	75.00	30	OCh	709	-22.7	-3.7	-3.8	0.1
7.0								
193.625000	75.00	-	ASE	733	-22.7	-3.6	-3.8	0.1
8.1								
193.699997	75.00	32	OCh	757	-22.7	-3.6	-3.7	0.1
6.7								
193.774994	75.00	-	ASE	781	-22.7	-3.5	-3.7	0.1
8.2								
193.850006	75.00	34	OCh	805	-22.7	-3.5	-3.7	0.1
6.6								
193.925003	75.00	-	ASE	829	-22.7	-3.5	-3.6	0.1
8.1								
194.000000	75.00	36	OCh	853	-22.8	-3.5	-3.7	0.2
6.6								
194.074997	75.00	-	ASE	877	-22.8	-3.4	-3.6	0.1
8.3								
194.149994	75.00	38	OCh	901	-22.7	-3.4	-3.5	0.1
10.9								
194.225006	75.00	-	ASE	925	-22.8	-3.3	-3.5	0.1
8.2								
194.300003	75.00	40	OCh	949	-22.9	-3.3	-3.5	0.1
7.1								
194.375000	75.00	-	ASE	973	-22.8	-3.3	-3.4	0.1
8.4								
194.449997	75.00	42	OCh	997	-22.9	-3.2	-3.5	0.2
7.3								
194.524994	75.00	-	ASE	1021	-22.9	-3.2	-3.4	0.1
8.4								
194.600006	75.00	44	OCh	1045	-22.8	-3.2	-3.3	0.1
7.2								
194.675003	75.00	-	ASE	1069	-22.8	-3.2	-3.3	0.1
8.4								
194.750000	75.00	46	OCh	1093	-22.9	-3.1	-3.4	0.2
7.3								
194.824997	75.00	-	ASE	1117	-22.8	-3.1	-3.2	0.1
8.2								
194.899994	75.00	48	OCh	1141	-22.8	-3.0	-3.3	0.2
6.9								
194.975006	75.00	-	ASE	1165	-22.9	-3.0	-3.2	0.1
8.3								

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

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

Note

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

You can assess and monitor the power regulation and discrepancies across the network nodes for effective optical network management.

Configure the target PSDs

Use this task to configure the PSD profiles that manage the optical power levels.

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

You can configure the target power spectral densities at 33 points across the band. Each PSD value divides the spectrum into 150-GHz steps. APC uses the PSD value when a channel frequency matches a configured point. If not, APC calculates the target PSD for a channel based on the two nearest steps.

Procedure

Step 1 Use the **psd** <*1-33*> *value* command to set the target PSDs for single-band for each node on a C-band network.

This sample configuration sets the PSD value to 15 dBm or 12.5 GHz for setpoints 1 and 2.

Example:

```
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
```

Step 2 (Only for NCS 1010) Use the **dual-band-psd** <*1-33*> *value* command to set the target PSDs for dual-band for each node on a C+L band network.

This sample configuration sets the dual-band PSD values to -50 and -49 on setpoints 1 and 2 respectively, on the 0/0/0/0 controller.

Example:

```
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
```

The target PSD profiles are now configured for the selected band on all nodes in the path.

Disable APC

Use this task to manually disable APC, allowing user configuration to take effect instead of APC's automatic power regulation.

Procedure

Use the **apc disable** command to disable APC for a link on the transmitting OLT node.

Example:

```
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, the device sets all the setpoints to values in the configuration. If there is no configuration, the device sets all setpoints to their default values. Disabling APC affects traffic.
- (Only for NCS 1010) 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.

User configuration is applied instead of APC. All setpoints are set to either configured values or default values.

Configure centralized APC

Use this task to manage APC by enabling and disabling APC domains.

Procedure

Step 1 Use the **apc enable** command on the transmitting OLT node to enable APC for a link.

Example:

```
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
```

Step 2 Use the **apc pause** command on the transmitting OLT node to modify the network without APC compensating for the changes.

Example:

```
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 changes in the network require power correction. The status changes to paused after changes are detected, but the system does not perform power correction.
- Running the **apc-pause** command does not pause channel startup.

Step 3 Use the **apc-local [RX | TX] disable** command on an ILA node to disable APC locally.

Example:

```
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
```

Consider a scenario where the headend OLT encounters a headless event. If power correction is required at agent nodes, the APC manager is unavailable to initiate regulation. When APC is enabled, adjustments cannot be performed, and user configuration of **target-psd** does not take effect. Disabling APC locally on an agent node allows manual adjustment of parameters. Use the **apc-local disable** command to disable APC on an agent node.

Configure target drop PSD and minimum PSD

Use this task to manually configure the target PSD for drop ports. You can also set the minimum PSD threshold. These actions ensure that channel power levels meet the required target and maintain optimal channel quality across the network.

The 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 device applies drop PSD configuration for channels with cross connect settings. Use the **drop-psd** command to set the desired drop PSD.

If the PSD of a channel with minimal attenuation at the amplifier input on an OLT is less than the minimum PSD, APC marks the channel as failed. APC then replaces the channel using the ASE source.The default minimum PSD is –24 dBm/2.5 GHz. Use the **psd-min** command to set the desired minimum PSD.

Procedure

Step 1 Use the **drop-psd** command to set the desired drop PSD.

This sample configuration sets the target PSD at drop ports to –25 dBm/12.5 GHz.

Example:

```
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
```

Step 2 Use the **psd-min** command to set the desired minimum PSD.

This sample configuration sets the minimum PSD to –25 dBm/12.5 GHz.

Example:

```
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
```

Channel power levels meet the required target power profile.

View patchcord loss and path loss

(Only on NCS 1010) Use this task to obtain data about the loss between the LINE-TX port of the L-band device and the LINE-TX port of the C-band device. This is essential to launch the correct power into the transmission fiber and ensure accurate power level adjustments in the optical network.

In a C+L band configuration, optical applications require data about loss between the LINE-TX port of the L-band device to the LINE-TX port of the C-band device to launch correct power into the transmission fiber.

This data, also known as path loss, is calculated from these components:

- patchcord loss between the LINE-TX port of the L-band device and 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.

Procedure

Step 1 Use the **show olc partner-band-loss** command to view the patchcord loss and path loss values.

This sample is an output of the **show olc partner-band-loss** when executed on a C-band device.

Example:

```
RP/0/RP0/CPU0#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
```

This sample is an output of the **show olc partner-band-loss** when executed on a L-band device.

```
RP/0/RP0/CPU0#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
```

Step 2 Use the **show olc partner-band-loss controller ots** *R/S/I/P* command to view the patchcord loss and path loss values for individual controllers.

This sample is an output of the **show olc partner-band-loss controller ots** *R/S/I/P* when executed on a C-band device.

Example:

```
RP/0/RP0/CPU0#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
```

This sample is an output of the **show olc partner-band-loss controller ots** *R/S/I/P* when executed on a L-band device.

```
RP/0/RP0/CPU0#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
```

You can accurately monitor and manage optical power levels in the network.

Configure APC alarm hold-off timer and discrepancy threshold

Use this task to configure APC alarm sensitivity and timing. You can avoid false or premature alarms during APC.

Procedure

Step 1 Use the **apc-alarm-hold-off-timer** *time* command to configure the timer.

You can configure the time interval that must pass after APC detects a discrepancy before the APC-TARGET-PSD-NOT-MET alarm is raised. The default value is 30 seconds.

This sample configuration sets the APC alarm hold-off timer to 45 seconds.

Example:

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

Step 2 Use the **apc-alarm-discrepancy-threshold** *discrepancy*command to configure the discrepancy threshold.

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

This sample configuration sets the APC alarm discrepancy threshold to 1.5 dB.

Example:

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

The APC alarm parameters are configured, reducing false or premature alarms during APC operation.

Configure APC in span mode

Use this task to configure APC in span mode.

Procedure

Step 1 Use these commands to configure APC in span mode on an OLT node.

Example:

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

Step 2 Use these commands to configure APC in span mode on an ILA node.

Example:

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

APC operates in centralized mode during automatic link calibration. After ALC completes, it saves a system baseline. If span mode configurations are present, ALC switches APC mode to span mode.

Pause APC in span mode

Use this task to pause APC in span mode.

Procedure

Use these commands to pause APC in span mode.

Example:

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

Switch between APC modes

Use this task to switch from centralized APC to span mode APC operation and vice versa.

Procedure

Step 1 Switch from centralized APC to span mode APC.

a) Configure APC in manual mode on the OLT nodes.
b) Configure apc-span-mode on all nodes.
c) Initiate ALC and wait for the ALC process to complete.

After saving the ALC baseline, APC switches to span mode.

Step 2 Switch from span mode APC to centralized APC using one of these methods:

- **commit replace**
  - **a.** Reset all the nodes to their default configuration by using the **commit replace** command.
  - **b.** Reload all the nodes.
  - **c.** Configure the nodes with the required settings for link bringup.
  - **d.** Configure automatic link bringup or enable APC.

  APC starts regulation in centralized mode.
- **no** configuration of optical applications
  - **a.** Remove the optical applications configurations by using the **no** form of APC, link tuner, and gain estimator.

b. Configure the nodes with required configuration for link bring up.

c. Configure automatic link bringup or enable APC.

APC starts regulation in centralized mode.