CHAPTER 6

Network Applications

This chapter describes Cisco ONS 15454 DWDM networks and includes the following sections:

6.1 Network Topology Discovery

Each ONS 15454 DWDM node has a network topology discovery function that can:

- Identify other ONS 15454 DWDM nodes in an ONS 15454 DWDM network.
- Identify the different types of DWDM networks.
- Identify when the DWDM network is complete and when it is incomplete.

ONS 15454 DWDM nodes use node services protocol (NSP) to update nodes automatically whenever a change in the network occurs. NSP uses two information exchange mechanisms: hop-by-hop message protocol and broadcast message protocol. Hop-by-hop message protocol elects a master node and exchanges information between nodes in a sequential manner, which instigates a token ring protocol. In a token ring protocol:

- Each node that receives a hop-by-hop message passes it to the next site according to the ring topology and the line direction from which the token was received.
- The message originator always receives the token after it has been sent over the network.
- Only one hop-by-hop message can run on the network at any one time.

NSP broadcast message protocol distributes information that can be shared by all ONS 15454 DWDM nodes on the same network. Broadcast message delivery is managed independently from delivery of the two tokens. Moreover, no synchronization among broadcast messages is required; every node is authorized to send a broadcast message any time it is necessary.

6.2 Automatic Power Control

The ONS 15454 automatic power control (APC) feature performs the following functions:

- Maintains constant per-channel power when changes to the number of channels occur.
- Compensates for optical network degradation (aging effects).
- Simplifies the installation and upgrade of DWDM optical networks by automatically calculating the amplifier setpoints.

Note APC functions are performed by software algorithms on the OPT-BST, OPT-PRE, and TCC2/TCC2P cards.

Amplifier software uses a gain control loop with fast transient suppression to keep the channel power constant regardless of any changes in the number of channels. Amplifiers monitor the changes to the input power and change the output power according to the calculated gain setpoint. The shelf controller software emulates the output power control loop to adjust for fiber degradation. To perform this function, the TCC2 or TCC2P (shelf controller) card needs the channel distribution, which is provided by a signaling protocol, and the expected per-channel power, which you can provision. The TCC2/TCC2P card compares the actual amplifier output power with the expected amplifier output power and modifies the setpoints if any discrepancies occur.

6.2.1 APC at the Amplifier Card Level

In constant gain mode, the amplifier power out control loop performs the following input and output power calculations, where “G” represents gain and “t” represents time.

Pout (t) = G * Pin (t) (mW)

Pout (t) = G + Pin (t) (dB)

In a power-equalized optical system, the total input power is proportional to the number of channels. The amplifier software compensates for any variation of the input power due to changes in the number of channels carried by the incoming signal.

Amplifier software identifies changes in the read input power in two different instances, t1 and t2, as a change in the carried traffic. The letters *m* and *n* in the following formula represent two different channel numbers. Pin/ch represents the per-channel input power:

Pin (t1)= nPin/ch

Pin (t2) = mPin/ch

Amplifier software applies the variation in the input power to the output power with a reaction time that is a fraction of a millisecond. This keeps the power constant on each channel at the output amplifier, even during a channel upgrade or a fiber cut.

Amplifier parameters are configured using east and west conventions for ease of use. Selecting “west” provisions parameters for the preamplifier receiving from the west and the booster amplifier transmitting to the west. Selecting “east” provisions parameters for the preamplifier receiving from the east and the booster amplifier transmitting to the east.

Starting from the expected per-channel power, the amplifiers automatically calculate the gain setpoint after the first channel is provisioned. An amplifier gain setpoint is calculated in order to make it equal to the loss of the span preceding the amplifier. After the gain is calculated, the setpoint is no longer changed by the amplifier. Amplifier gain is recalculated every time the number of provisioned channels returns to zero. If you need to force a recalculation of the gain, move the number of channels back to zero.

6.2.2 APC at the Node and Network Levels

The amplifier adjusts the gain to compensate for span loss. Span loss can change due to aging fiber and components, or to changes in operating conditions. To correct the gain or express variable optical attenuator (VOA) setpoints, APC calculates the difference between the power value read by the photodiodes and the expected power value. The expected power values are calculated using:

- Provisioned per-channel power value
- Channel distribution (the number of express, add, and drop channels in the node)
- Amplified spontaneous emission (ASE) estimation

Channel distribution is determined by the sum of the provisioned and failed channels. Information about provisioned wavelengths is sent to APC on the applicable nodes during circuit creation. Information about failed channels is collected through a signaling protocol that monitors alarms on ports in the applicable nodes and distributes that information to all the other nodes in the network.

ASE calculations purify the noise from the power level reported from the photodiode. Each amplifier can compensate for its own noise, but cascaded amplifiers cannot compensate for ASE generated by preceding nodes. The ASE effect increases when the number of channels decreases; therefore, a correction factor must be calculated in each amplifier of the ring to compensate for ASE build-up.

APC is a network-level feature. The APC algorithm designates a master node that is responsible for starting APC hourly or every time a new circuit is provisioned or removed. Every time the master node signals for APC to start, gain and VOA setpoints are evaluated on all nodes in the network. If corrections are needed in different nodes, they are always performed sequentially following the optical paths starting from the master node.

APC corrects the power level only if the variation exceeds the hysteresis thresholds of +/– 0.5 dB. Any power level fluctuation within the threshold range is skipped because it is considered negligible. Because APC is designed to follow slow time events, it skips corrections greater than 3 dB. This is the typical total aging margin that is provisioned during the network design phase. After you provision the first channel or the amplifiers are turned up for the first time, APC does not apply the 3 dB rule. In this case, APC corrects all the power differences to turn up the node.

Note Software Release 7.x does not report corrections that are not performed and exceed the 3 dB correction factor to Cisco Transport Controller (CTC), Cisco Transport Manager (CTM), and Transaction Language One (TL1) management interfaces.

To avoid large power fluctuations, APC adjusts power levels incrementally. The maximum power correction is +/– 0.5 dB. This is applied to each iteration until the optimal power level is reached. For example, a gain deviation of 2 dB is corrected in four steps. Each of the four steps requires a complete APC check on every node in the network. APC can correct up to a maximum of 3 dB on an hourly basis. If degradation occurs over a longer time period, APC will compensate for it by using all margins that you provision during installation.

When no margin is available, adjustments cannot be made because setpoints exceed ranges. APC communicates the event to CTC, CTM, and TL1 through an APC Fail condition. APC will clear the APC fail condition when the setpoints return to the allowed ranges.

APC automatically disables itself when:

- A HW FAIL alarm is raised by any card in any of the network nodes.
- A Mismatch Equipment Alarm (MEA) is raised by any card in any of the network nodes.
- An Improper Removal (IMPROPRMVL) alarm is raised by any card in any of the network nodes.
- Gain Degrade (GAIN-HDEG), Power Degrade (OPWR-HDEG), and Power Fail (PWR-FAIL) alarms are raised by the output port of any amplifier card in any of the network nodes.
- A VOA degrade or fail alarm is raised by any of the cards in any of the network nodes.

The APC state (Enable/Disable) is located on every node and can be retrieved by the CTC or TL1 interfaces. If an event that disables APC occurs in one of the network nodes, APC is disabled on all the others and the APC state changes to DISABLE - INTERNAL. The disabled state is raised only by the node where the problem occurred to simplify troubleshooting.

APC raises the following standing conditions at the port level in CTC, TL1, and Simple Network Management Protocol (SNMP):

- APC Out of Range—APC cannot assign a new setpoint for a parameter that is allocated to a port because the new setpoint exceeds the parameter range.
- APC Correction Skipped—APC skipped a correction to one parameter allocated to a port because the difference between the expected and current values exceeds the +/– 3 dB security range.

After the error condition is cleared, signaling protocol enables APC on the network and the APC DISABLE - INTERNAL condition is cleared. Because APC is required after channel provisioning to compensate for ASE effects, all optical channel network connection (OCHNC) and optical channel client connection (OCHCC) circuits that you provision during the disabled APC state are kept in the Out-of-Service and Autonomous, Automatic In-Service (OOS-AU,AINS) (ANSI) or Unlocked-disabled,automaticInService (ETSI) service state until APC is enabled. OCHNCs and OCHCCs automatically go into the In-Service and Normal (IS-NR) (ANSI) or Unlocked-enabled (ETSI) service state only after APC is enabled.

6.2.3 Managing APC

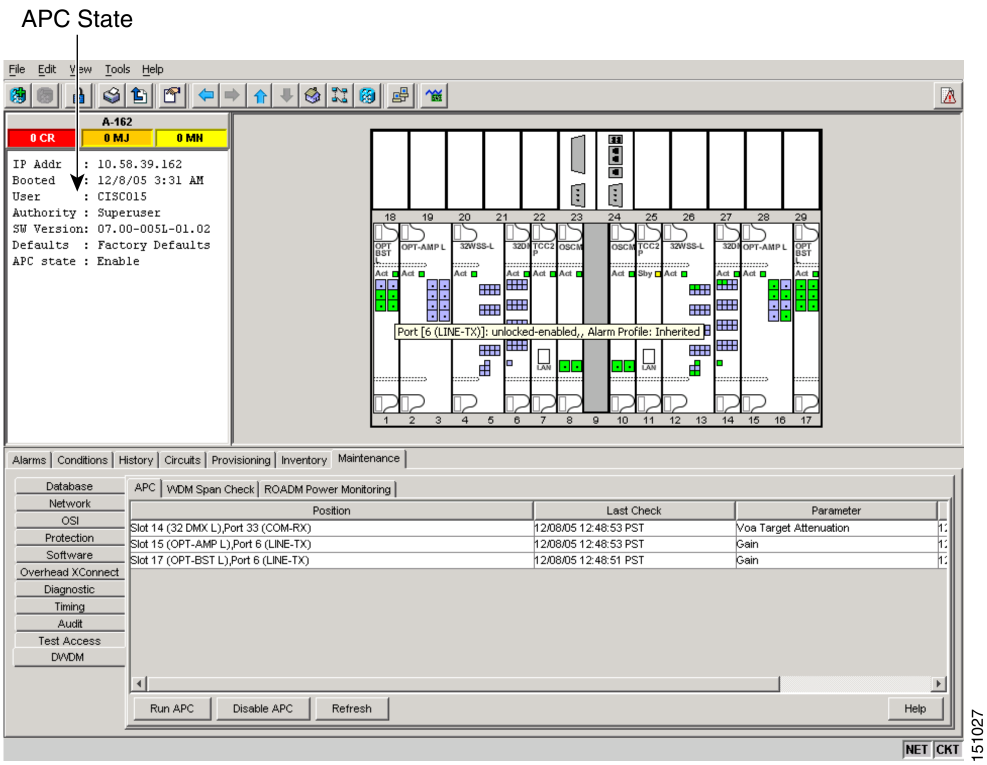
The automatic power control status is indicated by four APC states shown in the node view status area:

- Enable—APC is enabled.
- Disable - Internal—APC has been automatically disabled for an internal cause.
- Disable - User—APC was disabled manually by a user.
- Not Applicable—The node is provisioned to Metro Access or Not DWDM, which do not support APC.

You can view the automatic power control information and disable and enable APC manually on the Maintenance > DWDM > APC tab (Figure 6-1).

Caution When APC is disabled, aging compensation is not applied and circuits cannot be activated. Do not disable APC unless it is required for specific maintenance or troubleshooting tasks. Always enable APC as soon as the tasks are completed.

Figure 6-1 Automatic Power Control



The APC subtab provides the following information:

- Slot ID—The ONS 15454 slot number for which APC information is shown is listed in the Position column.
- Port—The port number for which APC information is shown is listed in the Position column.
- Card—The card for which APC information is shown is listed in the Position column.
- Last Modification—Date and time that APC last modified a setpoint for the parameters shown in Table 6-1.
- Last Check—Date and time that APC last verified the setpoints for the parameters shown in Table 6-1.

Table 6-1 APC-Managed Parameters

Card	**Port**	**Parameters**
OPT-BST	LINE-3-TX	• Gain • Total Signal Output Power
OPT-PRE	LINE-1-TX	• Gain • Total Signal Output Power
AD-xB-xx.x	LINE-1-TX BAND-n[1]-TX	VOA Target Attenuation

Table 6-1 APC-Managed Parameters (continued)

Card	Port	Parameters
AD-1C-xx.x AD-2C-xx.x	LINE-1-TX	VOA Target Attenuation
AD-4C-xx.x	LINE-1-TX CHAN-*n*[2]-TX	VOA Target Attenuation
32DMX	LINE-1-TX	VOA Target Attenuation

1. n = 1–8
2. n = 1–32

6.3 ROADM Power Equalization Monitoring

Reconfigurable optical add/drop multiplexing (ROADM) nodes allow you to monitor the 32WSS card equalization functions on the Maintenance > DWDM > Power Monitoring tab (Figure 6-2). The tab shows the input channel power (Padd), the express or pass-through (Ppt) power, and the power level at output (Pout).

Figure 6-2 Power Monitoring Subtab

6.4 Span Loss Verification

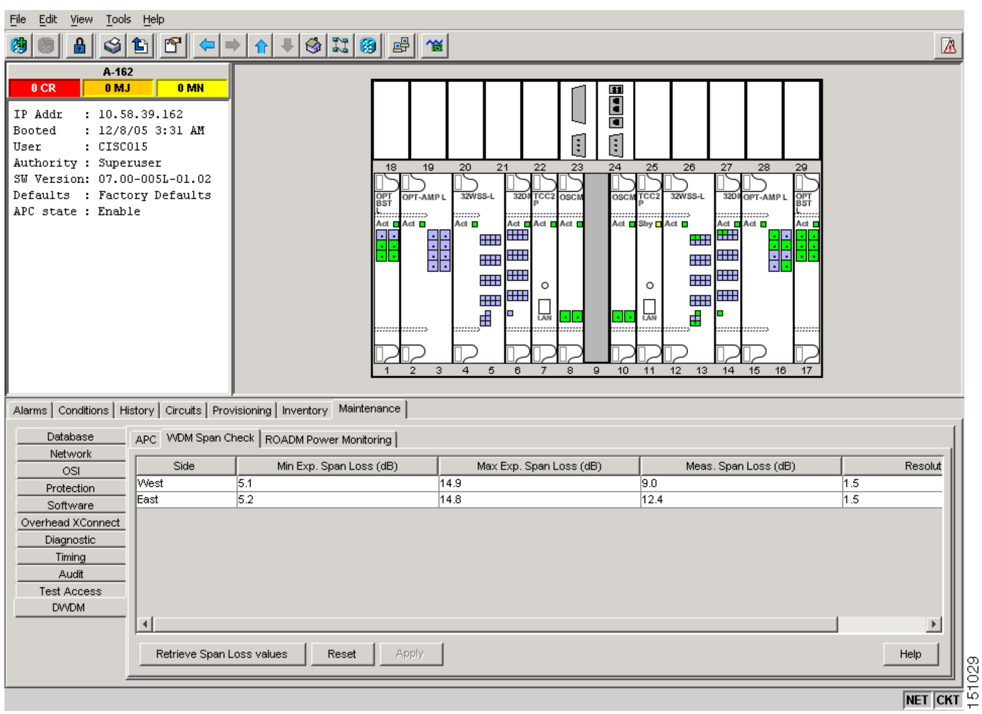
Span loss measurements can be performed from the Maintenance > DWDM > WDM Span Check tab (Figure 6-3). The CTC span check compares the far-end optical service channel (OSC) power with the near-end OSC power. A Span Loss Out of Range condition is raised when the measured span loss is higher than the maximum expected span loss. It is also raised when the measured span loss is lower than the minimum expected span loss and the difference between the minimum and maximum span loss values is greater than 1 dB. The minimum and maximum expected span loss values are calculated by Cisco MetroPlanner for the network and imported into CTC. However, you can manually change the minimum and expected span loss values.

CTC span loss measurements provide a quick span loss check and are useful whenever changes to the network occur, for example after you install equipment or repair a broken fiber. CTC span loss measurement resolutions are:

- +/– 1.5 dB for measured span losses between 0 and 25 dB
- +/– 2.5 dB for measured span losses between 25 and 38 dB

For ONS 15454 span loss measurements with higher resolutions, an optical time domain reflectometer (OTDR) must be used.

Figure 6-3 Span Loss Verification



6.5 Network Optical Safety—Automatic Laser Shutdown

Automatic laser shutdown (ALS) is a key component of the DWDM network optical safety. If a fiber break occurs on the network, ALS automatically shuts down the OSCM and OSC-CSM OSC laser output power and the optical amplifiers contained in the OPT-BST cards. The card-level, Maintenance > ALS subtab provides the following ALS management options for OSCM, OSC-CSM, and OPT-BST cards:

- Disable—ALS is off. The OSC laser transmitter and optical amplifiers are not automatically shut down when a traffic outage loss of signal (LOS) occurs.
- Auto Restart—ALS is on. The OSC laser transmitter and optical amplifiers automatically shut down when traffic outages (LOS) occur. The laser automatically restarts when the conditions that caused the outage are resolved.

Note Auto Restart is the default ALS provisioning for OSCM, OSC-CSM, and OPT-BST cards.

- Manual Restart—ALS is on. The OSC laser transmitter and optical amplifiers automatically shut down when traffic outages (LOS) occur. However, the laser must be manually restarted when conditions that caused the outage are resolved.
- Manual Restart for Test—Manually restarts the OSC laser transmitter and optical amplifiers for testing.

A network optical safety strategy is achieved through the ALS settings on the OPT-BST, OSCM, and OSC-CSM cards. When ALS is enabled on these cards, a network safety mechanism goes into effect in the event of a system failure. However, ALS is also provided on the transponder (TXP) and muxponder (MXP) cards. As long as a network uses OPT-BST, OSCM, and OSC-CSM cards and ALS is enabled on them, ALS does not need to be enabled on the TXPs or MXPs; in fact, ALS is disabled on TXP and MXP by default, and the network optical safety is not impacted.

However, if TXPs and MXPs are connected directly to each other without passing through a DWDM layer, ALS should be enabled on them. The ALS protocol goes into effect when a fiber is cut, enabling some degree of network point-to-point bidirectional traffic management between those cards.

In addition, if ALS is disabled on the DWDM network (ALS is disabled on the OPT-BST, OSCM, and OSC-CSM cards), ALS can be enabled on the TXP and MXP cards to provide some laser management in the event of a fiber break in the network between the cards.

6.5.1 Automatic Power Reduction

Automatic power reduction (APR) is controlled by the software and is not user configurable. During amplifier restart after a system failure, the amplifier (OPT-BST, for example) operates in pulse mode and an automatic power reduction level is activated so that the Hazard Level 1 power limit is not exceeded. This is done to ensure personnel safety.

When a system failure occurs (cut fiber or equipment failure, for example) and ALS Auto Restart is enabled, a sequence of events is placed in motion to shut down the amplifier laser power, then automatically restart the amplifier after the system problem is corrected. As soon as a loss of optical payload and OSC is detected at the far end, the far-end amplifier shuts down. The near-end amplifier then shuts down because in similar fashion, it detects a loss of payload and OSC due to the far-end amplifier shutdown. At this point, the near end attempts to establish communication to the far end using the OSC laser transmitter. To do this, the OSC emits a two-second pulse at very low power (maximum of 0 dB) and waits for a similar two-second pulse in response from the far-end OSC laser transmitter. If no response is received within 100 seconds, the near end tries again. This process continues until the near end receives a two-second response pulse from the far end. This is an indication that the system failure has been corrected and that there is full continuity in the fiber between the two ends.

After the OSC communication has been established, the near-end amplifier is configured by the software to operate in pulse mode at a reduced power level. It emits a nine-second laser pulse with an automatic power reduction to +8 dB. This level assures that Hazard Level 1 is not exceeded, for personnel safety, even though the establishment of successful OCS communication has assured that any broken fiber has been fixed. If the far-end amplifier responds with a nine-second pulse within 100 seconds, both amplifiers are changed from pulse mode at reduced power to normal operating power mode.

For a direct connection between TXP or MXP cards, when ALS Auto Restart is enabled and the connections do not pass through a DWDM layer, a similar process takes place. However, because the connections do not go through any amplifier or OSC cards, the TXP or MXP cards attempt to establish communication directly between themselves after a system failure. This is done using a two-second restart pulse, in a manner similar to that previously described between OSCs at the DWDM layer. The power emitted during the pulse is below Hazard Level 1.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.** Statement 1056

Note If you must disable ALS, ensure that all fibers are installed in a restricted location. Enable ALS immediately after finishing the maintenance or installation process.

6.5.2 Fiber Cut Scenarios

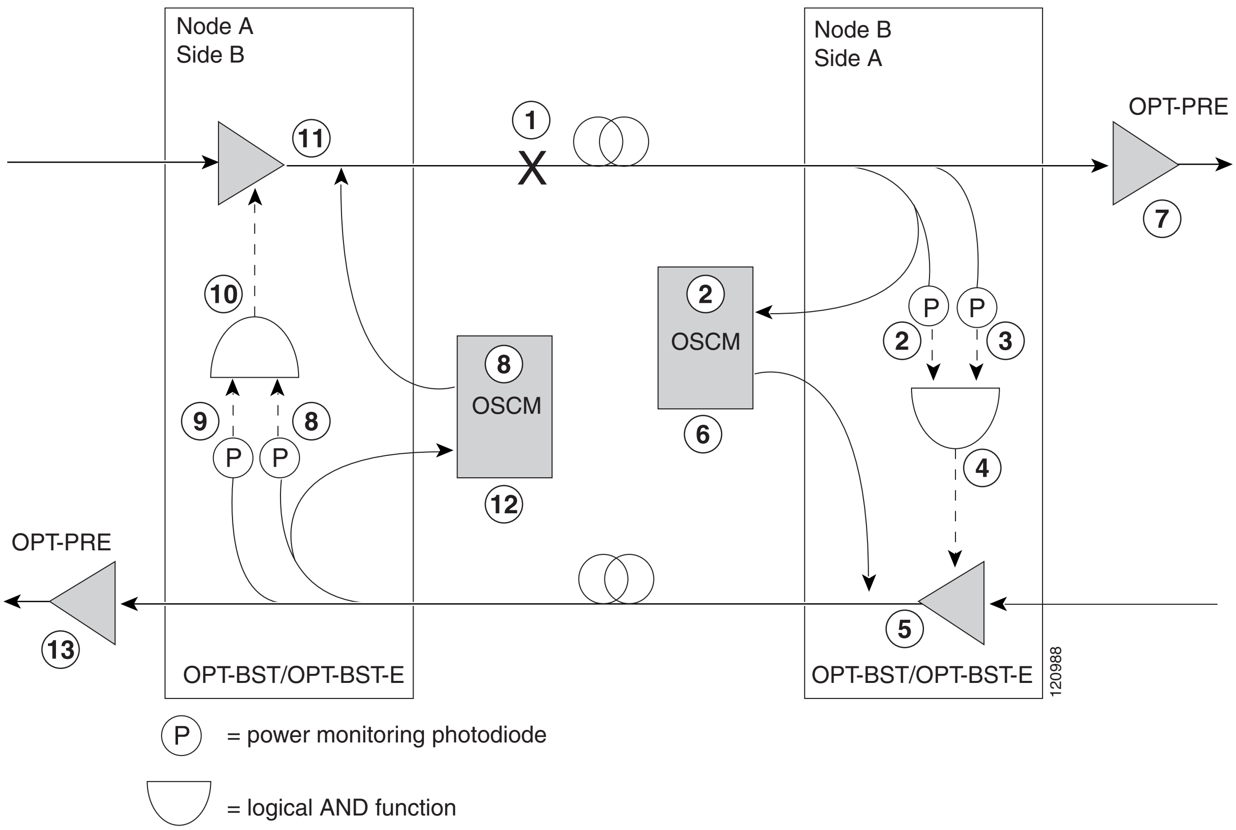
In the following paragraphs, four ALS scenarios are given:

- Nodes using OPT-BST/OPT-BST-E cards (amplified nodes)
- Nodes using OSC-CSM cards (passive nodes)
- Nodes using OPT-BST-L cards (amplified nodes)
- Nodes using OPT-AMP-L cards (amplified nodes)

6.5.2.1 Scenario 1: Fiber Cut in Nodes Using OPT-BST/OPT-BST-E Cards

Figure 6-4 shows nodes using OPT-BST/OPT-BST-E cards with a fiber cut between them.

Figure 6-4 Nodes Using OPT-BST/OPT-BST-E Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-BST/OPT-BST-E transmitter, OPT-PRE transmitter, and OSCM lasers to shut down. This in turn leads to a LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM, OPT-PRE transmitter, and OPT-BST/OPT-BST-E transmitter lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 6-4):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects a Loss of Incoming Overhead (LOS-O) on the OPT-BST/OPT-BST-E card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. The Node B power monitoring photodiode detects a Loss of Incoming Payload (LOS-P) on the OPT-BST/OPT-BST-E card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. On the OPT-BST/OPT-BST-E card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
5. The OPT-BST/OPT-BST-E card amplifier is shut down within three seconds.
6. The OSCM laser is shut down.
7. The OPT-PRE card automatically shuts down due to a loss of incoming optical power.

8. The Node A power monitoring photodiode detects a LOS-O on the OPT-BST/OPT-BST-E card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. The Node A power monitoring photodiode detects a LOS-P on the OPT-BST/OPT-BST-E card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. On the OPT-BST/OPT-BST-E, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
11. The OPT-BST/OPT-BST-E card amplifier is shut down within three seconds.
12. The OSCM laser is shut down.
13. The Node A OPT-PRE card automatically shuts down due to a loss of incoming optical power.

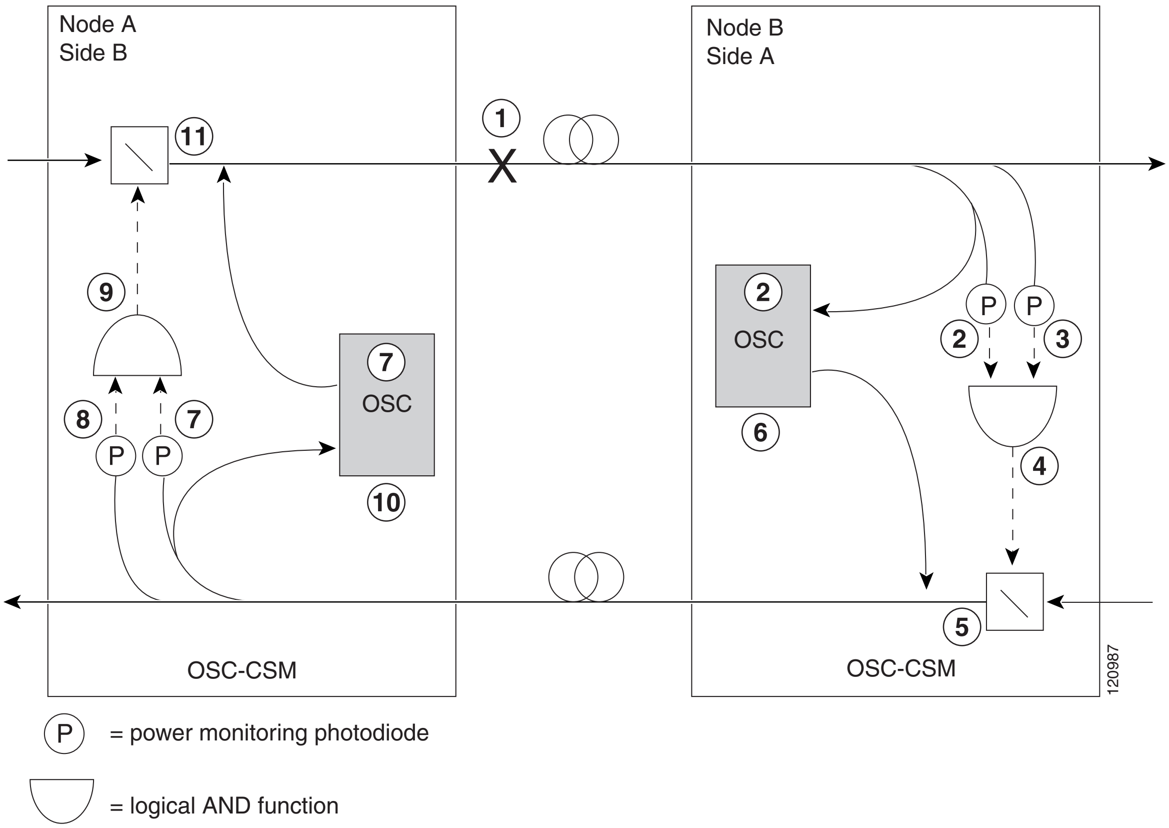
When the fiber is repaired, either an automatic or manual restart at the Node A OPT-BST/OPT-BST-E transmitter or at the Node B OPT-BST/OPT-BST-E transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse is used to signal that the optical path has been restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST/OPT-BST-E transmitter to begin transmitting an optical signal. The OPT-BST/OPT-BST-E receiver at Node A receives that signal and signals the Node A OPT-BST/OPT-BST-E transmitter to resume transmitting.

Note During a laser restart pulse, APR (see the "6.5.1 Automatic Power Reduction" section on page 6-8) ensures that the laser power does not exceed Class 1 limits.

6.5.2.2 Scenario 2: Fiber Cut in Nodes Using OSC-CSM Cards

Figure 6-5 shows nodes using OSC-CSM cards with a fiber cut between them.

Figure 6-5 Nodes Using OSC-CSM Cards



Two photodiodes at the Node B OSC-CSM card monitor the received signal strength for the received optical payload and OSC signals. When the fiber is cut, LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the Node B OSC laser to shut down and the optical switch to block traffic. This in turn leads to LOS for both the optical payload and OSC signals at Node A, which causes Node A to turn off the OSC laser and the optical switch to block outgoing traffic. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 6-5):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects a LOS-O on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. The Node B power monitoring photodiode detects a LOS-P on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. On the OSC-CSM, the simultaneous LOS-O and LOS-P detection triggers a change in the position of the optical switch. CTC reports a LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
5. The optical switch blocks outgoing traffic.
6. The OSC laser is shut down.
7. The Node A power monitoring photodiode detects a LOS-O on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
8. The Node A power monitoring photodiode detects a LOS-P on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

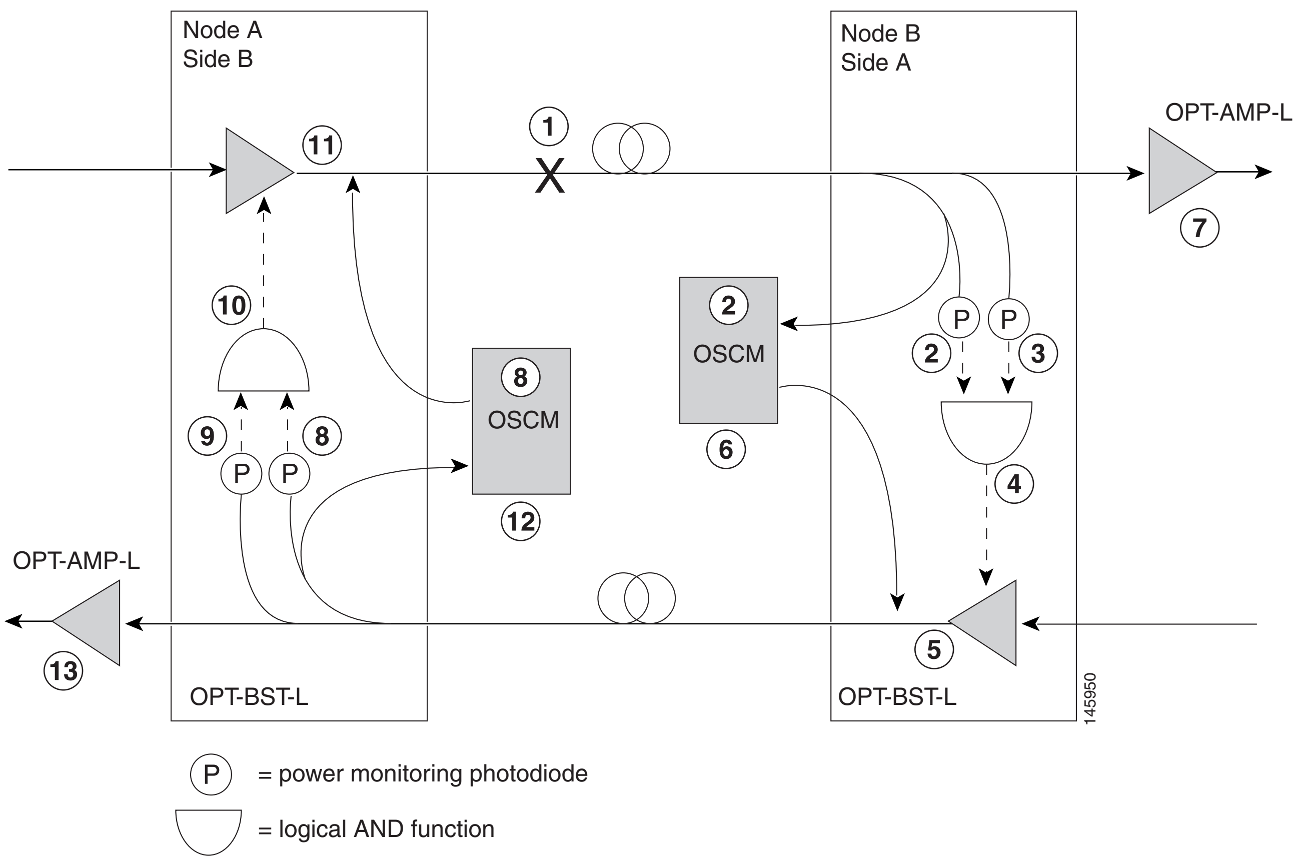
9. On the OSC-CSM, the simultaneous LOS-O and LOS-P detection triggers a change in the position of the optical switch. CTC reports a LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. The OSC laser is shut down.
11. The optical switch blocks outgoing traffic.

When the fiber is repaired, either an automatic or manual restart at the Node A OSC-CSM OSC or at the Node B OSC-CSM OSC is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse is used to signal that the optical path has been restored and transmission can begin. For example, when the far-end Node B receives a pulse, it signals to the Node B OSC to begin transmitting its optical signal and for the optical switch to pass incoming traffic. The OSC-CSM at Node A then receives the signal and tells the Node A OSC to resume transmitting and for the optical switch to pass incoming traffic.

6.5.2.3 Scenario 3: Fiber Cut in Nodes Using OPT-BST-L Cards

Figure 6-6 shows nodes using OPT-BST-L cards with a fiber cut between them.

Figure 6-6 Nodes Using OPT-BST-L Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-BST-L transmitter and OSCM lasers to shut down. This in turn leads to a LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM OSC transmitter and OPT-BST-L amplifier lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 6-6):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-O on the OPT-BST-L card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. The Node B power monitoring photodiode detects a LOS-P on the OPT-BST-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. On the OPT-BST-L card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
5. The OPT-BST-L card amplifier is shut down within three seconds.
6. The OSCM laser is shut down.
7. The OPT-AMP-L card automatically shuts down due to a loss of incoming optical power.
8. The Node A power monitoring photodiode detects a LOS-O on the OPT-BST-L card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. The Node A power monitoring photodiode detects a LOS-P on the OPT-BST-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. On the OPT-BST-L, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
11. The OPT-BST-L card amplifier is shut down within three seconds.
12. The OSCM laser is shut down.
13. The Node A OPT-AMP-L card automatically shuts down due to a loss of incoming optical power.

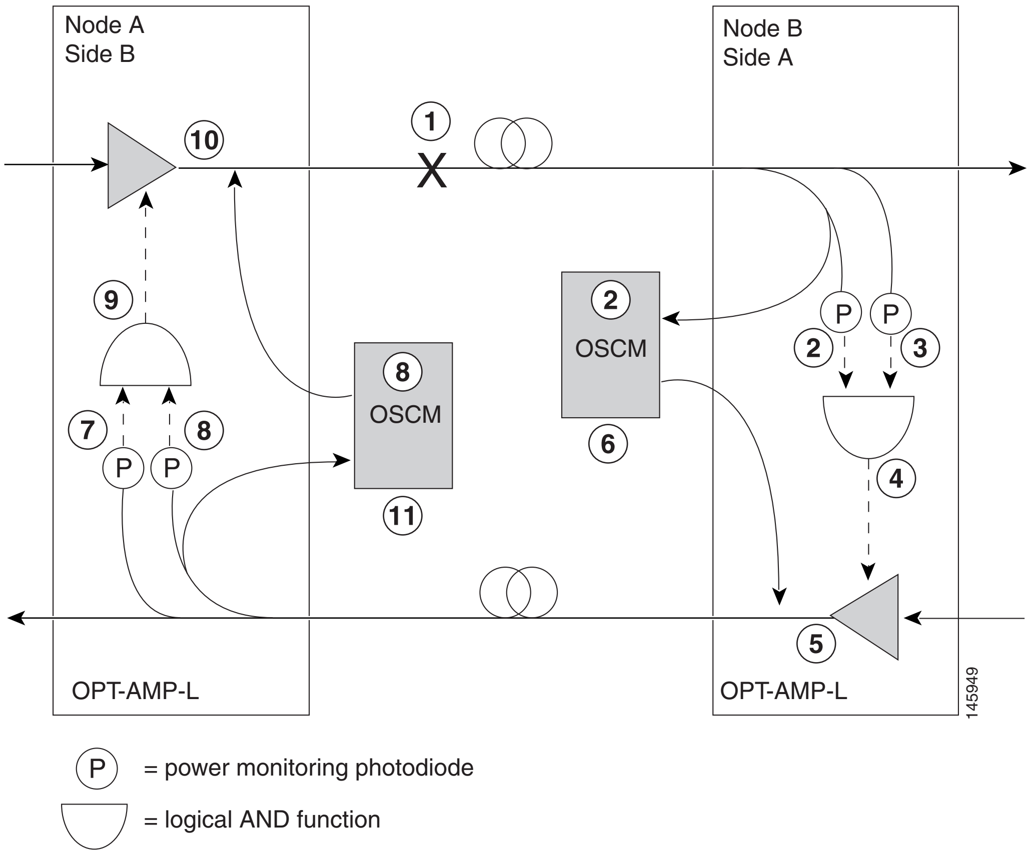
When the fiber is repaired, either an automatic or manual restart at the Node A OPT-BST-L transmitter or at the Node B OPT-BST-L transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse is used to signal that the optical path has been restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST-L transmitter to begin transmitting an optical signal. The OPT-BST-L receiver at Node A receives that signal and signals the Node A OPT-BST-L transmitter to resume transmitting.

Note During a laser restart pulse, APR (see the "6.5.1 Automatic Power Reduction" section on page 6-8) ensures that the laser power does not exceed Class 1 limits.

6.5.2.4 Scenario 4: Fiber Cut in Nodes Using OPT-AMP-L (OPT-BST Mode) Cards

Figure 6-7 shows nodes using OPT-AMP-L (in OPT-BST mode) cards with a fiber cut between them.

Figure 6-7 Nodes Using OPT-AMP-L Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-AMP-L amplifier transmitter and OSCM OSC lasers to shut down. This in turn leads to a LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM OSC and OPT-AMP-L amplifier lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 6-7):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-O on the OPT-AMP-L card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. The Node B power monitoring photodiode detects an LOS-P on the OPT-AMP-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. On the OPT-AMP-L card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
5. The OPT-AMP-L card amplifier is shut down within three seconds.
6. The OSCM laser is shut down.
7. The Node A power monitoring photodiode detects a LOS-O on the OPT-AMP-L card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

8. The Node A power monitoring photodiode detects a LOS-P on the OPT-AMP-L card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. On the OPT-AMP-L, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. The OPT-AMP-L card amplifier is shut down within three seconds.
11. The OSCM laser is shut down.

When the fiber is repaired, either an automatic or manual restart at the Node A OPT-AMP-L transmitter or at the Node B OPT-AMP-L transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse is used to signal that the optical path has been restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-AMP-L transmitter to begin transmitting an optical signal. The OPT-AMP-L receiver at Node A receives that signal and signals the Node A OPT-AMP-L transmitter to resume transmitting.

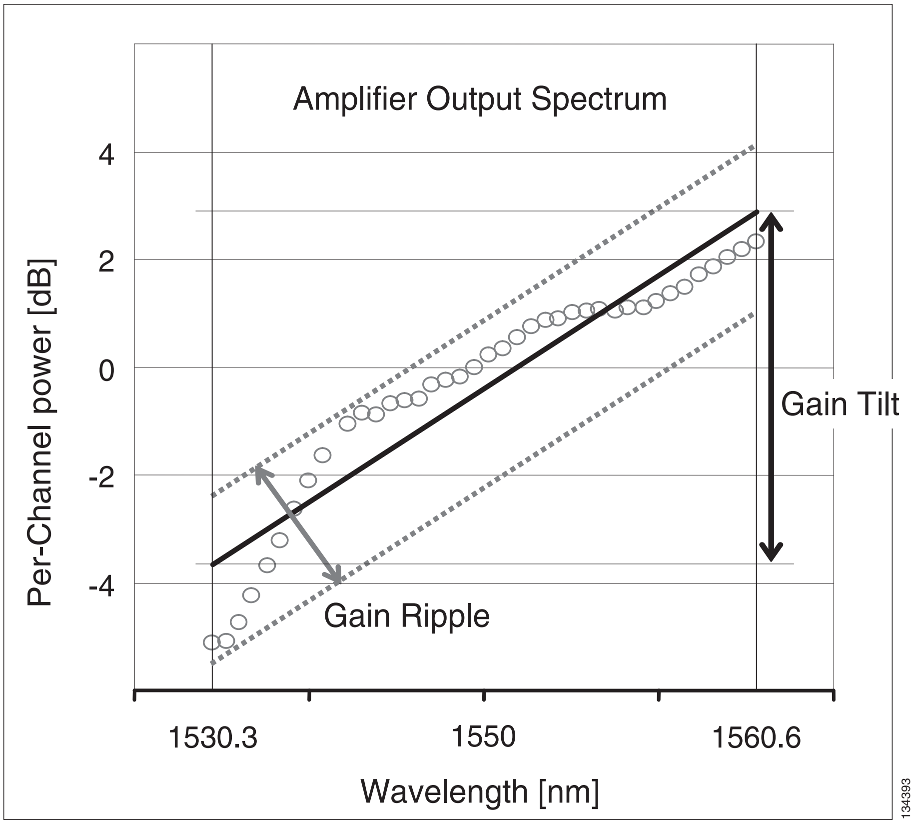
Note During a laser restart pulse, APR (see the "6.5.1 Automatic Power Reduction" section on page 6-8) ensures that the laser power does not exceed Class 1 limits.

6.6 Network-Level Gain-Tilt Management of Optical Amplifiers

The ability to control and adjust per-channel optical power equalization is a principal feature of ONS 15454 DWDM metro core network applications. A critical parameter to assure optical spectrum equalization throughout the DWDM system is the gain flatness of erbium-doped fiber amplifiers (EDFAs).

Two items, gain tilt and gain ripple, are factors in the power equalization of optical amplifier cards such as the OPT-BST and OPT-PRE. Figure 6-8 shows a graph of the amplifier output power spectrum and how it is affected by gain tilt and gain ripple.

Figure 6-8 Effect of Gain Ripple and Gain Tilt on Amplifier Output Power



Gain ripple and gain tilt are defined as follows:

- Gain ripple is random and depends on the spectral shape of the amplifier optical components.
- Gain tilt is systematic and depends on the gain setpoint (Gstp) of the optical amplifier, which is a mathematical function F(Gstp) that relates to the internal amplifier design.

Gain tilt is the only contribution to the power spectrum disequalization that can be compensated at the card level. A VOA internal to the amplifier can be used to compensate for gain tilt.

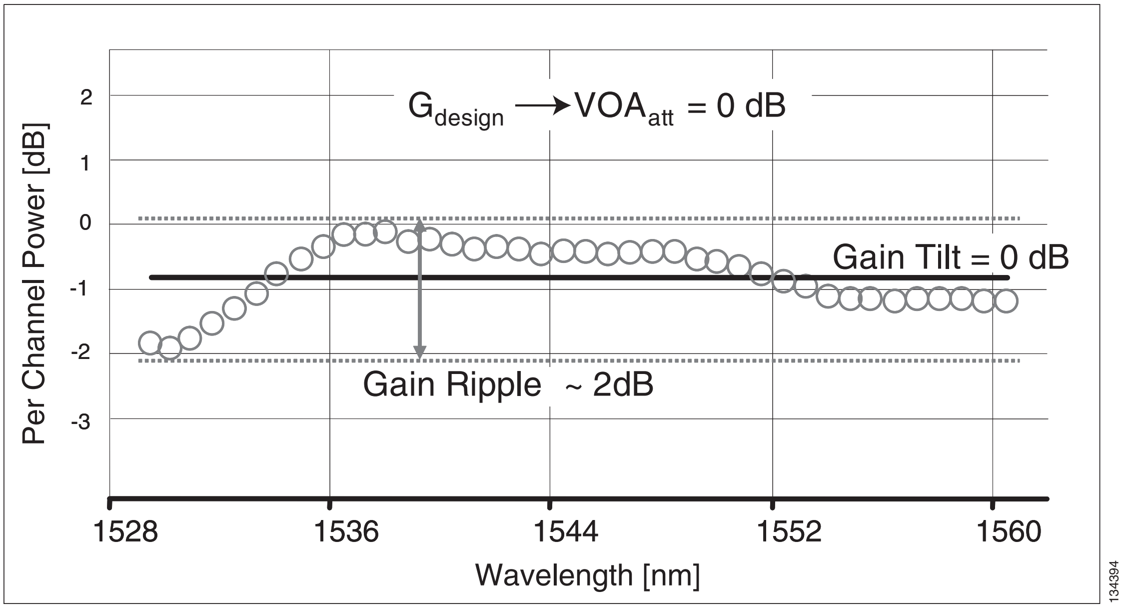
An optical spectrum analyzer (OSA) is used to acquire the output power spectrum of an amplifier. The OSA shows the peak-to-peak difference between the maximum and minimum power levels, and takes into account the contributions of both gain tilt and gain ripple.

Note Peak-to-peak power acquisition using an OSA cannot be used to measure the gain tilt, because gain ripple itself is a component of the actual measurement.

6.6.1 Gain Tilt Control at the Card Level

The OPT-BST and OPT-PRE amplifier cards have a flat output (gain tilt = 0 dB) for only a specific gain value (Gdesign), based on the internal optical design (see Figure 6-9).

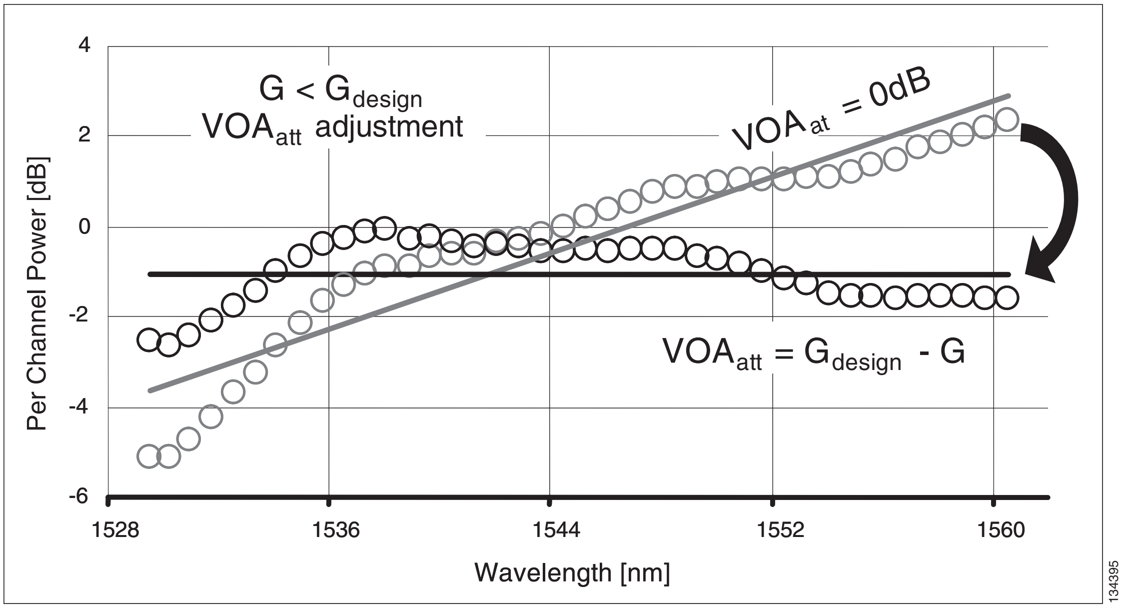
Figure 6-9 Flat Gain (Gain Tilt = 0 dB)



If the working gain setpoint of the amplifier is different from Gdesign, the output spectrum begins to suffer a gain tilt variation.

In order to compensate for the absolute value of the increase of the spectrum tilt, the OPT-BST and OPT-PRE cards automatically adjust the attenuation of the VOA to maintain a flat power profile at the output, as shown in Figure 6-10.

Figure 6-10 Effect of VOA Attenuation on Gain Tilt



The VOA attenuator automatic regulation guarantees (within limits) a zero tilt condition in the EDFA for a wide range of possible gain setpoint values.

Table 6-2 shows the flat output gain range limits for the OPT-BST and OPT-PRE cards, as well as the maximum (worst case) values of gain tilt and gain ripple expected in the specific gain range. OPT-AMP-L card can also function as an OPT-BST or OPT-PRE.

Table 6-2 Flat Output Gain Range Limits

Amplifier Card Type	Flat Output Gain Range	Gain Tilt (Maximum)	Gain Ripple (Maximum)
OPT-BST	G < 20 dB	0.5 dB	1.5 dB
OPT-PRE	G < 21 dB	0.5 dB	1.5 dB

If the operating gain value is outside of the range shown in Table 6-2, the EDFA introduces a tilt contribution for which the card itself cannot directly compensate. This condition is managed in different ways, depending the amplifier card type:

- OPT-BST—The OPT-BST amplifier is, by card design, not allowed to work outside the zero tilt range. Cisco MetroPlanner validates network designs using the OPT-BST amplifier card only when the gain is less than or equal to 20 dB.
- OPT-PRE—Cisco MetroPlanner allows network designs even if the operating gain value is equal to or greater than 21 dB. In this case, a system-level tilt compensation strategy is adopted by the DWDM system. A more detailed explanation is given in the "6.6.2 System Level Gain Tilt Control" section on page 6-19.

6.6.2 System Level Gain Tilt Control

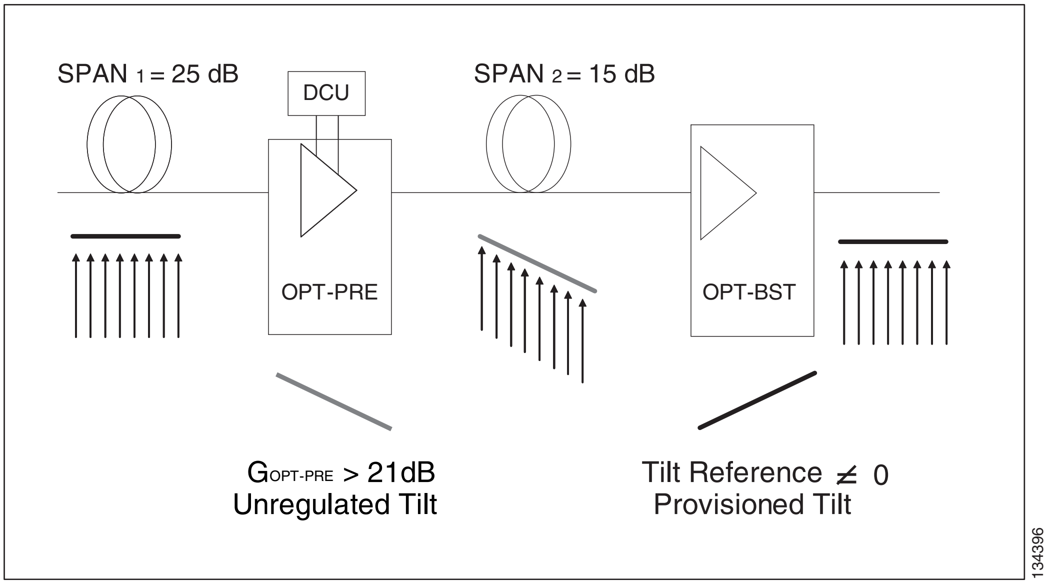
System level gain tilt control for OPT-PRE cards is achievable with two main scenarios:

- Without an ROADM node
- With an ROADM node

6.6.2.1 System Gain Tilt Compensation Without ROADM Nodes

When an OPT-PRE card along a specific line direction (west-to-east or east-to-west) is working outside the flat output gain range (G > 21 dB), the unregulated tilt is compensated for in spans not connected to ROADM nodes by configuring an equal but opposite tilt on one or more of the amplifiers in the downstream direction. The number of downstream amplifiers involved depends on the amount of tilt compensation needed and the gain setpoint of the amplifiers that are involved. See Figure 6-11.

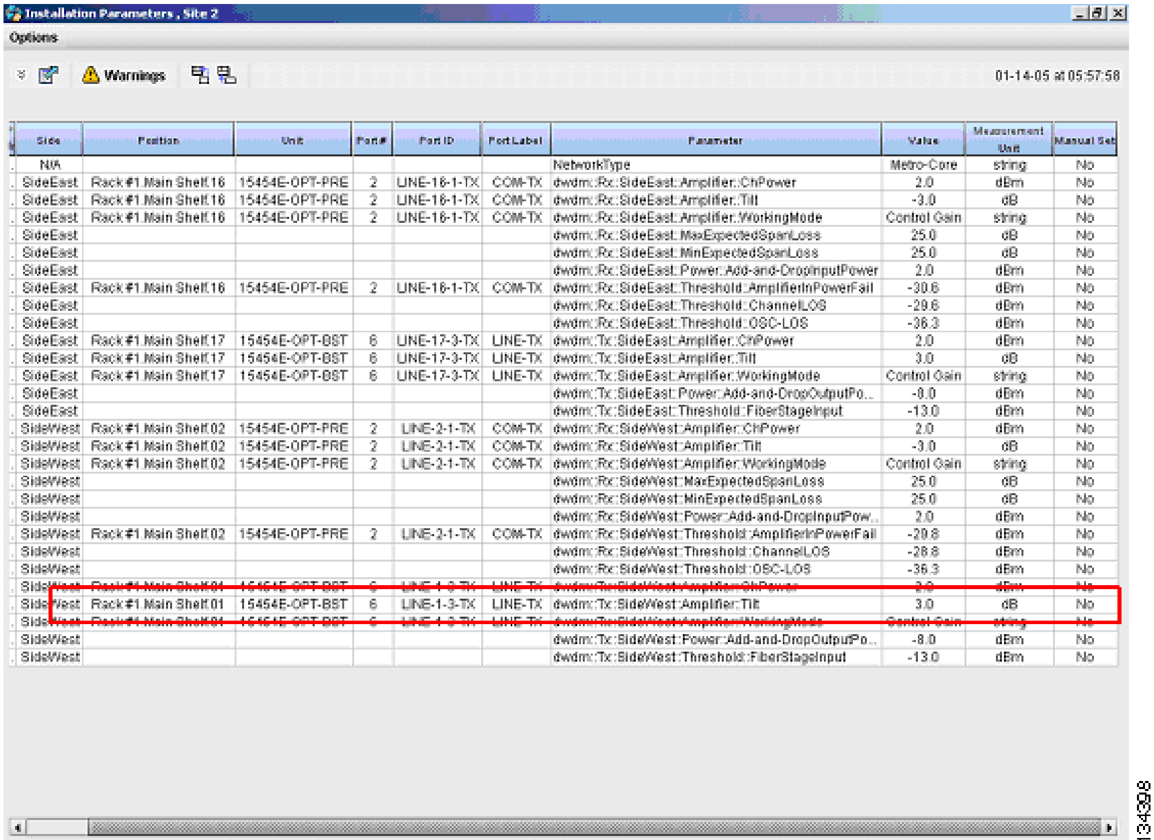
Figure 6-11 System Tilt Compensation Without an ROADM Node



The proper tilt reference value is calculated by Cisco MetroPlanner and inserted in the Installation Parameter List imported during the node turn-up process (see the "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*). For both OPT-PRE and OPT-BST cards, the provisionable gain tilt reference range is between –3 dB and +3 dB.

During the automatic node setup (ANS) procedure, the tilt value for the OPT-BST or OPT-PRE card is provisioned by the TCC2/TCC2P card (see Figure 6-12). The provisioned tilt reference value is reported in the CTC OPT-PRE or OPT-BST card view (in the Provisioning > Opt. Ampli. Line > Parameters > Tilt Reference tab).

Figure 6-12 Cisco MetroPlanner Installation Parameters



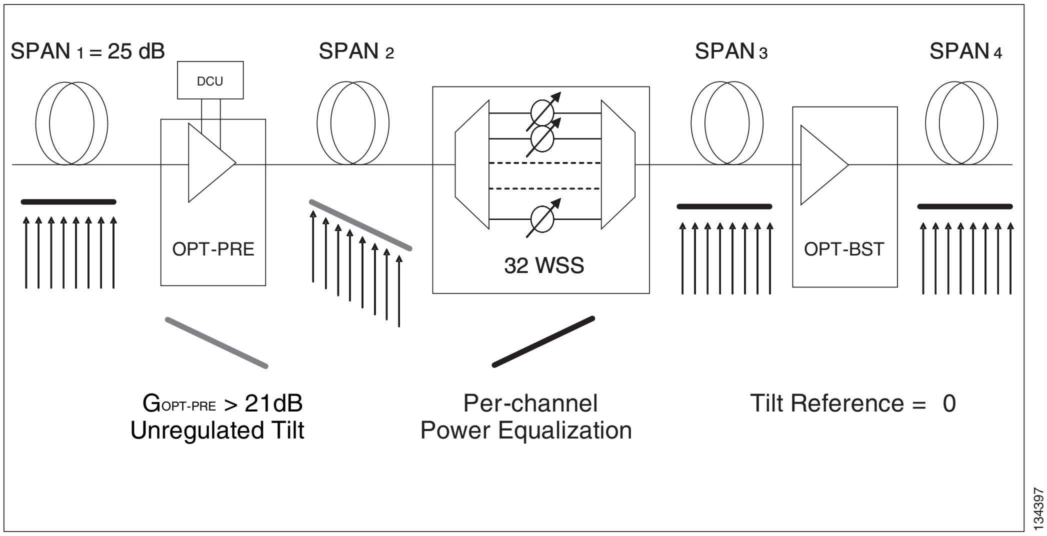
Side	Position	Unit	Port #	Port ID	Port Label	Parameter	Value	Measurement Unit	Manual Set
N/A						NetworkType	Metro-Core	string	No
SideEast	Rack #1 Main Shelf 16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::ChPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf 16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::Tilt	-3.0	dB	No
SideEast	Rack #1 Main Shelf 16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::WorkingMode	Control Gain	string	No
SideEast						dwdm::Rx::SideEast::MaxExpectedSpanLoss	25.0	dB	No
SideEast						dwdm::Rx::SideEast::MinExpectedSpanLoss	25.0	dB	No
SideEast						dwdm::Rx::SideEast::Power::Add-and-DropInputPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf 16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Threshold::AmplifierInPowerFail	-30.6	dBm	No
SideEast						dwdm::Rx::SideEast::Threshold::ChannelLOS	-29.6	dBm	No
SideEast						dwdm::Rx::SideEast::Threshold::OSC-LOS	-36.3	dBm	No
SideEast	Rack #1 Main Shelf 17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::ChPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf 17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::Tilt	3.0	dB	No
SideEast	Rack #1 Main Shelf 17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::WorkingMode	Control Gain	string	No
SideEast						dwdm::Tx::SideEast::Power::Add-and-DropOutputPo...	-8.0	dBm	No
SideEast						dwdm::Tx::SideEast::Threshold::FiberStageInput	-13.0	dBm	No
SideWest	Rack #1 Main Shelf 02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::ChPower	2.0	dBm	No
SideWest	Rack #1 Main Shelf 02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::Tilt	-3.0	dB	No
SideWest	Rack #1 Main Shelf 02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::WorkingMode	Control Gain	string	No
SideWest						dwdm::Rx::SideWest::MaxExpectedSpanLoss	25.0	dB	No
SideWest						dwdm::Rx::SideWest::MinExpectedSpanLoss	25.0	dB	No
SideWest						dwdm::Rx::SideWest::Power::Add-and-DropInputPow...	2.0	dBm	No
SideWest	Rack #1 Main Shelf 02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Threshold::AmplifierInPowerFail	-20.8	dBm	No
SideWest						dwdm::Rx::SideWest::Threshold::ChannelLOS	-28.8	dBm	No
SideWest						dwdm::Rx::SideWest::Threshold::OSC-LOS	-36.3	dBm	No
SideWest	Rack #1 Main Shelf 01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::ChPower	2.0	dBm	No
SideWest	Rack #1 Main Shelf 01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::Tilt	3.0	dB	No
SideWest	Rack #1 Main Shelf 01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::WorkingMode	Control Gain	string	No
SideWest						dwdm::Tx::SideWest::Power::Add-and-DropOutputPo...	-8.0	dBm	No
SideWest						dwdm::Tx::SideWest::Threshold::FiberStageInput	-13.0	dBm	No

6.6.2.2 System Gain Tilt Compensation With ROADM Nodes

When an ROADM node is present in the network, as shown in Figure 6-13, a per-channel dynamic gain equalization can be performed. Both gain tilt and gain ripple are completely compensated using the following techniques:

- Implementing the per-channel VOAs present inside the 32WSS
- Operating in Power Control Mode with the specific power setpoint designed by Cisco MetroPlanner

Figure 6-13 System Tilt Compensation With an ROADM Node



6.7 Automatic Node Setup

ANS is a TCC2/TCC2P function that adjusts values of the variable optical attenuators (VOAs) on the DWDM channel paths to equalize the per-channel power at the amplifier input. This power equalization means that at launch, all the channels have the same amplifier power level, independent from the input signal on the client interface and independent from the path crossed by the signal inside the node. This equalization is needed for two reasons:

- Every path introduces a different penalty on the signal that crosses it.
- Client interfaces add their signal to the ONS 15454 DWDM ring with different power levels.

To support ANS, the integrated VOAs and photodiodes are provided in the following ONS 15454 DWDM cards:

- AD-xB-xx.x card express and drop paths
- AD-xC-xx.x card express and add paths
- 4MD-xx.x card input ports
- 32MUX-O card input ports
- 32WSS card input ports
- 32DMX-O and 32DMX card output ports

Optical power is equalized by regulating the VOAs. Based on the expected per-channel power, ANS automatically calculates the VOA values by:

- Reconstructing the different channel paths
- Retrieving the path insertion loss (stored in each DWDM transmission element)

VOAs operate in one of three working modes:

- Automatic VOA Shutdown—In this mode, the VOA is set at maximum attenuation value. Automatic VOA shutdown mode is set when the channel is not provisioned to ensure system reliability in the event that power is accidentally inserted.

- Constant Attenuation Value—In this mode, the VOA is regulated to a constant attenuation independent from the value of the input signal. Constant attenuation value mode is set on the following VOAs:
  - OADM band card VOAs on express and drop paths (as operating mode)
  - OADM channel card VOAs during power insertion startup
  - Multiplexer/Demultiplexer card VOAs during power insertion startup
- Constant Power Value—In this mode, the VOA values are automatically regulated to keep a constant output power when changes occur to the input power signal. This working condition is set on OADM channel card VOAs as "operating" and on 32MUX-O, 32WSS, 32DMX-O, and 32DMX card VOAs as "operating mode."

In the normal operating mode, OADM band card VOAs are set to a constant attenuation, while OADM channel card VOAs are set to a constant power. ANS requires the following VOA provisioning parameters to be specified:

- Target attenuation (OADM band card VOA and OADM channel card startup)
- Target power (channel VOA)

To allow you to modify ANS values based on your DWDM deployment, provisioning parameters are divided into two contributions:

- Reference Contribution— (Display only) Set by ANS.
- Calibration Contribution—Set by user.

The ANS equalization algorithm requires the following knowledge of the DWDM transmission element layout:

- The order in which the DWDM elements are connected together on the express paths
- Channels that are dropped and added
- Channels or bands that have been configured as pass-through

ANS assumes that every DWDM port has a line direction parameter that is either west to east (W-E) or east to west (E-W). ANS automatically configures the mandatory optical connections according to following main rules:

- Cards equipped in Slots 1 to 6 have a drop section facing west.
- Cards equipped in Slots 12 to 17 have a drop section facing east.
- Contiguous cards are cascaded on the express path.
- 4MD-xx.x and AD-xB-xx.x are always optically coupled.
- A 4MD-xx.x absence forces an optical pass-through connection.
- Transmit (Tx) ports are always connected to receive (Rx) ports.

Optical patchcords are passive devices that are not autodiscovered by ANS. However, optical patchcords are used to build the alarm correlation graph. From CTC or TL1 you can:

- Calculate the default connections on the NE.
- Retrieve the list of existing connections.
- Retrieve the list of free ports.
- Create new connections or modify existing ones.
- Launch ANS.

After you launch ANS, one of the following statuses is provided for each ANS parameter:

- Success - Changed—The parameter setpoint was recalculated successfully.
- Success - Unchanged—The parameter setpoint did not need recalculation.
- Not Applicable—The parameter setpoint does not apply to this node type.
- Fail - Out of Range—The calculated setpoint is outside the expected range.
- Fail - Port in IS State—The parameter could not be calculated because the port is in service.

Optical connections are identified by the two termination points, each with an assigned slot and port. ANS checks that a new connection is feasible (according to embedded connection rules) and returns a denied message in the case of a violation.

ANS requires provisioning of the expected wavelength. When provisioning the expected wavelength, the following rules apply:

- The card name is generically characterized by the card family, and not the particular wavelengths supported (for example, AD-2C for all 2-channel OADMs).
- At the provisioning layer, you can provision a generic card for a specific slot using CTC or TL1.
- Wavelength assignment is done at the port level.
- An equipment mismatch alarm is raised when a mismatch between the identified and provisioned value occurs. The default value for the provisioned attribute is AUTO.

6.7.1 Automatic Node Setup Parameters

All ONS 15454 ANS parameters are calculated by Cisco MetroPlanner for nodes configured for metro core networks. (Parameters must be configured manually for metro access nodes.) Cisco MetroPlanner exports the calculated parameters to an ASCII file called NE Update. In CTC, you can import the NE Update file to automatically provision the node. Table 6-3 shows ANS parameters arranged in east and west, transmit and receive groups.

Table 6-3 ANS Parameters

Direction	ANS Parameters
West Side - Receive	• West Side Rx Max Expected Span Loss • West Side Rx Min Expected Span Loss • West Side Rx Amplifier Working Mode • West Side Rx Amplifier Ch Power • West Side Rx Amplifier Gain • West Side Rx Amplifier Tilt • West Side OSC LOS Threshold • West Side Channel LOS Threshold • West Side Rx Amplifier Input Power Fail Th • West Side Add and Drop Stage Input Power • West Side Add and Drop Stage Drop Power • West Side Add and Drop Stage Band (*n*) Drop Power (*n* = 1 to 8) • West Side Add and Drop Stage Channel (*n*) Drop Power (*n* = 1 to 32)
East Side - Receive	• East Side Rx Max Expected Span Loss • East Side Rx Min Expected Span Loss • East Side Rx Amplifier Working Mode • East Side Rx Amplifier Ch Power • East Side Rx Amplifier Gain • East Side Rx Amplifier Tilt • East Side OSC LOS Threshold • East Side Channel LOS Threshold • East Side Rx Amplifier Input Power Fail Th • East Side Add and Drop Stage Input Power • East Side Add and Drop Stage Drop Power • East Side Add and Drop Stage Band (*n*) Drop Power (*n* = 1 to 8) • East Side Add and Drop Stage Channel (*n*) Drop Power (*n* = 1 to 32)

Table 6-3 ANS Parameters (continued)

Direction	ANS Parameters
West Side - Transmit	• West Side Tx Amplifier Working Mode • West Side Tx Amplifier Ch Power • West Side Tx Amplifier Gain • West Side Tx Amplifier Tilt • West Side Fiber Stage Input Threshold • West Side Add and Drop Stage Output Power • West Side Add and Drop Stage By-Pass Power
East Side - Transmit	• East Side Tx Amplifier Working Mode • East Side Tx Amplifier Ch Power • East Side Tx Amplifier Gain • East Side Tx Amplifier Tilt • East Side Fiber Stage Input Threshold • East Side Add and Drop Stage Output Power • East Side Add and Drop Stage By-Pass Power

6.7.2 View and Provision ANS Parameters

All ANS parameters can be viewed and provisioned from the node view Provisioning > WDM-ANS > Provisioning tab, shown in Figure 6-14. The WDM-ANS > Provisioning > Provisioning tab presents the parameters in the following tree view:

root

+/– East

    +/– Receiving

        +/– Amplifier

        +/– Power

        +/– Threshold

    +/– Transmitting

        +/– Amplifier

        +/– Power

        +/– Threshold

+/– West

    +/– Receiving

        +/– Amplifier

        +/– Power

        +/– Threshold

    +/– Transmitting

+/– Amplifier

+/– Power

+/– Threshold

Figure 6-14 WDM-ANS Provisioning

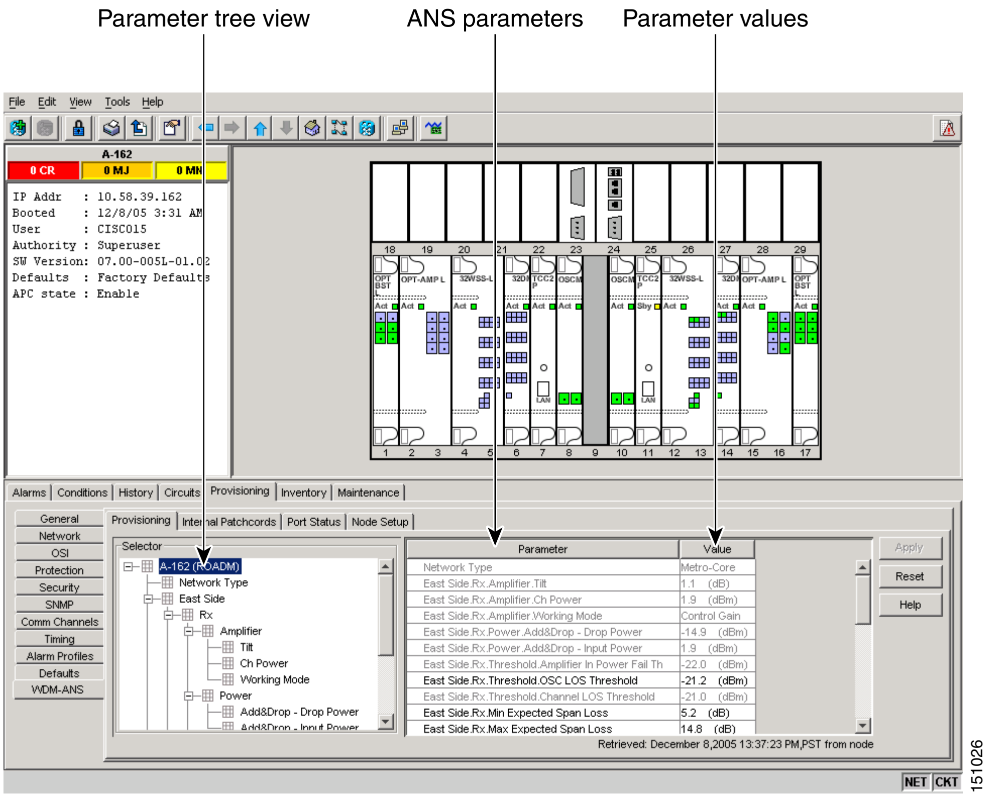


Table 6-4 shows the available parameters based on platform, line direction, and functional group.

Table 6-4 ANS-WDM > Provisioning Subtab Parameters

Tree Element	Parameters
root	Network Type (dwdm)
root +/– East +/– Receiving	East Side Rx Max Expected Span Loss East Side Rx Min Expected Span Loss
root +/– East +/– Receiving +/– Amplifier	East Side Rx Amplifier Working Mode East Side Rx Amplifier Ch Power East Side Rx Amplifier Gain East Side Rx Amplifier Tilt

Table 6-4 ANS-WDM > Provisioning Subtab Parameters (continued)

Tree Element	Parameters
root +/– East +/– Receiving +/– Power	East Side Add&Drop - Input Power East Side Add&Drop - Drop Power East Side Band *n* Drop Power (*n* = 1–8) East Side Channel *n* Drop Power East (*n* = 1–32)
root +/– East +/– Receiving +/– Threshold	East Side OSC LOS Threshold East Side Channel LOS Threshold East Side Rx Amplifier In Power Fail Th
root +/– East +/– Transmitting +/– Amplifier	East Side Tx Amplifier Working Mode East Side Tx Amplifier Ch Power East Side Tx Amplifier Gain East Side Tx Amplifier Tilt
root +/– East +/– Transmitting +/– Power	East Side Add&Drop - Output Power East Side Add&Drop - By-Pass Power
root +/– East +/– Transmitting +/– Threshold	East Side Fiber Stage Input Threshold
root +/– West +/– Receiving	West Side Rx Max Expected Span Loss West Side Rx Min Expected Span Loss
root +/– West +/– Receiving +/– Amplifier	West Side Rx Amplifier Working Mode West Side Rx Amplifier Ch Power West Side Rx Amplifier Gain West Side Rx Amplifier Tilt
root +/– West +/– Receiving +/– Power	West Side Add&Drop - Input Power West Side Add&Drop - Drop Power West Side Band *n* Drop Power (*n* = 1–8) West Side Channel *n* Drop Power (*n* = 1–32)
root +/– West +/– Receiving +/– Threshold	West Side OSC LOS Threshold West Side Channel LOS Threshold West Side Rx Amplifier In Power Fail Th
root +/– West +/– Transmitting +/– Amplifier	West Side Tx Amplifier Working Mode West Side Tx Amplifier Ch Power West Side Tx Amplifier Gain West Side Tx Amplifier Tilt
root +/– East +/– Transmitting +/– Power	West Side Add&Drop - Output Power West Side Add&Drop - By-Pass Power
root +/– West +/– Transmitting +/– Threshold	West Side Fiber Stage Input Threshold

The ANS parameters that appear in the WDM-ANS > Provisioning tab depend on the node type. Table 6-5 shows the DWDN node types and their ANS parameters.

Table 6-5 ANS Parameters By Node Type

Node Type	Parameter Group	Parameters
Hub	Network	Network Type
	Span Loss	East and West Expected Span Loss
	Amplifier Tx	East and West Side Transmit Amplifier Working Mode East and West Side Transmit Amplifier Channel Power East and West Side Transmit Amplifier Gain East and West Side Transmit Amplifier Tilt
	Amplifier Rx	East and West Side Receive Amplifier Working Mode East and West Side Receive Amplifier Channel Power East and West Side Receive Amplifier Gain East and West Side Receive Amplifier Tilt
	Thresholds Tx	East and West Side Fiber Stage Input Threshold
	Thresholds Rx	East and West Side Osc Los Threshold East and West Side Channel Los Threshold East and West Side Receive Amplifier Input Power Fail
	Power	East and West Side Add&Drop - Input Power East and West Side Add&Drop - Output Power East and West Side Add&Drop - By-Pass Power East and West Side Channel (*n*) Drop Power where *n* = 1-32

Table 6-5 ANS Parameters By Node Type (continued)

Node Type	Parameter Group	Parameters
Terminal	Network	Network Type
	Span Loss	East or West Expected Span Loss
	Amplifier Tx	East or West Side Transmit Amplifier Working Mode East or West Side Transmit Amplifier Channel Power East or West Side Transmit Amplifier Gain East or West Side Transmit Amplifier Tilt
	Amplifier Rx	East or West Side Receive Amplifier Working Mode East or West Side Receive Amplifier Channel Power East or West Side Receive Amplifier Gain East or West Side Receive Amplifier Tilt
	Thresholds Tx	East or West Side Fiber Stage Input Threshold
	Thresholds Rx	East or West Side Osc Los Threshold East or West Side Channel Los Threshold East or West Side Receive Amplifier Input Power Fail
	Power	East or West Side Add&Drop - Input Power East or West Side Add&Drop - Output Power East or West Side Channel (*n*) Drop Power (*n* = 1–32)
Flexible Channel Count Terminal	Network	Network Type
	Span Loss	East and West Expected Span Loss
	Amplifier Tx	East and West Side Transmit Amplifier Working Mode East and West Side Transmit Amplifier Channel Power East and West Side Transmit Amplifier Gain East and West Side Transmit Amplifier Tilt
	Amplifier Rx	East and West Side Receive Amplifier Working Mode East and West Side Receive Amplifier Channel Power East and West Side Receive Amplifier Gain East and West Side Receive Amplifier Tilt
	Thresholds Tx	East and West Side Fiber Stage Input Threshold
	Thresholds Rx	East and West Side Osc Los Threshold East and West Side Channel Los Threshold East and West Side Receive Amplifier Input Power Fail
	Power	East and West Side Add&Drop - Input Power East and West Side Add&Drop - Output Power East and West Side Band (*n*) Drop Power (*n* = 1–8)

Table 6-5 ANS Parameters By Node Type (continued)

Node Type	Parameter Group	Parameters
OADM	Network	Network Type
	Span Loss	East and West Expected Span Loss
	Amplifier Tx	East and West Side Transmit Amplifier Working Mode East and West Side Transmit Amplifier Channel Power East and West Side Transmit Amplifier Gain East and West Side Transmit Amplifier Tilt
	Amplifier Rx	East and West Side Receive Amplifier Working Mode East and West Side Receive Amplifier Channel Power East and West Side Receive Amplifier Gain East and West Side Receive Amplifier Tilt
	Thresholds Tx	East and West Side Fiber Stage Input Threshold
	Thresholds Rx	East and West Side Osc Los Threshold East and West Side Channel Los Threshold East and West Side Receive Amplifier Input Power Fail
	Power	East and West Side Add&Drop - Input Power East and West Side Add&Drop - Output Power East and West Side Band (*n*) Drop Power (*n* = 1–8)
Line Amplifier	Network	Network Type
	Span Loss	East and West Expected Span Loss
	Amplifier Tx	East and West Side Transmit Amplifier Working Mode East and West Side Transmit Amplifier Channel Power East and West Side Transmit Amplifier Gain East and West Side Transmit Amplifier Tilt
	Amplifier Rx	East and West Side Receive Amplifier Working Mode East and West Side Receive Amplifier Channel Power East and West Side Receive Amplifier Gain East and West Side Receive Amplifier Tilt
	Thresholds Tx	East and West Side Fiber Stage Input Threshold
	Thresholds Rx	East and West Side Osc Los Threshold East and West Side Channel Los Threshold East and West Side Receive Amplifier Input Power Fail

Table 6-5 ANS Parameters By Node Type (continued)

Node Type	Parameter Group	Parameters
ROADM	Network	Network Type
	Span Loss	East and West Expected Span Loss
	Amplifier Tx	East and West Side Transmit Amplifier Working Mode East and West Side Transmit Amplifier Channel Power East and West Side Transmit Amplifier Gain East and West Side Transmit Amplifier Tilt
	Amplifier Rx	East and West Side Receive Amplifier Working Mode East and West Side Receive Amplifier Channel Power East and West Side Receive Amplifier Gain East and West Side Receive Amplifier Tilt
	Thresholds Tx	East and West Side Fiber Stage Input Threshold
	Thresholds Rx	East and West Side Osc Los Threshold East and West Side Channel Los Threshold East and West Side Receive Amplifier Input Power Fail
	Power	East and West Side Add&Drop - Input Power (if a 32DMX east/west card is installed) East and West Side Add&Drop - Output Power East and West Side Add&Drop - Drop Power (if a 32DMX east/west card is installed) East and West Side Channel (n) Drop Power (if a 32DMX-O east/west card is installed) (*n* = 1–32)

Table 6-6 shows the following information for each ONS 15454 ANS parameter:

- Min—Minimum value in decibels.
- Max—Maximum value in decibels.
- Def—Default value in decibels. Other defaults include MC (metro core), CG (control gain), U (unknown).
- Group—Group(s) to which the parameter belongs: ES (east side), WS (west side), Rx (receive), Tx (transmit), Amp (amplifier), P (power), DB (drop band), DC (drop channel), A (attenuation), Th (threshold).
- Network Type—Parameter network type: MC (metro core), MA (metro access), ND (not DWDM)
- Optical Type—Parameter optical type: TS (32 channel terminal), FC (flexible channel count terminal), O (OADM), H (hub), LS (line amplifier), R (ROADM), U (unknown)

Table 6-6 ANS Parameters Summary

Parameter Name	Min	Max	Def	Group	Network Type	Optical Type
Network Type	—	—	MC	Root	MC, MA, ND	U, TS, FC, O, H, LS, R
West Side Rx Max Expected Span Loss	0	60	60	WS, Rx	MC, MA	TS, FC, O, H, LS, R

Table 6-6 ANS Parameters Summary (continued)

Parameter Name	Min	Max	Def	Group	Network Type	Optical Type
East Side Rx Max Expected Span Loss	0	60	60	ES, Rx	MC, MA	TS, FC, O, H, LS, R
West Side Rx Min Expected Span Loss	0	60	60	WS, Rx	MC, MA	TS, FC, O, H, LS, R
East Side Rx Min Expected Span Loss	0	60	60	ES, Rx	MC, MA	TS, FC, O, H, LS, R
West Side Tx Amplifier Working Mode	—	—	CG	WS, Tx, Amp	MC, MA, ND	TS, FC, O, H, LS, R
East Side Tx Amplifier Working Mode	—	—	CG	ES, Rx	MC, MA	TS, FC, O, H, LS, R
West Side Rx Amplifier Working Mode	—	—	CG	WS, Tx, Amp	MC, MA, ND	TS, FC, O, H, LS, R
East Side Rx Amplifier Working Mode	—	—	CG	ES, Rx	MC, MA	TS, FC, O, H, LS, R
West Side Tx Amplifier Ch Power	–10	17	2	WS, Tx, Amp	MC, MA, ND	TS, FC, O, H, LS, R
East Side Tx Amplifier Ch Power	–10	17	2	WS, Tx, Amp	MC, MA, ND	TS, FC, O, H, LS, R
West Side Rx Amplifier Ch Power	–10	17	2	WS, Tx, Amp	MC, MA, ND	TS, FC, O, H, LS, R
East Side Rx Amplifier Ch Power	–10	17	2	WS, Tx, Amp	MC, MA, ND	TS, FC, O, H, LS, R
West Side Tx Amplifier Gain	0	30	0	WS, Tx, Amp	MA	TS, FC, O, H, LS, R
East Side Tx Amplifier Gain	0	30	0	WS, Tx, Amp	MA	TS, FC, O, H, LS. R
West Side Rx Amplifier Gain	0	30	0	WS, Tx, Amp	MA	TS, FC, O, H, LS, R
East Side Rx Amplifier Gain	0	30	0	WS, Tx, Amp	MA	TS, FC, O, H, LS, R
West Side Tx Amplifier Tilt	0	30	0	WS, Tx, Amp	MC, MA	TS, FC, O, H, LS, R
East Side Tx Amplifier Tilt	0	30	0	WS, Tx, Amp	MC, MA	TS, FC, O, H, LS, R
West Side Rx Amplifier Tilt	0	30	0	WS, Rx, Amp	MC, MA	TS, FC, O, H, LS, R
East Side Rx Amplifier Tilt	0	30	0	WS, Rx, Amp	MC, MA	TS, FC, O, H, LS, R
West Side OSC LOS Threshold	–50	30	U	WS, Rx, Th	MC, MA	TS, FC, O, H, LS, R
East Side OSC LOS Threshold	–50	30	U	WS, Rx, Th	MC, MA	TS, FC, O, H, LS, R
West Side Channel LOS Threshold	–50	30	U	WS, Rx, Th	MC, MA	TS, FC, O, H, LS, R
East Side Channel LOS Threshold	–50	30	U	ES, Rx, Th	MC, MA, ND	TS, FC, O, H, LS, R
West Side Fiber State Input Threshold	–50	30	U	WS, Tx, Th	MC, MA, ND	TS, FC, O, H, LS, R
East Side Fiber State Input Threshold	–50	30	U	ES, Tx, Th	MC, MA, ND	TS, FC, O, H, LS, R
West Side Add&Drop - Output Power	–50	30	–14	WS, Tx, P	MC	TS, FC, O, H, R
East Side Add&Drop - Output Power	–50	30	–14	ES, Tx, P	MC	TS, FC, O, H, R
West Side Add&Drop - Input Power	–50	30	–14	WS, Rx, P	MC	TS, FC, O, H, R
East Side Add&Drop - Input Power	–50	30	–14	ES, Rx, P	MC	TS, FC, O, H, R
West Side Add&Drop - By-Pass Power	–50	30	–14	WS, Tx, P	MC	H
East Side Add&Drop - By-Pass Power	–50	30	–14	ES, Tx, P	MC	H
West Side Add&Drop - Drop Power	–50	30	–14	WS, Tx, P	MC	R
East Side Add&Drop - Drop Power	–50	30	–14	ES, Tx, P	MC	R
West Side Band 1...8 Drop Power	–50	30	–14	WS, Rx, P, DB	MC	FC, O
East Side Band 1...8 Drop Power	–50	30	–14	ES, Rx, P, DB	MC	FC, O

Table 6-6 ANS Parameters Summary (continued)

Parameter Name	Min	Max	Def	Group	Network Type	Optical Type
West Side Channel 1...32 Drop Power	–50	30	–14	WS, Rx, P, DC, B1	MC, MA	TS, H, R
East Side Channel 1...32 Drop Power	–50	30	–14	ES, Rx, P, DC, B1	MC, MA	TS, H, R