



# Raman Tuning

This chapter describes the Raman tuning optical application for Cisco .

Table 1: Feature History

Feature Name	Release Information	Description
Raman Tuning Manual Mode	Cisco IOS XR Release 7.11.1	You can now configure Raman Tuning in manual mode to not initiate tuning automatically. You can initiate tuning manually. This feature gives you the flexibility to initiate tuning and not have Raman Tuning run every time there is a span-up event in the network.

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## Raman tuning

Raman tuning involves adjusting the power and wavelength of Raman pump lasers to optimize the amplification of optical signals traveling through an optical fiber.

### Purpose of Raman tuning

The primary goal of Raman tuning is to achieve the desired Raman Gain over a specific span of optical fiber, ensuring optimal signal performance.

The process of Raman tuning involves specific steps to ensure optimal signal amplification:

- Raman tuning is performed independently in both directions of the span at the node level.

- Communication between peer nodes is required to coordinate the tuning process and achieve the desired gain over the optical fiber span.

### Automatic Raman tuning

When Raman tuning is set to automatic mode, the NCS 1010 autonomously initiates the Raman tuning process under specific conditions to ensure optimal signal amplification.

### Conditions that trigger automatic Raman tuning

The NCS 1010 performs automatic Raman tuning in these scenarios:

- After an initial link bring-up for the first time.
- After a fiber cut.
- After a device undergoes a power cycle event.
- After a line card undergoes a cold reload.
- During a Distributed Feedback (DFB) shut or unshut event.
- After an OTS controller is shut or unshut on either the near-end or far-end node.
- After the span length configuration is modified.
- After high Back Reflection is cleared and returns to acceptable levels.
- During a span loss check at system startup.

## Raman tuning parameters

The Raman tuning algorithm uses Target Raman Gain, Raman Pump Powers, and DFB VOA Attenuation to optimize Raman amplifier performance in optical fiber communication systems.

This table provides an overview of the Raman tuning parameters in signal amplification.

**Table 2: Raman Tuning Parameters**

Raman Tuning Parameters	Description	Usage
Target Raman Gain (dB)	It is the desired level of amplification the Raman amplifier aims to achieve. This gain is the increase in optical signal power resulting from Raman scattering when the signal passes through the medium with co-propagating or counter-propagating pump lasers.	The desired Raman gain is typically used for compensating for signal losses in the optical fiber, ensuring signal integrity and strength over long distances.

Raman Tuning Parameters	Description	Usage
Raman Pump Powers (mW)	<p>It is the power levels of the Raman pump lasers used in the Raman amplification process.</p> <p>Higher pump power results in a higher gain but also increases the risk of fiber damage.</p>	The power from Raman pumps is used to inject laser at specific wavelengths into the fiber, which then interacts with the signal through the Raman scattering effect to amplify it.
DFB VOA Attenuation (dB)	<p>It is the attenuation settings of the Variable Optical Attenuator (VOA) used with Distributed Feedback (DFB) lasers.</p> <p>DFB lasers provide high-precision, stable-wavelength light emission, commonly used in telecommunications.</p>	<p>DFB VOA attenuation is used to fine-tune the signal power levels to ensure the amplified signal meets the target gain requirements.</p> <p>Adjusting the attenuation helps balance the pump power and signal power.</p>

## Raman tuning modes

Raman tuning in NCS 1010 can be performed through various modes, each offering different levels of control and automation.

The table provides an overview of the modes in which Raman tuning can be configured.

**Table 3: Raman tuning modes**

Raman tuning modes	Description
Enable (Automatic mode)	<p>In this mode, the system automatically initiates Raman tuning when a link goes down and comes back up. Raman tuning calculates and sets the values of the following parameters automatically:</p> <ul style="list-style-type: none"> <li>• Raman target gain</li> <li>• Raman power</li> <li>• DFB VOA attenuation</li> </ul> <p>However, this mode also allows you to manually set the target gain, which triggers Raman tuning to adjust pump powers and DFB VOA attenuation values to achieve the target gain.</p> <p>For more details about the conditions that trigger Raman tuning automatically, see <a href="#">Raman Tuning Initiation Conditions, on page 4</a>.</p>

Raman tuning modes	Description
Disable	<p>In this mode, you must manually set the values <a href="#">Raman tuning parameters</a>. After configuring these values, you must manually initiate Raman tuning.</p> <p>It may be necessary to manually configure these parameters to troubleshoot network issues or fine-tune the system for improved performance.</p>
Manual	<p>In this mode, Raman tuning must be manually initiated when a link goes down and comes back up.</p> <p>Once initiated, the system automatically calculates the desired gain and adjusts both pump powers and DFB VOA attenuation to achieve the specified target gain.</p>

## Raman Tuning Initiation Conditions

When Raman tuning is set to automatic mode, the NCS 1010 automatically initiates Raman tuning after:

- an initial link bring up for the first time
- after a fiber cut
- a device undergoes a power cycle event
- a line card undergoes a cold reload
- a Distributed Feedback (DFB) shut or unshut event
- an OTS controller shut or unshut event on either the near-end or far-end node
- a modification in the span length configuration
- a high Back Reflection is cleared and returns to acceptable levels, and
- a span loss check at system start up.

## Raman tuning status

The Raman tuning status shows whether the system is measuring, calculating, optimizing, or has completed the tuning. It also indicates any conditions that prevent tuning.

This table describes the various Raman tuning status:

**Table 4: Raman tuning status**

Raman Tuning Status	Description
WORKING—MEASUREMENT	Raman tuning is measuring the span loss on the link.
WORKING—CALCULATION	Raman tuning is calculating the gain target and required pump powers.

Raman Tuning Status	Description
WORKING—OPTIMIZATION	Raman tuning is optimizing the pump powers.
TUNED	Raman tuning is complete.
BLOCKED	The system cannot perform Raman tuning because the link is down or there is a high Raman Back Reflection.
DISABLED	Raman tuning is disabled.

## Configure Raman Tuning in Automatic or Manual Mode

Configuring Raman Tuning in automatic or manual mode allows you to choose how Raman tuning is applied in your network. In automatic mode, the system automatically triggers Raman tuning and adjusts its parameters. In manual mode, you must manually initiate Raman tuning, while the system still automatically adjusts the parameters.

Use this task to configure Raman tuning in automatic or manual mode on a NCS 1010 node.

### Procedure

**Step 1** Select the controller on which Raman tuning needs to be enabled after entering into the optical applications configuration mode.

**Example:**

```
RP/0/RP0/CPU0:ios(config)#optical-line-control
RP/0/RP0/CPU0:ios(config-olc)#controller ots 0/0/0/0
```

**Step 2** Enable Raman tuning in the automatic or manual mode.

**raman-tuning {enable | manual}**

**Step 3** Commit the changes and exit the optical applications and configuration modes.

**Example:**

```
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#exit
RP/0/RP0/CPU0:ios(config-olc-ots)#exit
```

**Step 4** Initiate Raman tuning if it is configured in the *Manual* mode.

**Example:**

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

When configured in automatic mode, Raman tuning starts automatically. Once Raman tuning is completed successfully, certain actions such as soft reloads, Route Processor (RP) reloads, changes to the Raman OSRI settings, and forced Automatic Power Reduction (APR) changes do not cause the Raman tuning process to be retrIGGERED. This means that the tuning settings are retained through these events.

# Manually configure Raman tuning parameters

Manually configuring Raman tuning parameters allows you to troubleshoot network issues or optimize system performance by directly adjusting key settings. To configure Raman tuning parameters manually, disable Raman tuning and then configure the required parameters.

Follow these steps to manually configure Raman tuning parameters on a NCS 1010 node.

## Procedure

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- Step 1** Select the controller on which Raman tuning needs to be enabled after entering into the optical applications configuration mode.
- optical-line-control**  
**controller ots R/S/I/P**
- Step 2** Disable Raman tuning.
- raman-tuning** *disable*
- Step 3** Configure the Raman tuning parameters: Raman gain target, pump powers, and DFB VOA attenuation.
- raman-tuning { raman-gain-target } value**  
**raman-tx-power pump pump value value**
- Step 4** Commit the changes and exit the optical applications and other configuration modes.
- commit**  
**exit**
- Step 5** Initiate Raman tuning if configured in the *manual* mode.
- olc start-raman-tuning controller ots R/S/I/P**
- 

## Example

```
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)#raman-tx-power 1 value 21100
RP/0/RP0/CPU0:ios(config-olc)#controller DFB 0/0/0/0
RP/0/RP0/CPU0:ios(config-Dfb)#tx-voa-attenuation 100
RP/0/RP0/CPU0:ios(config-olc-ots)#commit
RP/0/RP0/CPU0:ios(config-olc-ots)#exit
RP/0/RP0/CPU0:ios(config-olc-ots)#exit
RP/0/RP0/CPU0:ios#olc start-raman-tuning controller ots 0/0/0/0
```

# Verify Raman Tuning Configuration

Use this task to verify the Raman tuning status to check the current state of the Raman tuning process and the values of its parameters.

## Procedure

Verify the Raman tuning status.

The entries highlighted in bold show the status of Raman tuning and the Raman tuning parameter values.

### Example:

```
/*Verify Raman tuning status if All Controllers*/
RP/0/RP0/CPU0:ios#show 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

/*Verify Raman tuning status on a specific controller*/
RP/0/RP0/CPU0:ios#show 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
```

For more details about the Raman tuning status, see [Raman tuning status, on page 4](#), and for details about Raman tuning parameters, see [Raman tuning parameters, on page 2](#).

# View Detailed Raman Tuning Status

Use this task to view the detailed Raman tuning status, such as:

- Last Run Fail Reason
- Last Run Fail Timestamp
- Last Successful Tuning Gain
- Last Successful Tuning Timestamp

## Procedure

View the detailed status of Raman tuning.

The entries highlighted in bold show the previous Raman tuning fail reason and timestamps.

### Example:

```
/*View Detailed Raman tuning status of all controllers*/
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

/*View Raman tuning status of a specific controller*
/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
```

# View Individual Raman Pump Values

Use this task to view the individual Raman pump values and other parameter details, including the status of safety lock and OSRI.

Use this task to view the individual Raman pump values and other parameter details:

- Raman parameter status
- Raman pump details
- Raman configured parameters status

## Procedure

View the Raman pump values.

The entries highlighted in bold show the status of Raman tuning parameters and the values of Raman pump power.

### Example:

```
/*View Raman pump values and other parameter details*/

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

## Raman Tuning and OTDR Lock and OSRI

**Table 5: 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>

**Table 6: 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>
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>

### Concurrent Operation of OTDR and Raman Tuning

The OTDR Lock prohibits the concurrent operation of Optical Time-Domain Reflectometer (OTDR) scanning and Raman tuning on a single fiber. This ensures that the Raman pump lasers do not interfere with the OTDR measurements during the tuning process, which could introduce noise and affect the accuracy of the OTDR measurements.

To address this limitation, Raman tuning locks OTDR at both ends of the fiber before the tuning process starts and then releases the lock after the tuning is complete. If Raman tuning is in progress, any request to start an OTDR scan is rejected.

When the OTDR scan is in progress, these conditions apply.

- Any lock requested by Raman tuning is rejected and Raman tuning retries every minute to acquire the OTDR lock.
- The Raman tuning only starts once the OTDR lock is acquired at both ends of the fiber.

For more details about initiating OTDR, see [Configure OTDR](#).

### Raman Tuning with OSRI

Raman tuning is a sensitive operation that requires careful handling to avoid disrupting service and to maintain network integrity. Optical Safety Remote Interlock (OSRI) feature is used to safely disable the amplifier on the corresponding node (peer node) during the Raman tuning process. This is done to prevent any accidental exposure to high-power laser light.



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**Note** While Raman tuning is underway and traffic is blocked, only the OSC remains active.

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At the transmission end of the span, a dedicated Raman probe laser, typically a distributed feedback (DFB) laser operating at a specific frequency (e.g., 191.1 THz), is combined with the outgoing optical channels. This DFB laser serves as a continuity check to ensure optical safety during the Raman tuning process.

At the receiving end, several wavelengths in the range of 1424 nm to 1495 nm are injected in the direction opposite to the signal propagation. These wavelengths are used to provide Raman amplification for both C-band and L-band optical channels.

