



Configure Optical Modules

This chapter describes how to configure the Optical Amplifier Module and Protection Switching Module (PSM).



Note When you plan to replace a configured optical module with a different type of optical module, you must clear the configurations of the old module before you install the new module. For example, when replacing a configured EDFA module with a PSM in the same slot, clear the EDFA configurations.

In general, configurations in a card equipped in an NCS 1001 slot include:

- Card configuration—hw-module parameters configuration related to the slot *S* where the card is equipped
- OTS controller configurations
- Optics controller configurations—only for EDFA cards

The following commands clear the configurations in the previous card.

1. `no hw-module location 0/RP0/CPU0 slot <S>`

Clear the card parameters configuration.

2. `no controller ots Rack/Slot/Instance/Port`

Clear each OTS controller configuration.

3. `no controller optics Rack/Slot/Instance/Port`

(Optional) Clear the controller optics configurations. This must be done only if the card previously equipped in slot *S* was an EDFA.

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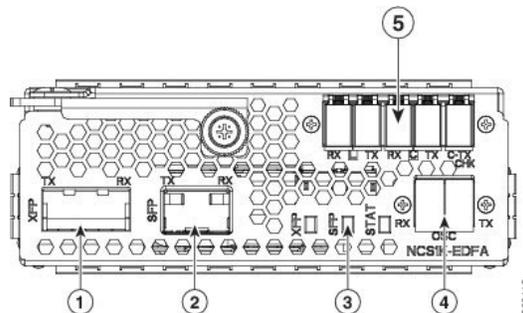
Optical Amplifier Module

The optical amplifier module (NCS1K-EDFA) has pre-amplifier and booster amplifier.

The optical amplifier module provides the following functionality.

- Preamplifier (LINE-RX to COM-TX) - Single preamplifier variant, with switchable gain ranges, according to link loss:
 - Range # 1: 0 to 24 dB gain, Tilt control: 24 to 27 gain, with tilt uncontrolled
 - Range # 2: 20 to 34 dB gain, Tilt control: 34 to 37 dB gain, with tilt uncontrolled
 - 23dBm output power @ COM-TX port
- Booster amplifier (COM-RX to LINE-TX) - True variable gain booster amplifier
 - Gain range: 1 to 20. 20 to 25 uncontrolled tilt.
 - 23dBm output power @ LINE-TX port
- ADD/DROP OSC channel supports both 1510nm and 1610nm +/-10nm
- OCM assesses channel presence and Gain regulation and per channel power monitoring.

Figure 1: EDFA Front View



1	XFP for OSC and additional OTDR feature
2	SFP for OSC (Optical Service Channel)

3	Status LED
4	Service Channel input and output port [OSC - RX, TX]
5	PRE and BST amplifier inputs and output ports [L (LINE) - RX, TX] [C (COM) - RX, TX] [COM - TX CHECK]

The following table describes the mapping of controllers and optical ports for the optical amplifier module.

Controller	Optical Ports
Ots 0/slot/0/0	<ul style="list-style-type: none"> • COM-RX (booster input) • COM-TX (preamplifier output)
Ots 0/slot/0/1	<ul style="list-style-type: none"> • LINE-RX (preamplifier input) • LINE-TX (booster output)
Ots 0/slot/0/2	<ul style="list-style-type: none"> • OSC-RX • OSC-TX
Ots 0/slot/0/3	COM-CHECK

Amplifier Configuration

NCS 1001 supports two methods to control amplifiers.

- Manual-All the amplifier settings are controlled by the user.
- Automatic-All the amplifier settings are controlled by the internal amplifier power regulator.

UDC Port Configuration

There are three UDC RJ-45 ports on the faceplate of NCS 1001. Each port is statically associated with a slot (UDC1 to slot 1, UDC2 to slot 2 and UDC3 to slot3). UDC ports are one Gigabit Ethernet ports and the user can transmit any Ethernet traffic into these ports.

UDC traffic flows through the line, added and dropped by the OSC add/drop filters in the optical amplifier module (NCS1K-EDFA). UDC traffic flows through the line tagged. The tagging and untagging operations are performed by NCS 1001, based on the UDC VLAN specified in the configuration, without any limit on the transmitted traffic. The traffic can be tagged, multiple tagged, or untagged. However, 100% utilization cannot be achieved because four bytes of tag are added to each packet.

UDC Application for Remote Management

The following diagrams describe the application of UDC that can be used by EPNM to manage NCS 1000 series at the remote site.

Figure 2: UDC Application for Remote Management - Scenario One

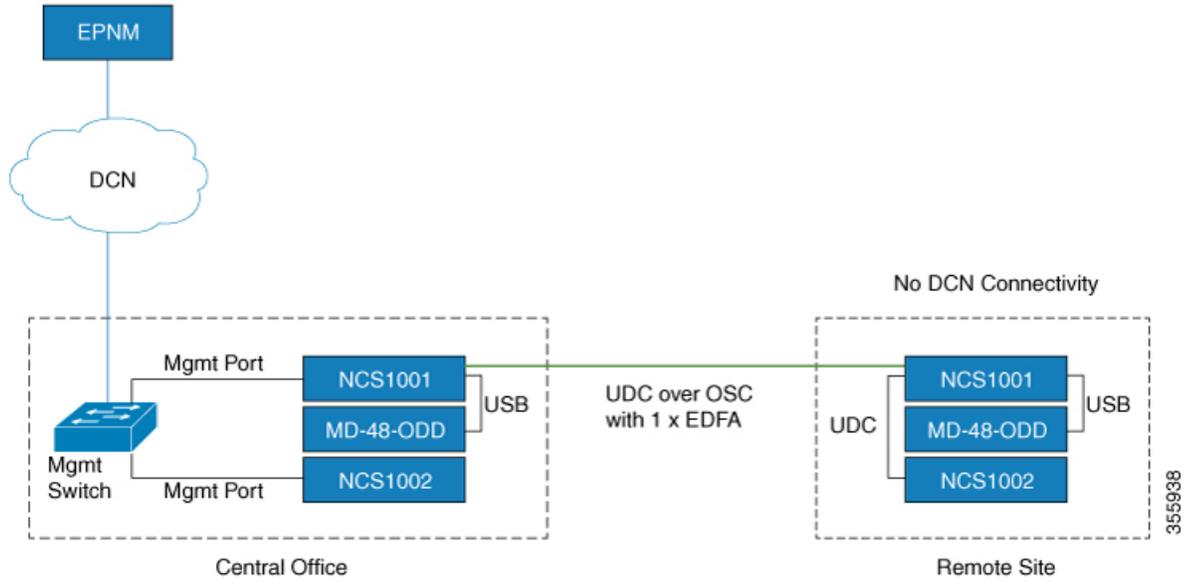
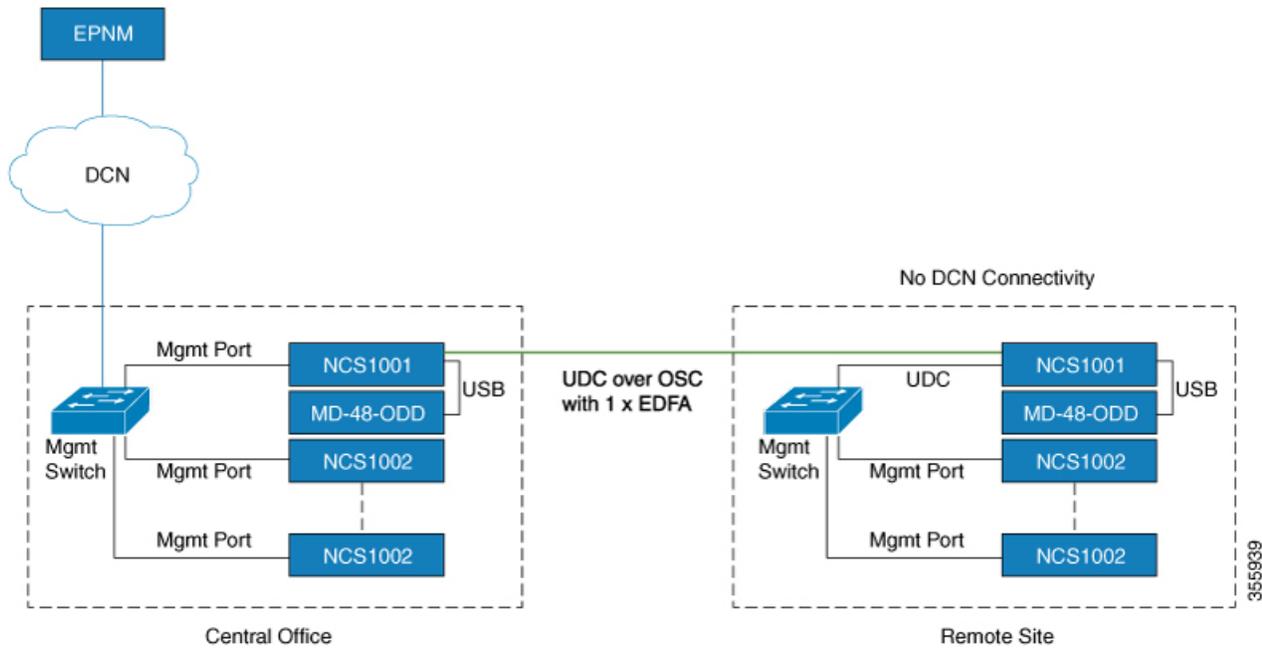


Figure 3: UDC Application for Remote Management - Scenario Two



Configure Amplifier Module

configure

hw-module location 0/RP0/CPU0 slot *slot-number* ampli

node-type *value*

grid-mode *value*

udc-vlan *value*

commit

end

Example

The following is a sample in which the amplifier module is inserted in slot 3 and udc-vlan is set to 4000.

```
configure
hw-module location 0/RP0/CPU0 slot 3 ampli
[
    grid-mode 100GHz
    udc-vlan 4000
]
```

Amplifier Module Configuration Parameters

Table 1: Amplifier Module Configuration Parameters

Parameter	Description	Range/Values	Default
grid-mode	Defines the optical spectrum on the interfaces of the amplifier module.	<ul style="list-style-type: none"> 100GHz-Configures the amplifier with 100GHz grid of channels with 48 channel spacing. 50GHz-Configures the amplifier with 50GHz grid of channels with 96 channel spacing. gridless-Configures the amplifier in the flex spectrum. 	50GHz
node-type	Defines the type of the node in which the amplifier is set to work.	TERM, ILA	TERM
udc-vlan	Defines the VLAN associated to the selected slot and its UDC port.	2 to 4080	

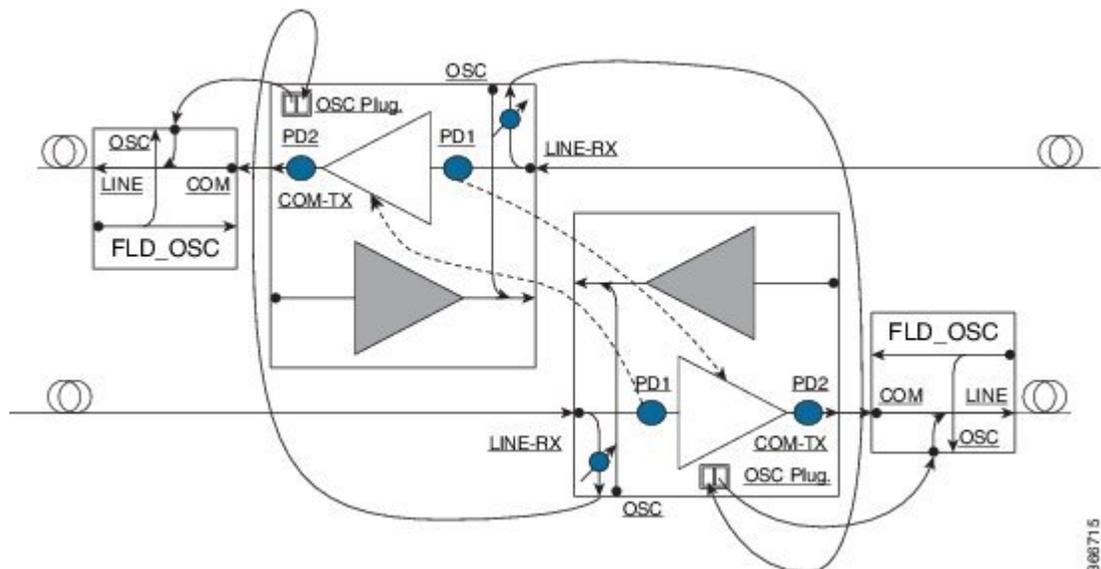
In-Line Amplifier

The optical amplifier module (NCS1K-EDFA) can be configured in In-line amplifier (ILA) mode. ILA mode is used when it is not possible to connect to terminal nodes with a single span. ILA mode is supported only in slots 1 and 3.

ILA mode supports only the operation of preamplifier in the two directions. The booster module is switched off in ILA mode. ILA mode supports gain range 1 and 2 of the preamplifier and provides 23dBm output power pre-amplification.

In the ILA mode, the LINE-RX and COM-TX ports of the optical amplifier module are enabled whereas the LINE-TX and COM-RX ports of the optical amplifier module are disabled. OCM reports LINE-RX and COM-TX port values whereas LINE-TX and COM-RX port values are set to -40.00 dBm. In the ILA mode, the LINE-RX terminates on the LINE-RX on the optical amplifier module whereas the LINE-TX terminates on the external OSC module (15216-FLD-OSC=).

Figure 4: ILA Optical Diagram



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Configure Amplifier Module in ILA Manual Mode

When the amplifier is set to ILA, all the configurations are performed only on the pre-amplifier. After the node is set to ILA, the amplifier gain, RX-low threshold, and the amplifier tilt can be configured on the pre-amplifier.

configure

hw-module location 0/RP0/CPU0 slot slot-number ampli node-type value

commit

end

controller controllertype Rack/Slot/Instance/Port

```

ampli-control-mode {automatic | manual}
ampli-gain value
rx-low-threshold value
ampli-tilt value
commit
end

```

Example

The following is a sample in which the amplifier module is configured in ILA manual mode. The node type is set to ILA. This parameter switches off the booster side and activate safety between slots 1 and 3.

```

configure
  hw-module location 0/RP0/CPU0 slot 3 ampli node-type iLA
  commit
end
controller ots 0/3/0/0
ampli-control-mode manual
ampli-gain 200
rx-low-threshold -300
ampli-tilt -10
commit
end

```

Configure Amplifier Module in ILA Automatic Mode

The configurations performed on the amplifier module in ILA automatic mode are similar to the configurations performed on the terminal node. The configurations are performed only on the pre-amplifier as the booster is switched off in ILA mode.

```

configure
hw-module location 0/RP0/CPU0 slot slot-number ampli
grid-mode value
node-type value
commit
end
controller controllertype Rack/Slot/Instance/Port
ampli-control-mode {automatic | manual}
ampli-channel-power value
ampli-tilt value
rx-low-threshold value
channel-power-max-delta value
ampli-gain value

```

```
ampli-gain-range {normal | extended}
```

```
commit
```

```
end
```

Example

The following is a sample in which the amplifier module is configured in ILA automatic mode.

```
configure
  hw-module location 0/RP0/CPU0 slot 3 ampli
  grid-mode 50GHz
  node-type iLA
  commit
end
controller ots 0/3/0/0
ampli-control-mode automatic
ampli-channel-power 30
ampli-tilt -10
rx-low-threshold -331
ampli-gain 220
ampli-gain-range extended
commit
end
```

The following is a sample of **show running-config** command.

```
line console
exec-timeout 0 0
!
line default
exec-timeout 0 0
session-timeout 0
!
ntp
server 10.58.228.1
update-calendar
!
hw-module location 0/RP0/CPU0 slot 1
ampli udc-vlan 11
ampli grid-mode 50GHz
ampli node-type ILA
!
hw-module location 0/RP0/CPU0 slot 3
ampli udc-vlan 10
ampli grid-mode 50GHz
ampli node-type ILA
!
interface MgmtEth0/RP0/CPU0/0
ipv4 address 10.58.229.143 255.255.252.0
!
interface MgmtEth0/RP0/OSC1/0
shutdown
!
interface MgmtEth0/RP0/OSC2/0
shutdown
!
interface MgmtEth0/RP0/OSC3/0
shutdown
!
```

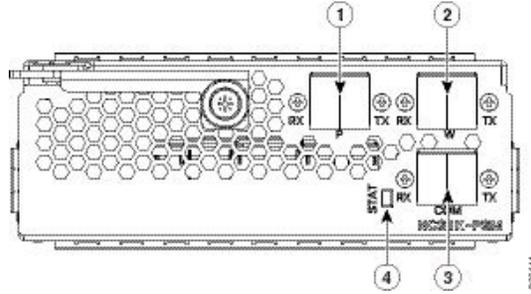
```
controller Ots0/1/0/0
ampli-tilt -12
ampli-control-mode automatic
ampli-channel-power 22
channel-power-max-delta 45
!
controller Ots0/1/0/1
rx-low-threshold -250
!
controller Ots0/3/0/0
ampli-tilt -12
ampli-control-mode automatic
ampli-channel-power 22
channel-power-max-delta 45
!
controller Ots0/3/0/1
rx-low-threshold -250
!
router static
address-family ipv4 unicast
  0.0.0.0/0 10.58.228.1
!
!
netconf-yang agent
ssh
!
ssh server v2
end
```

Protection Switching Module

The protection switching module (NCS1K-PSM) provides the following functionality.

- In TX section:
 - Splits input optical channels to both working and protection lines.
 - Forces the switch in the remote site by opening one of the two line paths (by putting the related VOA in AVS).
- In RX section:
 - Selects the signals from working or protection line. Each line is monitored through a PD.
 - Balances the two line losses by changing the VOA attenuation value at the same time of the switch change of state.

Figure 5: PSM Front View



1	Protected path input and output port [P - RX, TX]
2	Working path input and output port [W - RX, TX]
3	COM input and output port [COM - RX, TX]
4	Status LED

The following table describes the mapping of controllers and optical ports for the protection switching module.

Controller	Optical Ports
Ots 0/slot/0/0	COM-TX
Ots 0/slot/0/1	Working path input and output port [W - RX, TX]
Ots 0/slot/0/2	Protected path input and output port [P - RX, TX]

Configure Protection Switching Module

The following table explains the possible configuration on Protection Switching Module:

PSM Module Configuration Parameters

Table 2: PSM Module Configuration Parameters

Parameter	Description	Range/Values
lockout-from	Excludes the selected port from protection. Triggers a switch when the active port is specified in the lockout. For example, configuring a lockout-from working port triggers a switch to protect when working port is the active one. While lockout-from protected port triggers a switch to working when protected port is the active one.	Working and Protected
path-protection	Enables the PSM path protection.	
section-protection	Enables the PSM section protection.	
uni-dir	Enables the PSM uni directional (in switches only).	
auto-threshold	Enables the PSM auto threshold setting.	

Example

The following is an example of configuration of a lockout from working in which the PSM is inserted in slot 2.

```
conf t
#hw-module location 0/RP0/CPU0 slot 2 psm lockout-from "working"
commit
```

You can apply manual switching by using the following command:

hw-module slot *slot number* manual-switch-to working | protected

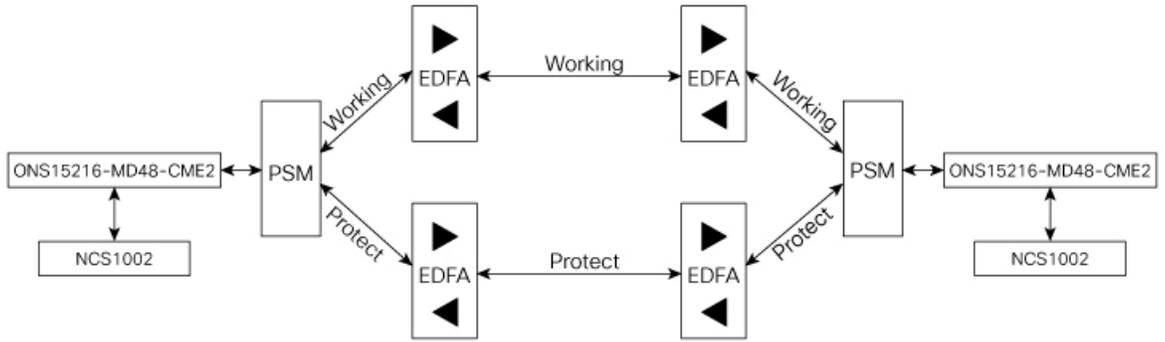
The switch by user command from the path without the ILA node in the middle is performed bi-directionally. If the ILA and terminal nodes are in section-protection, the manual and lockout switch command from the path with ILA node in the middle are performed uni-directionally.



Note FPD upgrade on FW_PSMv1 from FW 1.43 and FW 1.44 to FW 1.45 affects the traffic.

(From R6.2.1) **Section Protection**

Figure 6: Section Protection Topology



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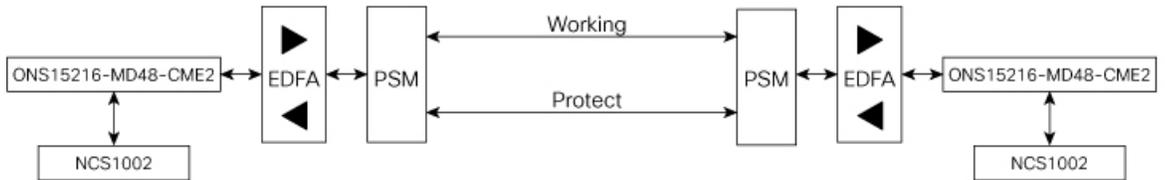
See the PSM Module Configuration Parameters section to set the section-protection parameter on both the PSMs. Ensure that the PSM in a section protection topology is inserted in slot 2. Connect the EDFA in slot 1 to the Protected port of the PSM and EDFA in slot 3 to the Working port of the PSM.



Note To measure the correct switching time while testing the section protection topology, we recommend you to wait for 120 seconds between two subsequent switching events (or between a switching event and the restoration). This waiting period allows the EDFAs to stabilize after the first switching occurrence, thus avoiding the power at the PSM to oscillate around the threshold.

(From R6.3.2) **Path Protection**

Figure 7: Path Protection Topology



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See the PSM Module Configuration Parameters section to set the path-protection parameter on both the PSMs.

Protection Switching Module with Manual Threshold

The switch can operate in all conditions, if it is set in Autothreshold.

When the path protection is configured with a manual threshold, you must ensure that:

- During the first installation, the value on the PSM RX-low Threshold should be set as 3 dB below the minimum power for a single channel. The value must ensure that the PSM is able to switch on with a single channel or when the EDFA is in APR (+8 dBm).
- When the system is up and running with the final number of channels, the PSM RX-low Threshold must be set 3 dB below the target power.
- After a fiber cut and restore, in order to ensure that the PSM is able to switch on, it is necessary to set the value of PSM RX-low Threshold similar to the value set during the first installation.

The PSM Auto-threshold configuration is highly recommended for a three-way topology.

In a three-way topology, when the path protection is configured with a manual threshold, you must follow the above steps. If you did not configure all the above steps properly, you may encounter the following issues:

- Switch may not be bidirectional.
- Double switch on PSM in path protection, when set in three-way configuration.

It is possible to configure parameters such as rx-enable, tx-enable in OTS controllers (1 or 2, i.e. working or protected port) of PSM card.

For more information on OTS controllers, see [Configure OTS Controller](#).

Autothreshold for Protection Switching Module

When auto-threshold is not enabled, the RX-low threshold value active on PSM working and protected RX-ports can either be set by the user or the default values can be used.

The current threshold is the configured parameter if the values set are available in the show controller command output. The current value is -38dBm (default values), if the user doesn't have configured any value for those parameters.

If auto-threshold is enabled on the PSM, the RX-low thresholds values for port 1 and 2 configured by the user are ignored (current thresholds is not the configured parameter). When the auto threshold is enabled on the PSM card:

- If optical Power at Working-RX and Protected-RX port is stable (+/- 1 dB) for 2 minutes, related RX-Low threshold is automatically set to RX power – 3dB.
- If power is not stable, the related thresholds do not change.
- W-RX and P-RX are regulated independently.

The LOS-P behavior on the auto-threshold are:

- When a LOS-P alarm is detected on the working or protected RX-port, in case of auto-threshold is enabled, the related threshold remains the same. This behavior happens when the RX power is less than the related threshold on the RX-port working or protected.
- When the LOS-P alarm is cleared in the first 30 seconds, the ordinary auto-threshold mechanism is applied. This behavior happens after 2 minutes of stable RX-power and when the RX-low threshold is changed to the new RX power -3 dB.
- When the LOS-P is present after 30 seconds, the RX-low threshold is automatically moved to the values set by the user.
- When the LOS-P is cleared, the ordinary auto-threshold mechanism is applied again. This behavior happens when the RX power is higher than the related current threshold.

Enable Autothreshold for PSM

This procedure enables automatic thresholds for PSM. The configuration to set auto threshold mechanism are:

configure

```
hw-module location 0/RP0/CPU0 slot slot number psm auto-threshold
commit
end
```

slot number is the slot where the PSM is inserted.

Example

The following is a sample for enabling autothreshold on a PSM equipped in slot 1.

```
RP/0/RP0/CPU0:MYS-237#configure terminal
RP/0/RP0/CPU0:MYS-237(config)#hw-module location 0/RP0/CPU0 slot 1 psm auto-threshold
RP/0/RP0/CPU0:MYS-237(config)#commit
eRP/0/RP0/CPU0:MYS-237(config)#end
```

PSM Virtual Photodiode

Protection Switching Module (PSM) Virtual diode provides an optical power reading even if photodiodes are not available. PSM does not have photodiode on COM-RX. There are two photodiodes on Working-TX and Protected-TX present after the VOA.

The value of power on Com-RX is real, if at least one value between the W-TX and the P-TX power is not equal to -40 dB (related port in AVS).

When both the power of W-TX and P-TX are equal to -40dB (both related VOA in AVS-Automatic VOA Shutdown), it is impossible to calculate the real power on Com-RX port, and the value will be shown as -40dB.

The feature does not require any configuration. There is a change only in the *show controllers ots 0/<slot>/0/0* command, which shows the RX power on Com-RX port. RX low power alarm is not managed on Com-RX port.

Example for show controller

```
RP/0/RP0/CPU0:ios#show controllers ots 0/2/0/0
```

```
Wed Jan 24 14:33:22.898 CET
```

```
Controller State: Up
```

```
Transport Admin State: In Service
```

```
Port Type: Com
```

```
Laser State: Unknown
```

```
Optics Status::
```

```
Alarm Status:
```

```
-----
```

```
Detected Alarms: None
```

```
Alarm Statistics:
```

```
-----
```

```
LOW-RX-PWR = 0
```

```
LOW-TX-PWR = 0
```

```
RX-LOS-P = 0
```

```

RX-LOC = 0
AMPLI-GAIN-DEG-LOW = 0
AMPLI-GAIN-DEG-HIGH = 0
AUTO-LASER-SHUT = 0
AUTO-POW-RED = 0
AUTO-AMPLI-CTRL-DISABLED = 0
AUTO-AMPLI-CFG-MISMATCH = 0
SWITCH-TO-PROTECT = 0
AUTO-AMPLI-CTRL-RUNNING = 0

```

Parameter Statistics:

```

-----
TX Power = 15.30 dBm
RX Power = 5.30 dBm
tx-enable = 1
rx-enable = 1

```

Configured Parameters:

```

-----
tx-enable = 1
rx-enable = 1

```

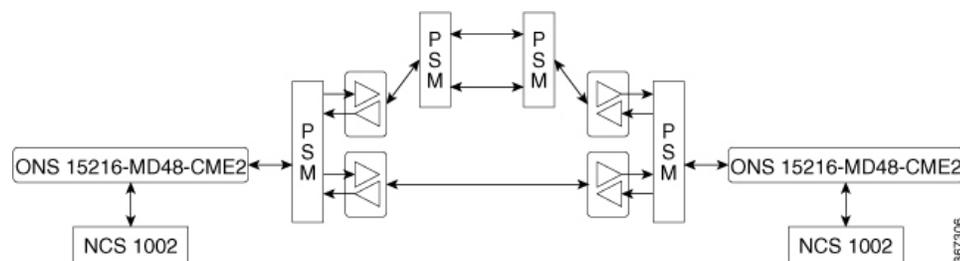
PSM 3-way Protection

NCS 1001 supports Protection Switching Module (PSM) 3-way protection scheme formed by combining a Section Protection scheme with a Path Protection scheme. There is no configuration change required in PSM to implement the PSM 3-way protection scheme. The Path Protection scheme is in the middle of one of the two paths of Section Protection scheme.

For the outer section protection it is suggested to use the PSM automatic threshold configuration.

Figure 8: 3-way Protection Network Topology

Figure 9: 3-way Protection Network Topology



The 3-way Protection Scheme has the following limitations:

- For each PSM switching the bi-directionality is not definite.
- The manual switching used to change the active path is sometimes unsuccessful.

The lockout configuration is recommended to control the switching operation from one path to another on all the 4 PSMs of the protection scheme. The lockout configuration must be applied on both local and corresponding remote PSM to ensure the bi-directionality.

OSC

OSC (Optical Service Channel) is an out-band channel added and dropped into the optical amplifier module. The wavelengths supported by OSC are 1510 nm and 1610 nm.

OSC provides a communication channel for the following types of traffic.

- Traffic coming from a UDC port
- Traffic for remote management of NCS 1001

Remote Management

Remote Management feature, introduced in R6.3.1, allows to configure the IP addresses of the local and remote nodes, to remotely manage NCS 1001.

Three OSC interfaces are configured to support remote management. The OSC interfaces are configured to provide static routes to remote nodes. Each OSC interface is statically associated with a slot (OSC1 to slot 1, OSC2 to slot 2, and OSC3 to slot3).

Configuration Steps

1. [Configure Management and OSC Interfaces](#)
2. [Configure Static Routes](#)

Network Topology Discovery

Network topology discovery feature based on OSPF protocol, introduced in R6.3.2, allows to discover NCS 1001 nodes connected to each other through OSC links without configuring the static routes. This feature checks for compatibility only between NCS 1001 nodes.

OSPF must be properly configured on the NCS 1001 nodes by defining the name, router ID, interfaces in the Area 0 section, and optionally, configuring the interfaces as passive. OSPF and OSPFv3 protocols are supported.

The following network topologies are supported.

- Point to Point
- Point to Point with ILA nodes (up to three ILA nodes)

Configuration Steps

1. [Configure Management and OSC Interfaces](#)
2. [Configure OSPF Routes](#)

Configure Management and OSC Interfaces

```
configure  
interface mgmtEth rack/slot/instance/port  
ipv4 address ipv4-address subnet-mask  
shutdown  
exit
```

Example

The following are samples of configuring the management and OSC interfaces.

```
configure  
interface MgmtEth 0/RP0/CPU0/0  
ipv4 address 10.58.227.198 255.255.255.0  
shutdown  
exit
```

```
configure  
interface MgmtEth 0/RP0/OSC1/0  
ipv4 address 10.1.1.1 255.255.255.0  
shutdown  
exit
```

```
configure  
interface MgmtEth 0/RP0/OSC2/0  
ipv4 address 10.1.2.1 255.255.255.0  
shutdown  
exit
```

```
configure  
interface MgmtEth 0/RP0/OSC3/0  
ipv4 address 10.1.3.1 255.255.255.0  
shutdown  
exit
```

Configure Static Routes

This procedure configures all the static routes into the NCS 1001 node.

```
configure  
router static address-family ipv4 unicast 0.0.0.0/0 default-gateway  
exit
```

Example

The following sample shows the NCS 1001 node connected to three different nodes using static routes.

```
configure
```

```

router static address-family ipv4 unicast
0.0.0.0/0 MgmtEth 0/RP0/CPU0/0 10.58.227.1
10.1.1.0/24 MgmtEth 0/RP0/OSC1/0 10.1.1.2
10.1.2.0/24 MgmtEth 0/RP0/OSC2/0 10.1.2.2
10.1.3.0/24 MgmtEth 0/RP0/OSC3/0 10.1.3.2
exit

```

Configure OSPF Routes

configure

router ospf *process-id*

router-id *ip-address*

area *area-id*

exit

Example

The following is a sample of configuring OSPF routes.

```

configure
interface MgmtEth0/RP0/CPU0/0
  ipv4 address 10.1.1.2 255.255.255.0
!
interface MgmtEth0/RP0/OSC1/0
  shutdown
!
interface MgmtEth0/RP0/OSC2/0
  ipv4 address 10.1.3.2 255.255.255.0
!
interface MgmtEth0/RP0/OSC3/0
  ipv4 address 10.1.4.2 255.255.255.0
!
router ospf remote
router-id 10.1.1.2
area 0
  interface MgmtEth0/RP0/CPU0/0
    passive enable
  !
  interface MgmtEth0/RP0/OSC2/0
  !
  interface MgmtEth0/RP0/OSC3/0
  !
!
!
end

```

Verify OSPF Routing Table

RP/0/RP0/CPU0:ios# **show ospf routes**

Sat Jul 29 09:54:25.937 UTC

Topology Table for ospf local with ID 10.1.4.1

```

Codes: O - Intra area, O IA - Inter area
       O E1 - External type 1, O E2 - External type 2
       O N1 - NSSA external type 1, O N2 - NSSA external type 2

O 10.1.1.0/24, metric 1
   10.1.1.2, directly connected, via MgmtEth0/RP0/CPU0/0
O 10.1.3.0/24, metric 1
   10.1.3.2, directly connected, via MgmtEth0/RP0/OSC2/0
O 10.1.7.0/24, metric 2
   10.1.3.1, from 10.58.227.198, via MgmtEth0/RP0/OSC2/0
O 10.58.227.0/24, metric 1
   10.1.3.1, from 10.58.227.198, via MgmtEth0/RP0/OSC2/0

```

Troubleshooting Network Issues

Troubleshooting must be performed by checking the status of the interfaces, subnets, static routing, and OSPF sections.

Problem	Command
Interfaces are in down state	show interfaces MgmtEth <i>rack/slot/instance/port</i>
Route to default gateway is not defined	show running-config
Wrong IP addresses or subnet are planned in design phase	show running-config
Wrong static routes are defined that overwrite OSPF routes	Compare the output of show ip route command with show ospf routes command
Interfaces are not added in the OSPF section configured	show running-config
Interfaces are in passive mode in the OSPF section configured	show running-config

